Fundamental Studies of the Surface Properties of Millerite under Different Pulp Potentials and Water Chemistry

by

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Abstract

Millerite (NiS) is one of the less common nickel-bearing minerals that is typically formed as a replacement for pentlandite ($(Fe,Ni)_9S_8$). Due to the scarcity of millerite, its flotation behavior is not well understood in literature. In this study, the surface properties of millerite were investigated. Cyclic voltammetry coupled with Fourier-transform infrared spectroscopy (FTIR) and contact angle measurements were used to study xanthate adsorption on millerite surface under different pulp potentials and water chemistry. In addition, micro-flotation tests were conducted on single and mixed mineral systems to evaluate the possibility of millerite depression from chalcopyrite by controlling pulp potentials.

Studies on electrochemistry and wettability at pH 9 suggest that nickel (II) ethyl xanthate forms initially at a lower potential and is responsible for imparting a slight hydrophobicity to millerite surface. As the potential is increased above the reversible potential for dixanthogen formation (Eh = 0.16 V for 1.4 x 10^{-4} M KEX), a steep increase in anodic current along with increased hydrophobicity was observed. This indicates that at higher potentials dixanthogen becomes the predominate species formed and is responsible for increased hydrophobicity observed for millerite.

At pH 12, the oxidation of millerite surface occurred above Eh = 0.1 V (SHE), which created a hydrophilic layer that prevented the xanthate from adsorbing on the millerite surface. X-ray photoelectron spectroscopy analysis of the oxidized millerite surface identified the presence of $Ni(OH)_2$ and $NiSO_4$ species. Micro-flotation studies showed that millerite recovery decreased with increasing potential under oxidizing conditions at pH 12. Mixed mineral flotation studies showed that millerite and chalcopyrite are both strongly floatable under open circuit potential at pH 12. However, as potential is increased to more oxidizing conditions (above 0.2 V), chalcopyrite remains strongly floatable while millerite becomes depressed. This finding showed that a large oxidizing potential range exists where chalcopyrite can be potentially separated from millerite at pH 12. In conclusion, this study investigated a

pathway for millerite separation from chalcopyrite through controlling pulp potentials, which is important for improving copper concentrate quality in the Cu/Ni mining industry.

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Table of Contents

List of Tables

List of Figures

Chapter 1 Introduction

1.1 Nickel Resources

Nickel is a naturally occurring base metal with high resistance to corrosion and oxidation. Nickel is widely used in alloy production with other metals to enhance their strength and resistance to heat and corrosion (Boland, 2012; Kuck, 2012). Nickel is estimated to be the fifth most abundant element on earth. Contrary to its ranking, most of nickel are deposited in the core of the earth and are not readily accessible (Boland, 2012). The majority of nickel used today comes from the two nickel deposits found in earth's crust in the form of magmatic nickel sulphide and nickeliferous laterite deposits (Boland, 2012). The largest nickel sulphide deposit is located in Canada in the Sudbury district of Ontario and the Thompson district of Manitoba (Cornwall, 1966). The most abundant nickel sulphide mineral of economic interest is pentlandite ($(Ni,Fe)_8S_9$). Millerite (NiS) is one of the less common nickel sulphide mineral that is typically formed as a replacement for pentlandite. Millerite is found along the margins of copper rich orebodies in the Sudbury region along with varying amounts of pentlandite, chalcopyrite ($CuFeS_2$), and bornite (Cu_5FeS_4).

Glencore's Strathcona Mill located in the Sudbury region processes ores from the two Sudbury mines as well as ores from third party custom feed. The simplified flowsheet of the mill is present in Figure 1.1. The facility feed consists mostly of copper, nickel and iron sulfides, which undergoes rougher separation to remove the iron sulfide from the copper and nickel sulfides. The cleaner circuit then aims to separate out copper and nickel sulfides. The copper-nickel separation is operated at saturated lime conditions at pH > 12. A high circulating load is also employed in order to concentrate the copper while allowing for the removal of nickel sulphides.

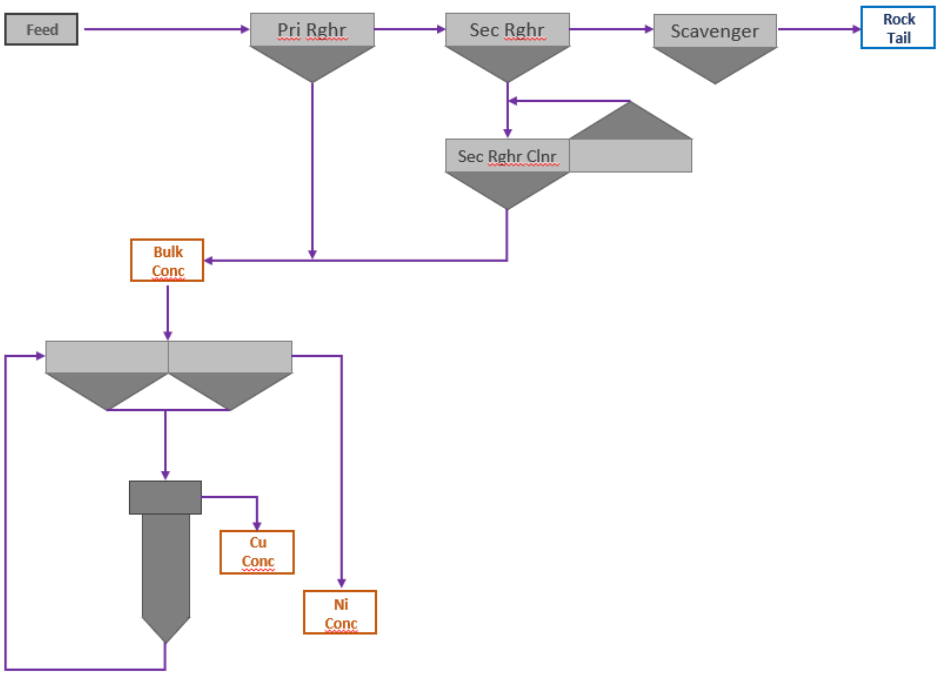

Figure 1.1: Simplified Schematic of Glencore's Strathcona Mill flowsheet

The copper concentrate consists mostly of chalcopyrite, along with small fractions of other associated sulphide minerals (bornite, cubanite, pyrrhotite, pentlandite and millerite). The targeted nickel grade for the copper concentrate steam is less than 0.5% Ni. Nickel is one of the undesired elements in the copper concentrate that is penalized above the threshold level set by smelters. Recently with the emergence of higher millerite bearing ores in the Sudbury region, millerite has become a topic of interest at the Sudbury Mill. The copper concentrate at Sudbury Mill experienced periodical fluctuations resulting in higher nickel impurities due to millerite being floated along with chalcopyrite to the copper concentrates. At 64.67% Ni content, if not successfully separated, millerite can greatly reduce the value of the copper concentrate. In addition, Ni value in the nickel concentrate is decreased due to the millerite misreporting to the copper concentrate.

Asides from Glencore's Sudbury Mill, Vale's Clarabelle Mill in Ontario also encountered similar issues in nickel-copper separation. Xu et al. (2011) studied the copper-nickel separation process at

Clarabelle Mill and found that millerite was responsible for the increased Ni% grade in the copper concentrates when processing copper rich ore. From detailed mineralogical investigations it was discovered that the copper rich ore contained a higher percentage of millerite in comparison to typical Sudbury nickel ore.

The aim of this study is to devise a strategy for millerite removal from copper concentrate. The bulk concentrate that feeds into the copper-nickel cleaner contains collectors added from previous processes. Therefore, it is most likely that millerite already has collectors pre-adsorbed to the surface at the copper-nickel separation process.

In this study, the collector adsorption process and flotation behavior of millerite were investigated. It was discovered that millerite separation from chalcopyrite is achievable at pH 12 using potential control. However, this discovery required pre-conditioning of the millerite surface at an oxidizing potential to prevent the collector adsorption process. This discovery differs from the current operating scheme at Strathcona Mill where collectors are already adsorbed to the millerite surface. Modification of the flotation circuit is required to conduct the pre-conditioning step. Currently, millerite does not present a major issue in copper-nickel separation due to the low percentages present in the bulk concentrate. However, it is predicted that eventually ores containing higher millerite percentages will be processed and millerite will become a significant issue later on. Therefore, modifications to the flotation circuit could be implemented when millerite becomes a significant issue in copper-nickel separation. This study investigated the mechanisms behind millerite floatability and provided insights for the development of the modified flotation circuit for the copper-nickel separation process.

1.2 Millerite

Millerite is a nickel sulphide mineral with an atomic ratio of 1:1 nickel to sulfur, and the composition of a pure millerite is shown in Table 1.1. Millerite is formed as a common metamorphic replacement of pentlandite within serpentinite ultramafic bodies with radiating cluster of acicular needles (Haldar, 2016). W.H. Miller, Professor of Mineralogy at Cambridge, first described millerite in 1842, and the mineral is later named in his honor by Haidinger in 1845 (Miller, 1842; Haidinger, 1845). Millerite has a metallic luster with the color ranging from pale brass-yellow to bronze. The specific gravity of millerite ranges from 5.3 - 5.5 and the hardness of millerite ranges from 3.0 - 3.5 on Moh's scale.

Table 1.1: The composition of millerite in weight percentage

Millerite (NiS)	
Element	wt%
Nickel	64.67%
Sulfur	35.33%
Total	100%

Two polymorphs exist for NiS depending on the temperature. Beta-NiS is the stable phase below 400°C, and NiAs-type structure occurs at higher temperatures (Rajamani V, 1974). Millerite occurs in nature only in the low temperature form. The low temperature millerite belongs to space group R3M with the lattice parameters a = 9.619 Å, b = 9.619 Å, and c = 3.150 Å. The crystal structure of beta millerite is shown in Figure 1.2.

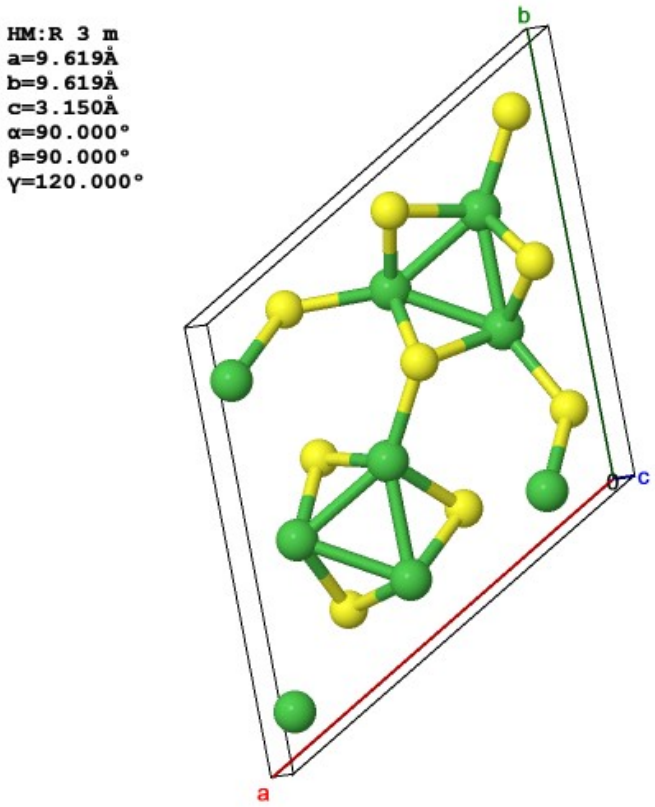

Figure 1.2: JMOL 3-D structure of beta millerite (Downs & Hall-Wallace, 2003)

1.3 References

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Chapter 2 Literature Review

2.1 Flotation of Sulphide Minerals

Froth flotation is a method that is typically employed to concentrate valuable minerals from gangue. This technique employs separation based on hydrophobicity differences of the minerals in a flotation cell. More hydrophobic minerals will attach to air bubbles and are floated upwards while more hydrophilic minerals settle down to the bottom of the cell. The hydrophobicity differences between the concentrate and gangue can be further altered through the addition of collectors. Froth flotation was first employed in sulfide mineral flotation at Broken Hill mine in Australia. With this development valuable metals was able to be concentrated and separated from its associated gangue minerals (Bunyak, 2000). Sulfide mineral flotation has been widely studied in the past and as a group these minerals exhibit common properties that can be used to study their behavior systematically. Chander et al (1985) proposed categorization of sulphide minerals into two types, namely, reversible and irreversible sulphides. Reversible sulphides have the properties that can be predicted from thermodynamics. Irreversible sulphides are often affected by the surface coverage of oxidation-reduction reactions. Thus, its behavior requires the consideration of time effects on mineral surface properties.

2.1.1 Collectorless Flotation

To gain a better understanding of the flotation behavior of millerite, an understanding of sulphide mineral flotation in general is required. Investigations conducted in Australia and United States have demonstrated that many sulfide minerals can under certain conditions exhibit collectorless floatability and be floated without collector addition (M.C. Fuerstenau & Sabacky, 1981; Gardner & Woods, 1979; Heyes & Trahar, 1977).The reasons behind the collectorless floatability of sulphide minerals may vary.

Previous studies implied that sulphide minerals oxidize through a continuum of metal deficient sulphides to elemental sulfur by reactions of the type in Equation (2.1) and (2.2) (Wills & Napier-munn, 2006):

in acidic solutions:

$$MS \rightarrow M_{1-x}S + xM^{2+} + 2xe^{-} \tag{2.1}$$

and in alkaline solutions:

$$MS + xH_2O \rightarrow M_{1-x}S + xMO + 2xH^{+} + 2xe^{-} \tag{2.2}$$

Buckley et al (1985) have proposed that these sulfur rich metal deficient layers or elemental sulfur formed under oxidizing conditions can render the mineral hydrophobic.

Other reasons for collectorless flotation of sulphide minerals were also proposed, and a detailed review have been conducted by Maurice C. Fuerstenau, Chander, & Woods (2009). In most cases the flotation behavior depends on the mineral surface which is altered readily by chemical and electrochemical manipulations.

2.1.2 Electrochemistry of Sulphide Mineral Flotation

Collectors are used in froth flotation to increase the hydrophobicity of the mineral surface to allow for successful flotation. Collectors impart hydrophobicity to the minerals through adsorption onto the mineral surfaces; and the most widely used collectors are sulfhydryl compounds which possesses a polar thiol group. Xanthates are a group of widely used thiol collectors. Xanthate collectors have a non-polar hydrocarbon tail (-R) and a polar head group (-O-C=SS-). The polar head group is hydrophilic and is able to adsorb onto the mineral surface, while the non-polar tail group is oriented away from the surface that can then impart hydrophobicity to the mineral surface as shown in *Figure 2.1*. Xanthates are named depending

on the chain length of the non-polar group and the cation attached to the polar group. A schematic of sodium ethyl xanthate is shown in Figure 2.2.

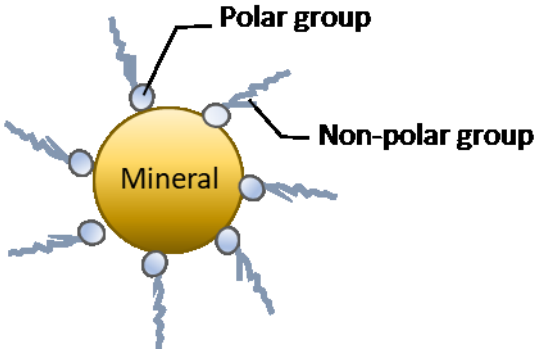

Figure 2.1: Schematic depiction of xanthate collector adsorption onto mineral surface

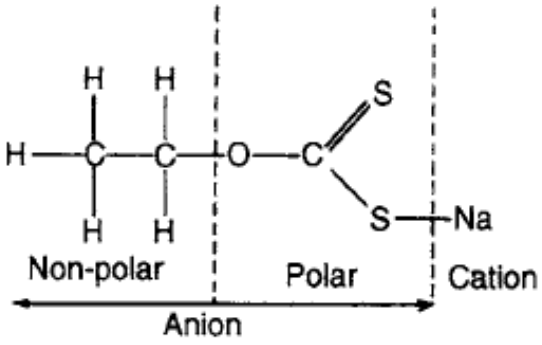

Figure 2.2: Structure of sodium ethyl xanthate (Wills & Napier-munn, 2006)

Reactions of xanthate with sulphide minerals have been a topic of research for many years. Xanthate adsorption is a mixed potential mechanism with anodic oxidation of xanthate coupled with a cathodic counterpart. This is typically provided through the reduction of oxygen (Ronald Woods, 1996). Identification of surface reactivity and chemical compounds formed at the surface is important in understanding the flotation behaviours of sulphide minerals. The interaction of xanthate on the sulphide mineral can occur through various pathways. Anodic oxidation of xanthate could yield chemisorbed xanthate ion (X^-), metal xanthate (MX) or dixanthogen (X_2) (Woods, 1984). To illustrate the possible

xanthate adsorption mechanisms on millerite surface, reactions for xanthate adsorption are listed below (Maurice C. Fuerstenau et al., 2009):

Chemisorbed xanthate:

$$X^- \rightarrow X_{ads} + e^- \tag{2.3}$$

Oxidation of xanthate to dixanthogen:

$$2X^- \rightarrow X_2 + 2e^- \tag{2.4}$$

Xanthate reaction with sulphide mineral to form metal xanthate compound:

$$X^- + MS \rightarrow MX + S^0 + e^- \tag{2.5}$$

Formation of metal xanthate compound through ion exchange on mineral surface that have prior oxidation on its surface:

$$MS + H_2O \rightarrow MO + S + 2H^+ + 2e^-; \quad MO + 2X^- \rightarrow 2MX^- \tag{2.6}$$

All of the above xanthate oxidation products impart hydrophobicity to the mineral surface. Due to the electrochemical nature of the xanthate interaction mechanism with sulphide minerals, electrochemical investigations could be used to study the adsorption mechanism of xanthate on sulphide minerals. The flotation recovery then becomes a function of the potential (Eh) applied to the mineral surface. A relationship could be established for pulp Eh versus mineral recovery. Different sulphide minerals exhibit different responses to Eh of the solution depending on the mineral's interaction mechanism. Selective flotation of minerals can then be achieved through the manipulation of the parameters of flotation such as Eh and pH to allow for separation of different mineral species.

Xanthate adsorption mechanism is controlled by the mixed potential mechanism and the oxidation products can be predicted from thermodynamics based on the reaction mechanism of xanthate with the mineral surface. Studies of the interaction between xanthate and sulfide minerals provide valuable information regarding the xanthate oxidation products. This information could then be used to allow for the optimization of flotation recovery. Pentlandite is an iron-nickel sulphide having formula of $(Fe,Ni)_9S_8$. Xanthate adsorption mechanisms on pentlandite have previously been studied by Hodgson & Agar (1989) and McNeil et al. (1994). McNeil et al. (1994) studied xanthate adsorption on pentlandite via UV spectrophotometry and proposed the formation of both dixanthogen (X_2) and nickel xanthate species (NiX_2). Hodgson & Agar (1989) employed electrochemical investigations via cyclic voltammetry to study xanthate adsorption mechanisms on pentlandite. They proposed that xanthate adsorbs initially via chemisorption onto the pentlandite surface and then it is oxidized to dixanthogen at higher potential.

2.1.3 Effect of pH on Flotation

The first systematic results on the role of pH in sulfide mineral flotation were investigated by Gaudin (Douglas W Fuerstenau, 2005; Gaudin, 1929). Gaudin demonstrated that mineral selectivity is dependent on pH and that it was possible to separate minerals through pH control. Sutherland & Wark (1955) investigated the relationship between concentration of collector (sodium diethyl dithiophospahte) and pH; their results are shown below in Figure 2.3. Sutherland et al. demonstrated that a critical pH value exists for minerals below which the mineral does not float and above which the mineral will float. This critical pH is dependent on the mineral type as well as collector selected. Both Gaudin and Sutherland demonstrated the importance of pH control in flotation of sulphide minerals and showed that pH plays an important role in the selectivity of sulphide mineral flotation (Gaudin, 1929; Sutherland, 1955).

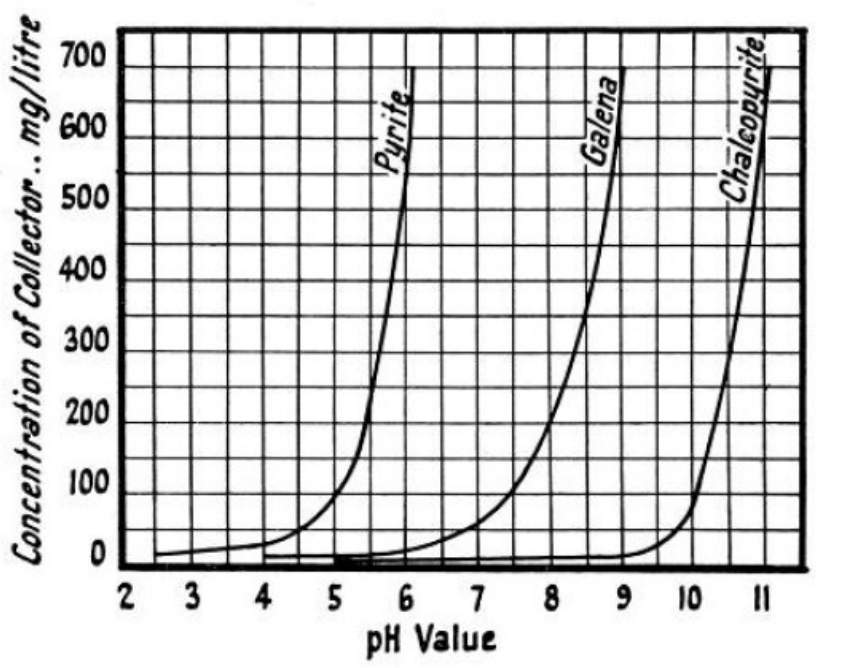

Figure 2.3: Relationship of sodium diethyldithiophosphate as a function of critical pH value (Douglas W Fuerstenau, 2005; Sutherland & Wark, 1955)

The role of pH in flotation is very complex, hydroxyl and hydrogen ions can modify the electric double layer and zeta (ζ) potential surrounding the mineral particles that in turn affects the hydration of the surfaces and the floatability of sulphide minerals (Wills & Napier-munn, 2006). Sulphide mineral flotation is typically carried out in alkaline environments since most collectors are stable under alkaline conditions. A simplified schematic of the electric double layer is shown in *Figure 2.4*.

Fuerstenau & Modi (1956) proposed an electrostatic model of flotation under which physisorbed collectors function as counter ions in the electric double layer. The point of zero charge (PZC) can then be related to the adsorption phenomenon of collectors. PZC defines the conditions when the electrical charge density of the surface is zero. When PZC > 0, flotation should respond to anionic (-) collectors; when PZC < 0, flotation should correspond to cationic (+) collectors.

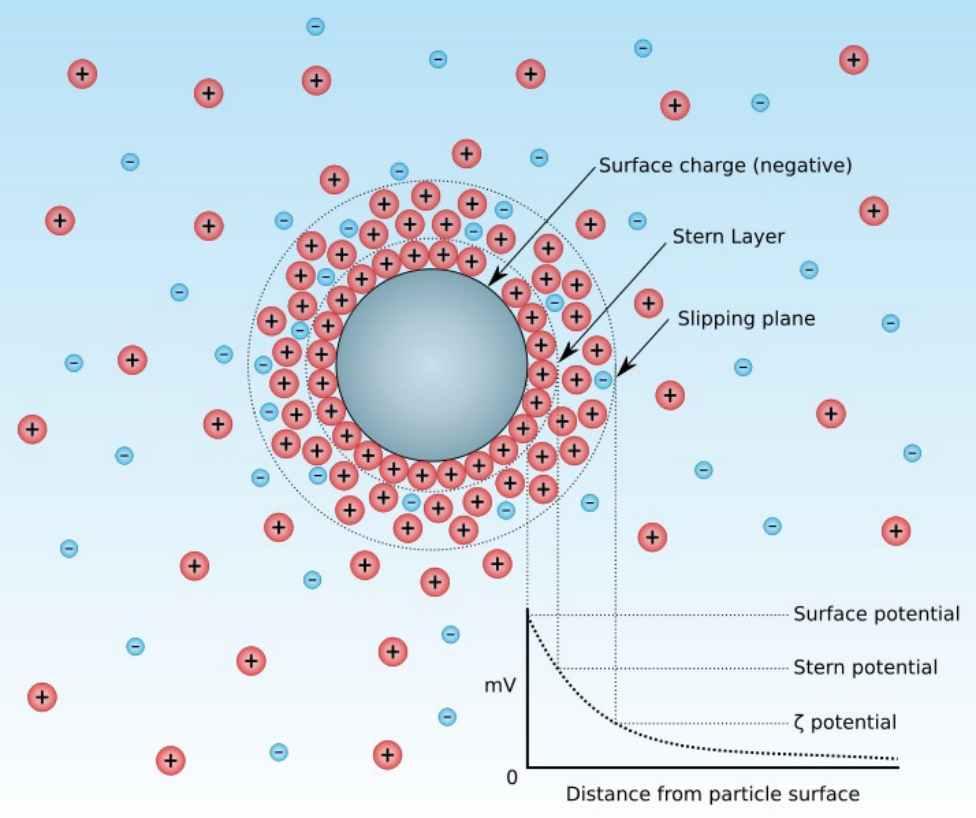

Figure 2.4: Diagram showing the ionic strength and potential difference as a function of distance from the charged surface of a particle suspended in a dispersion medium (Wikimedia Commons, 2012)

2.1.4 Eh-pH Diagrams

The degree of oxidation of the mineral surface greatly influences flotation recovery and selectivity. An understanding of how the mineral surface behaves under different Eh and pH conditions is vital in understanding the flotation behaviour of the mineral. Eh-pH diagrams were first developed by Pourbaix in 1963 and was named in his honor (Pourbaix, 1963). Eh-pH diagrams are constructed from thermodynamic information and provide the equilibrium and stability information of the system. Eh-pH diagrams can be used to identify the stability of the mineral at a given Eh and pH. Pourbaix diagrams can be constructed using stability equations of the mineral systems. The stability equations are derived based

on modified Nernst equation and Gibbs free energy of formation of the metal and its species. The modified Nernst equation is derived below:

Electrochemical cells are capable of doing working and can be measured as a change in free energy:

$$\Delta G = -n\mathcal{F}E \tag{2.7}$$

For a system at chemical equilibrium:

$$\Delta G^\circ = -n\mathcal{F}E^\circ\,; \quad \Delta G^\circ = -RT\,ln\,K_{eq} \tag{2.8}$$

Nernst equation for electrochemical cell

$$\Delta G = \Delta G^\circ + RT\,ln\,Q \tag{2.9}$$

where:

ΔG— standard free energy change

ΔG°— standard free energy change under standard conditions

n— e^- transferred in the reaction

$\mathcal{F}$— Faraday's constant $\mathcal{F} = 23.06\ \text{kcal/V}$

E— cell potential (V)

E°— standard cell potential (V)

RT— under standard conditions $R = 1.9872x10^{-3}\ \frac{kcal}{mol \cdot K}$, $T = 298\text{K}$

Q— reaction quotient

for a general electrochemical reaction:

$$rR + wH_2O = pP + hH^+ + ne^-$$

subbing (2.7) and (2.8) into (2.9) and manipulating the Nernst equation for a general electrochemical reaction yields (2.10) (Verink, 2011):

$$E = E° + \frac{0.0591}{n} log \frac{(\alpha_P)^p (\alpha_{H^+})^h}{(\alpha_R)^r (\alpha_{H_2O})^w} \quad (2.10)$$

taking $\alpha_{H_2O} = 1$, and $pH = -log\alpha_{H^+}$ (2.10) could be simplified into (2.11) (Verink, 2011):

$$E = \frac{\Delta G°}{n\mathcal{F}} + \frac{0.0591}{n} log \frac{(\alpha_P)^p}{(\alpha_R)^r} + \frac{[-0.0591h]}{n} pH \quad (2.11)$$

where:

$$\Delta G° = \sum \Delta G_f^\circ \text{ (reactants)} - \sum \Delta G_f^\circ \text{ (products)}$$

ΔG_f°— standard free energy of formation can be obtained from thermodynamic database

Pourbaix diagram could be constructed using equation (2.11) and equations for electrochemical reactions and equilibrium formulas. The Eh-pH diagram of millerite was constructed by Stamboliadis (1976) and shown below in Figure 2.5, the substances considered for the construction of the stability diagram are shown in Table 2.1.

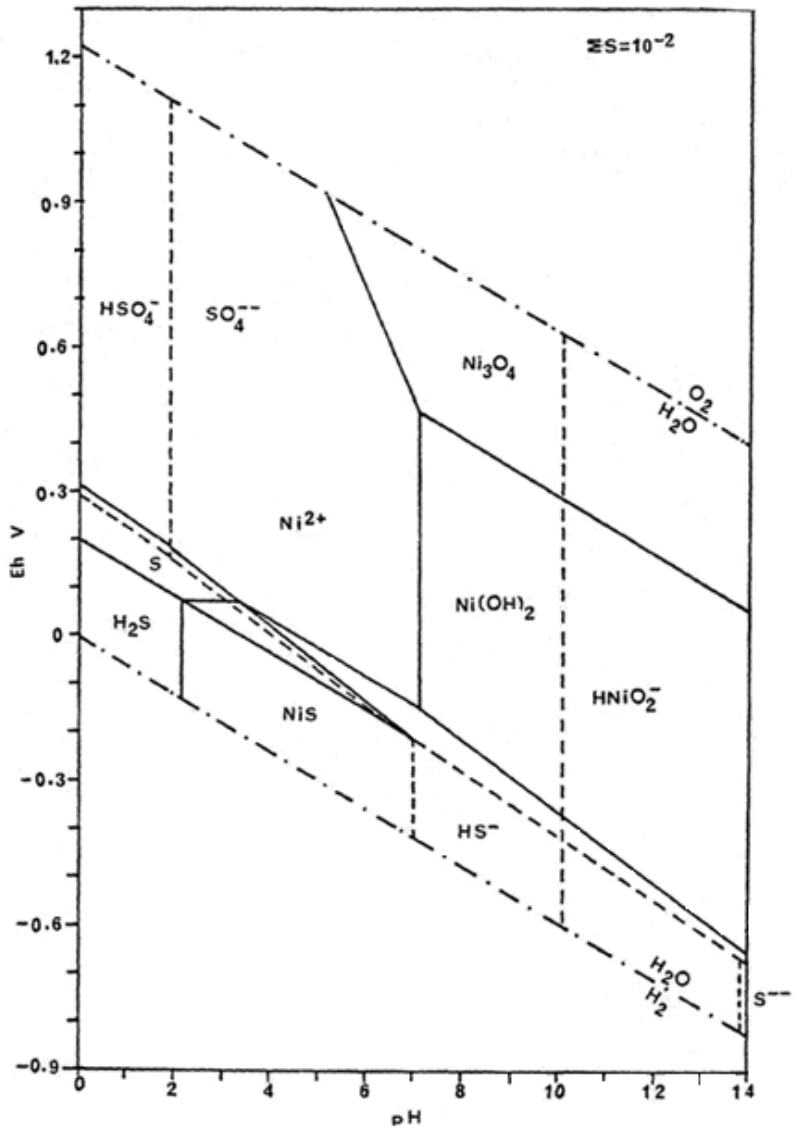

Figure 2.5: The stability diagram for millerite (Stamboliadis, 1976)

Table 2.1: Substances considered for the millerite stability diagram reproduced from (Stamboliadis, 1976)

Phase	Substance	ΔF˚, Kcal	Name
Solid	NiS	-17.7	Millerite
	$Ni(OH)_2$	-108.3	Nickel hydroxide
	$Ni_3O_4.2H_2O$	-283.5	Dihydrated Nickelonickelic oxide
Dissolved	Ni^{2+}	-11.5	Nickel ion
	$HNiO_2^-$	-83.46	Dinickelite ion

2.2 Previous investigations of Millerite Flotation

The flotation behaviors of pentlandite and chalcopyrite are both well defined in literature (Bozkurt, 1998; Fairthorne, 1997; Hodgson, 1989; Luttrell, 1984; Ralston, 1991; Senior, 1994). Due to the rarity of millerite, there is scarcely any information regarding its flotation behavior.

Stamboliadis (1976) studied the flotation recovery of millerite versus pH, conditioning time and collector adsorption with Dialkyl Dithiophosphates. Synthetic millerite was used in the study, keeping pH and conditioning time constant at pH 7.5 and 60 minutes, the flotation recovery of millerite versus collector adsorbed was studied. The flotation recovery of millerite versus concentration of dialkyl dithiophosphate adsorbed is shown in Figure 2.6. It was discovered that flotation recovery increased with increased unilayer adsorption, at least six unilayers must be adsorbed on the millerite surface to achieve complete recovery. The unilayer was defined as the amount of collector per gram of mineral necessary to form a complete monolayer.

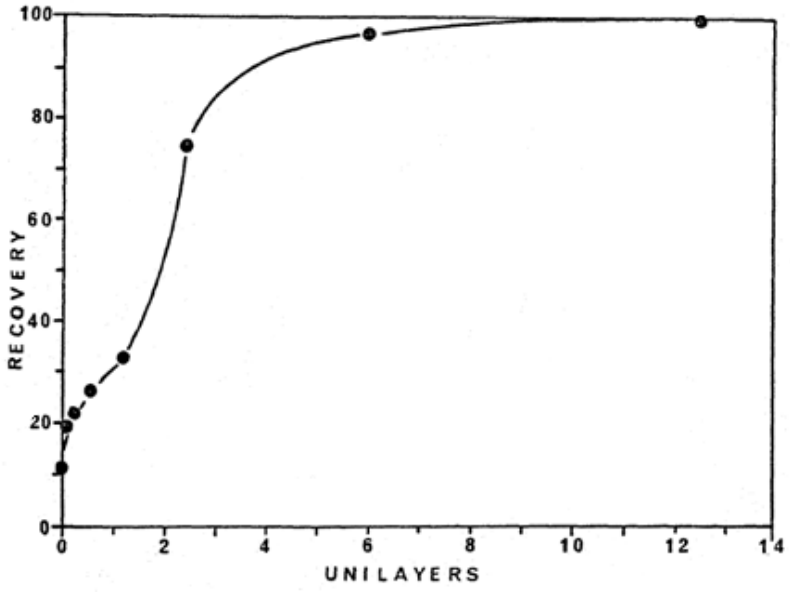

Figure 2.6: Flotation recovery of millerite versus the amount of dialkyl dithiophosphate adsorbed at pH 7.5 (Stamboliadis, 1976)

The effect of pH on millerite flotation was also studied by Stamboliadis, and it was discovered that at pH values greater than 12, millerite does not float even with three unilayer adsorption of collector. In addition, it was shown that for pH values exceeding pH 9, free collectors exists in solution and it was observed that minerals tend to flocculate at this pH range. The flotation recovery (solid line) and collector adsorption density (dashed line) versus pH are shown in Figure 2.7.

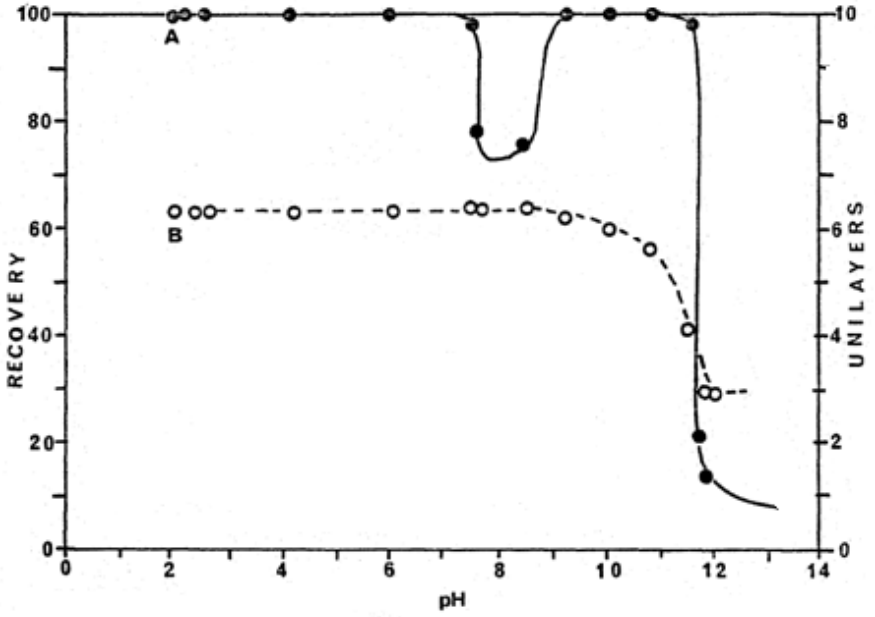

Figure 2.7: Flotation recovery of millerite (—) and dialkyl dithiophosphate adsorbed (- - -) as a function of pH (Stamboliadis, 1976)

The effect of conditioning time on flotation was also investigated at pH 8.5. For the first 10 minutes, recovery increases with time and reaches a maximum. For longer conditioning periods recovery decreases and remains constant near 75%. This phenomenon is attributed to flocculation due to longer conditioning time. To achieve 100% recovery for longer conditioning times, increased collector adsorption is required. The flotation recovery of millerite versus time and the flotation recovery of millerite versus collector adsorbed at pH 8.5 and 60 minutes conditioning time are shown in Figure 2.8.

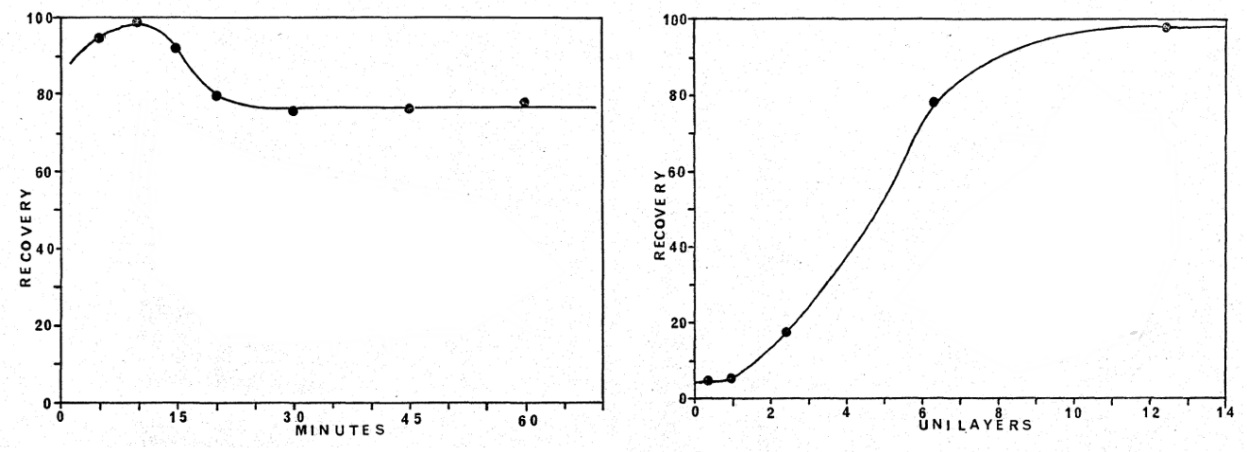

Figure 2.8: Flotation recovery of: millerite versus time (left), millerite versus dialkyl dithiophosphate adsorbed (right) at pH 8.5 (Stamboliadis, 1976)

In addition to the work by Stamboliadis, a more recent study was carried out by Smith et al. (2011) who investigated the effect of Eh, pH and cyanide on the flotation recovery of natural millerite. In the flotation study, millerite was found to be strongly floatable under oxidizing potential, with a lower limiting threshold potential at -100 mV SHE at pH 9. The flotation recovery of millerite and pentlandite as a function of potential is shown in *Figure 2.9*. The flotation edge observed in this study was noted to be lower than the formation potential of both dixanthogen and nickel xanthate. The exact mechanism responsible for millerite flotation is not yet understood.

The effect of pH on millerite flotation was also investigated by Smith et al, and they determined a noticeable decrease in millerite recovery with increasing pH to 10 and further decrease at pH 10.5. The effect of pH on the flotation recovery of millerite is shown in *Figure 2.10*. In addition to the effect of Eh and pH on the recovery of millerite, Smith et al. also investigated the effect of depressant on the recovery of millerite. Smith showed that single addition of cyanide (up to 300 g/t) had no discernable effect on depression of millerite. However, a two staged cyanide addition of 200 g/t each was able to significantly

depress millerite. Although the two staged cyanide addition showed good depressing effects on millerite, the dosage required for cyanide is quite high.

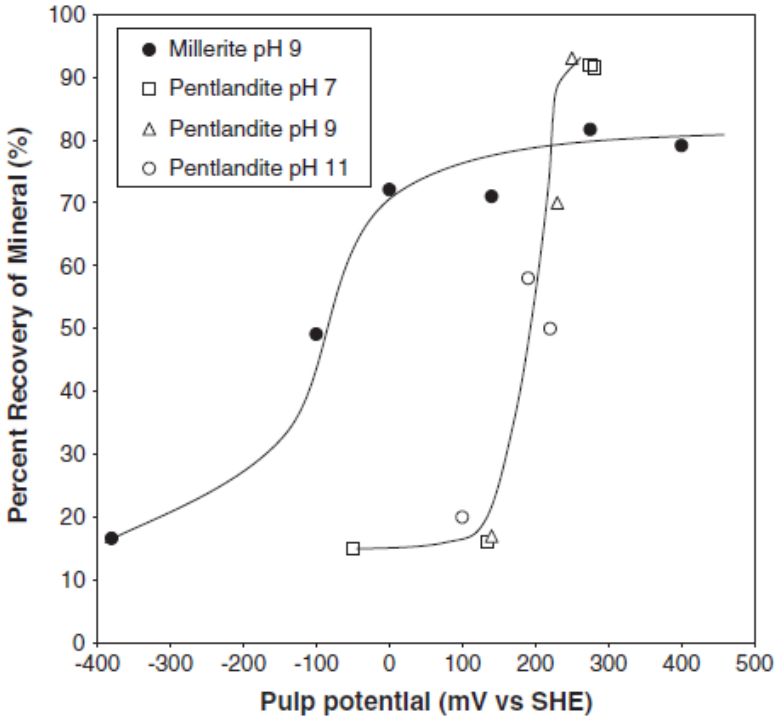

Figure 2.9: Mineral recovery at 8 min. as a function of pulp potential for millerite and pentlandite (1.4 x 10^{-4} M KEX) (Smith et al., 2011)

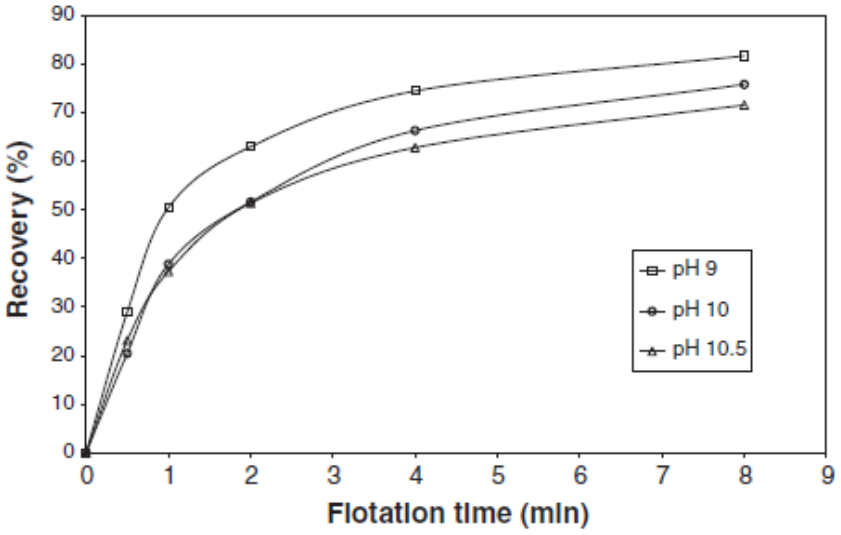

Figure 2.10: Effect of pulp pH on millerite floatability (1.4 x 10^{-4} M KEX) (Smith et al., 2011)

To gain a better understanding of the flotation behavior of millerite under different pulp potentials and pHs and to allow for the successful separation of millerite from chalcopyrite, the objective of this study is to study the mechanisms of xanthate adsorption onto millerite. In this study, the influence of pulp potential and pH on millerite flotation will be investigated in details through electrochemical and surface characterization studies. This work will provide a foundation for future studies of millerite in mixed mineral systems.

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Chapter 3 Research Methodologies

3.1 Characterization Techniques

3.1.1 X-Ray Fluorescence (XRF)

X-ray fluorescence (XRF) spectrometry is a non-destructive analytical technique that is used for the measurement of the elemental and atomic composition of materials. The technique can be utilized to measure solid, liquid or thin-film samples. In this study, powdered mineral samples between size fractions of 38 – 74 µm were used for XRF analysis. Measurement was conducted in this study using Orbis PC Micro-EDXRF Elemental Analyzer.

XRF spectrometry operates through irradiation of the sample surface by a primary x-ray source; and a rhodium source is used in this study. Excitation of the sample by the primary x-ray source results in the emission of a fluorescent x-ray by the sample (Shackley, 2011). The emitted radiation has energy that is characteristic of the atoms present and can be used to allow for identification of the specific element. XRF analysis provides a relatively simple and non-destructive method for the analysis of the composition of materials and was used for all composition analysis of minerals in this study. Three spot measurements were taken for each sample and the averaged value was recorded for the elemental composition for the mineral sample.

3.1.2 X-ray Diffraction (XRD)

X-ray diffraction (XRD) analysis is a non-destructive analytical technique that is used for the identification of crystalline phases of various materials. This technique is applicable for a range of materials from crystals, powders to fluids. XRD analysis provides the characterization of crystalline phases and can be used for identification of mineral phases in a mineral sample. In this study, powdered mineral

samples between size fractions of 38 – 74 µm were used for XRD measurements. The instrument used in this study is Bruker XRD.

X-ray diffraction operates by the interaction of the incident x-ray source with the sample to produce a diffraction pattern. The diffraction pattern recorded is a plot of the intensity of the x-ray scattered at different angles by the sample, and each crystalline phase has a unique diffraction pattern (Speakman, 1902). Identification of a mixture of different phases is possible through the reference patterns recorded. A database for recorded reference patterns is the Inorganic Crystal Structure Database (ICSD). MDI Jade software was used for identification of x-ray powder diffractions in this study. The software allows for comparison of reference patterns to experimental diffraction patterns obtained and automatically generates qualitative analysis of the mineral phases in the sample. Quantitative analysis of XRD was not utilized in this study, instead XRF analysis was used for identification of elements and back calculated based on mineral stoichiometry to determine sample purity.

3.1.3 Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (SEM/EDS)

Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDS) is a non-destructive analytical technique that can be used to measure the elements present on the SEM image of interest. Backscattered electron (BSE) mode was utilized in this study which generates a grayscale SEM image with color differences corresponding to elemental contrast.

SEM/EDS operates using a scanning electron microscopy which can provide image generation for the sample, and the magnification of the image can be altered according to user interest. Once the SEM image is pinpointed by the user at the desired magnification, EDS analysis could then be conducted to obtain elemental mapping and elemental composition of the SEM image. This technique is useful for the characterization of bulk samples and can give visual interpretations of the sample based on composition.

Measurements were conducted using Zeiss EVO M10 SEM with EDS, the magnification used is x1,000 (20 µm). Operation of the instrument on BSE mode allows for a view of the elemental contrast image of the mineral electrode. The coupled EDS analyzer can then be used for determination of the elemental composition of the regions shown on the BSE image. In this study, SEM/EDS analysis was utilized for determination of bulk mineral purity of the mineral electrodes encased in epoxy.

3.1.4 Cyclic Voltammetry (CV)

Cyclic voltammetry (CV) is an electrochemical characterization technique that can be used to study the oxidation/reduction reactions of the working electrode. CV is a powerful technique that relates the flow of electrons to chemical changes in the working electrode. In this study, electrochemical measurements were made using a Metrohm potentiosat (PGSTAT302N) connected to Autolab for control of cyclic voltammetry parameters and display of the voltammogram. A three-electrode setup was employed in this study, which consists of a working electrode, reference electrode as well as a counter electrode. The working electrode is made from the mineral of interest in this study, which is millerite. The reference electrode is used as a point of reference in the electrochemical setup, and the reference electrodes typically have a stable and well-known potential. In this study, saturated silver chloride electrode (Ag/AgCl) was used as the reference electrode. The counter electrode is used to close the current circuit in the setup, and current flows between the counter electrode and working electrode when potential is applied to the system. Counter electrodes are typically made from inert material so that it does not participate in the electrochemical reactions. A platinum mesh was used in this study.

In cyclic voltammetry, a potentiostat is used to apply potential to the working electrode (millerite) and the resulting current is recorded. The potential of working electrode in CV is scanned from a lower potential limit to an upper potential limit, once the upper potential is reached the scan is reversed and

the potential is swept back to the lower potential limit as shown in Figure 3.1. Current is generated when redox reactions occurs on the working electrode. Oxidation reactions of the working electrode release electrons to the system which results in a positive current. While in reduction reactions the working electrode accepts electrons, which results in a negative current in the voltammogram. Cyclic voltammetry is performed by cycling the potential (Eh) of a working electrode and measuring the resulting current. Redox reactions can be identified from the potential they initiated at and by the amount of current generated. For a more detailed description of the CV technique, please refer to these references (Bocarsly, 2012a; Elgrishi et al., 2017).

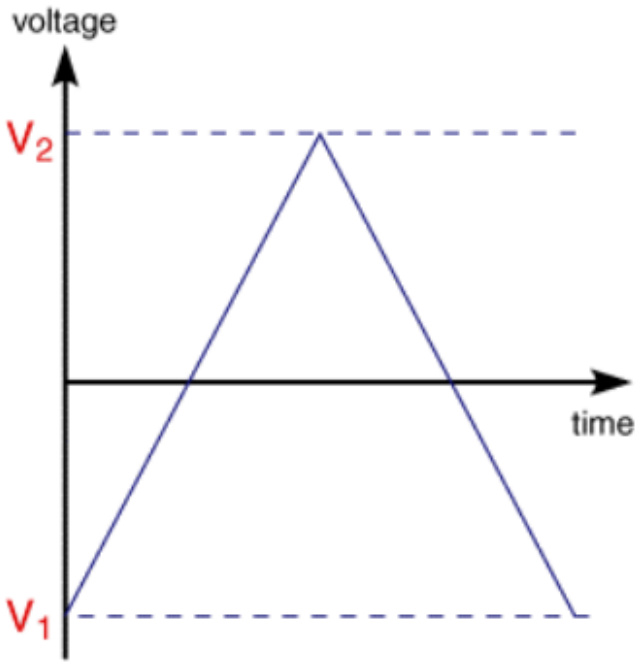

Figure 3.1: Schematic of the cyclic voltammetry waveform (Bocarsly, 2012b)

3.1.5 Fourier-transform Infrared Spectroscopy with Attenuated Total Reflection (FTIR-ATR)

Fourier-transform infrared spectroscopy with attenuated total reflection (FTIR) is a non-destructive analytical technique that can be utilized for the qualitative identification of organic or inorganic compounds for the sample of interest. This technique is applicable for a range of materials ranging from solids, powders to liquids. Measurements were conducted in this study using Nicolet iS50 FTIR spectrometer connected to OMNIC spectra software for analysis. Diamond is used as the ATR crystal in this study, FTIR absorbance spectra was collected by coadding 32 scans at a resolution of 4 cm^{-1}.

ATR is one of the accessories that can be coupled to FTIR, and this technique is useful for the study of surface properties of samples. The penetration depth of this technique is between 0.5 - 3 µm, and minimal sample preparation with fast sampling give this technique an advantage over other IR techniques (Bruker Optics, 2011). FTIR-ATR spectroscopy operates through the passage of an infrared beam through the ATR crystal to the sample surface. The beam undergoes total internal reflection which produces an evanescent wave which is collected by the detector that generates the absorbance spectrum of the sample. Chemical structures have unique spectral fingerprints and can be identified through the resulting absorption spectrum. The schematic of the FTIR-ATR system is shown in Figure 3.2.

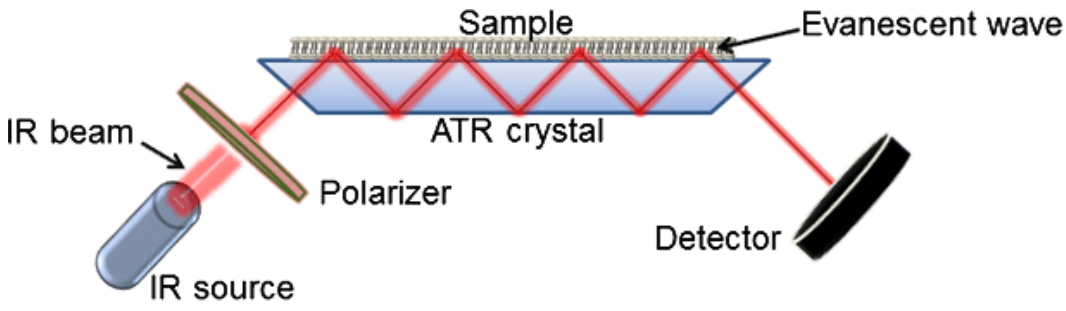

Figure 3.2: Schematic representation of FTIR-ATR system (Ausili, Sánchez, & Gómez-Fernández, 2015)

Xanthate collector—potassium ethyl xanthate (KEX) was used in this study, FTIR spectra was taken for KEX used in this study and shown in Figure 3.3. Leppinen (1990) have previously recorded the FTIR spectrum for solid KEX, their findings is used as the reference in this study.

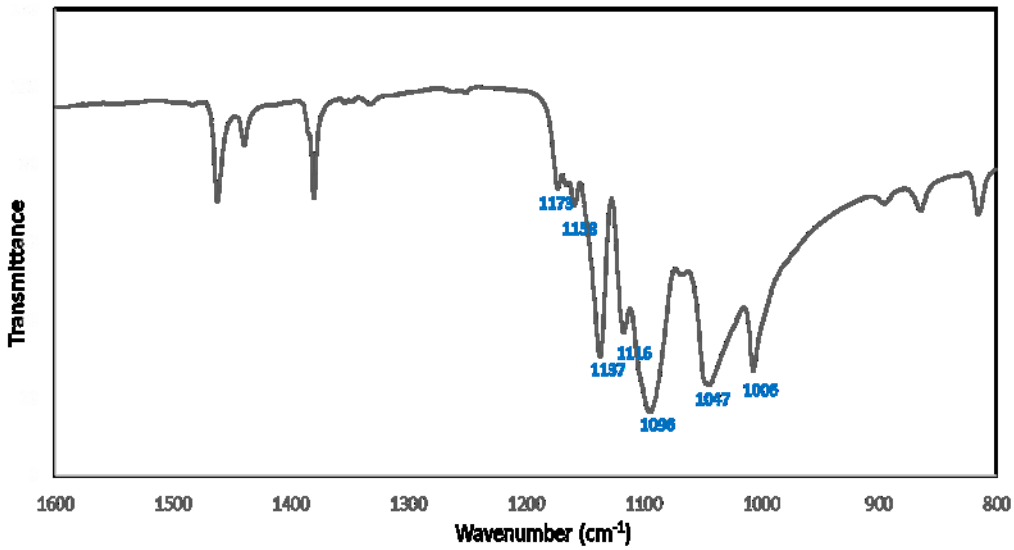

Figure 3.3: FTIR spectra of potassium ethyl xanthate (KEX) solid

3.1.6 Contact Angle Measurement

Contact angle measurement is a non-destructive technique that is used to measure the hydrophobicity of a surface. In this study, contact angle measurement was conducted on millerite electrode surface conditioned under different potentials. Measurements were conducted using Attension theta optical tensiometer connected to oneattension software for analysis. The contact mode was set to sessile drop method to observe the contact angle of a 6 µL deionized water droplet on millerite surface at desired conditions.

Sessile drop method is the standard technique employed for characterization of surface energies of solid surfaces of interest. In this study, sessile drop method was used to measure the contact angle of

a liquid droplet with the millerite surface using drop shape analysis technique. In this technique, a liquid of known parameters (deionized water) was dropped onto the millerite electrode surface. Contact angle of the liquid with the millerite surface was determined from the shape of the water droplet through drop shape analysis. An example of this technique is shown in Figure 3.4.

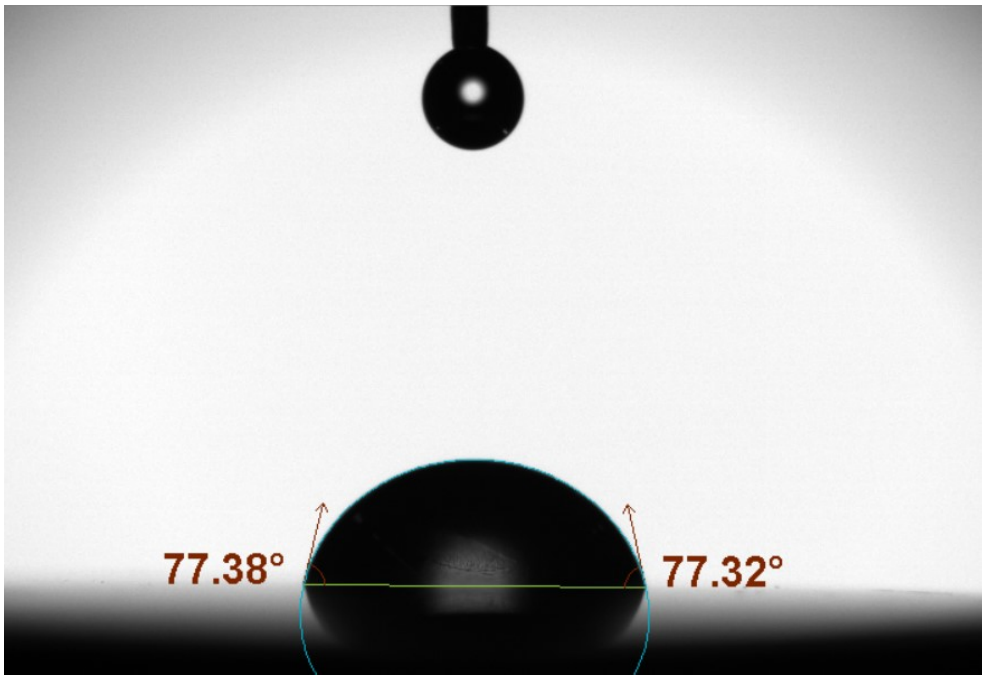

Figure 3.4: Contact angle measurement using sessile drop method with drop shape analysis technique

Contact angle (θ) measured represents the degree of wettability of the surface by the liquid. Hydrophilic surfaces (θ < 90°) can be wetted by the liquid while hydrophobic surfaces (θ > 90°) exhibit poor wetting behaviour. Utilization of contact angle measurements can provide important information regarding the wettability in relation to the flotation behaviour of the mineral surface under different conditions.

3.1.7 X-ray Photoelectron Spectroscopy (XPS)

X-ray photoelectron spectroscopy (XPS) is a surface analysis technique that can be used for analysis of the surface chemistry. XPS analysis can provide valuable elemental identification and chemical state information of the surface being analyzed. Measurements in this study were conducted using Kratos AXIS 165 XPS Spectrometer with a mono-chromatized AlKα X-ray (1478 eV).

XPS spectrum measures the intensity of the photoelectrons against binding energy. The sample surface is irradiated with mono-chromatized AlKα X-ray which causes the excitation and emission of core-level photoelectrons. Elemental and chemical compositions have characteristic binding energy values and can be identified through the peak positions in the XPS spectrum. Energy dispersive analysis of the emitted electrons creates an XPS spectrum which can provide a variety of information from elemental identification, chemical state of elements to relative composition of the constituents in the surface region (Smart, Mcintyre, & Bello, 2011).

3.2 References

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Chapter 4 Electrochemical and Spectroscopic Investigations of Xanthate Adsorption Mechanism on Millerite Surface under Different Pulp Potentials and Water Chemistry

4.1 Introduction

Millerite is found along the margins of copper rich orebodies in the Sudbury region along with varying amounts of pentlandite, chalcopyrite ($CuFeS_2$), and bornite (Cu_5FeS_4). Recently with the emergence of higher millerite bearing ores in the Sudbury region, an understanding of the surface properties and flotation chemistry of millerite is becoming important for the successful separation of millerite from chalcopyrite in copper-nickel separation. Froth flotation is typically used to recover valuable minerals from gangue, the flotation behavior of pentlandite and chalcopyrite are both well defined (Bozkurt, 1998; Fairthorne, 1997; Hodgson, 1989; Luttrell, 1984; Ralston, 1991; Senior, 1994). Due to the rarity of millerite, there is scarcely any information regarding its flotation behavior. A single mineral flotation study for millerite was carried out by Smith (2011), and millerite was found to be strongly floatable under oxidizing potential, with a lower limiting threshold potential at -100 mV SHE at pH 9. The flotation edge observed in this study was noted to be lower than the formation potential of both dixanthogen and nickel xanthate. The exact mechanism responsible for millerite flotation is not yet understood.

To gain a better understanding of the flotation behavior of millerite under different pulp potentials and water chemistry, the influence of pulp potential and pH on millerite flotation was investigated in details in this study through electrochemical and surface characterization techniques. This work will provide a foundation for future studies of millerite in mixed mineral systems.

4.2 Experimental

4.2.1 Samples and Electrode Preparation

Millerite from Levack mine, Sudbury, ON, Canada was purchased from Kaygeedee minerals. The purity of millerite was determined to be about 96% using Orbis PC Micro-EDXRF Elemental Analyzer. The results from X-ray fluorescence (XRF) measurement is listed in **Error! Reference source not found.** with stoichiometry of Ni:S showing a nearly ideal 1:1 ratio. X-ray diffraction (XRD) analysis of millerite sample was conducted with Bruker XRD and is shown in **Error! Reference source not found.**. XRD analysis showed all characteristic peaks fitted to the reference card for millerite (ICSD NO. 12-0041).

Table 4.1: XRF analysis of millerite used for electrode

Element	Spot #1 wt%	Spot #2 wt%	Spot #3 wt%	Average wt%
S	34.8	34.4	34.4	34.5
Fe	1.5	1.5	1.4	1.5
Co	0.3	0.3	0.3	0.3
Ni	61.4	61.9	62.1	61.8
Cu	1.9	1.9	1.8	1.9
Total	100	100	100	100

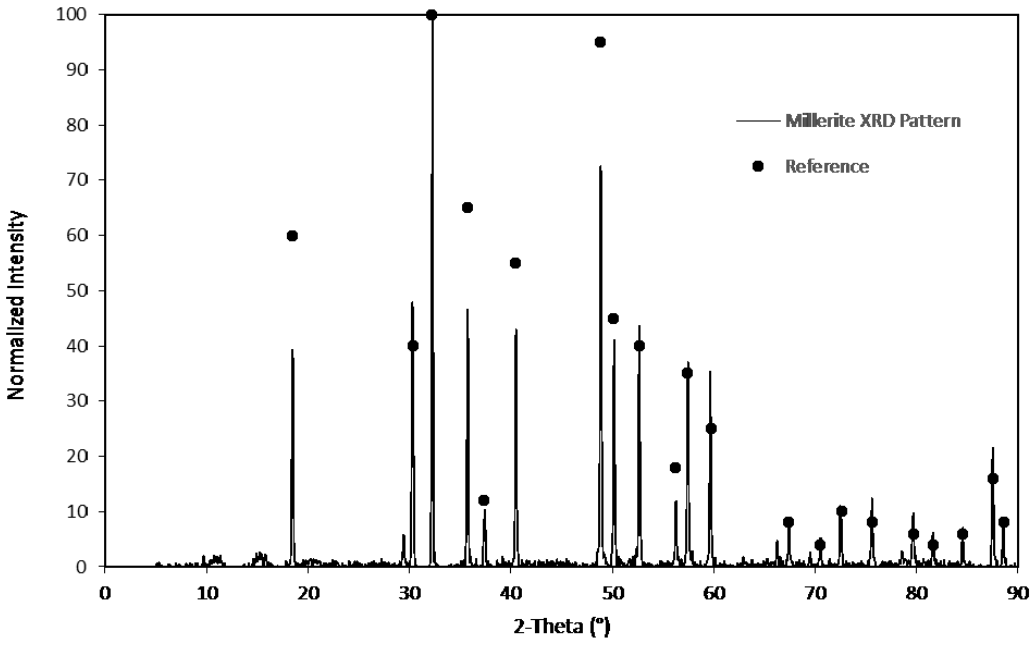

Figure 4.1: XRD analysis of millerite surface used for electrode

The millerite electrode was made from millerite fractured and cut into dimensions of roughly 5 x 10 x 5 mm. To assemble the electrode, a copper wire was attached to millerite through a conductive silver epoxy. The conductivity of the assembly was checked with a voltmeter to ensure that a good connection has been established, and the assembly is then placed into a circular mold of 30mm diameter and non-conductive epoxy is poured to fully immerse the assembly.

After the epoxy solution is completely hardened, the electrode is polished to reveal the millerite surface. The millerite electrode is polished through silicon carbide (SiC) polishing paper of subsequent finer grit from 600, 800 to 1200 grit. Prior to testing, the millerite surface is analyzed using SEM/EDX to check for impurities shown in Figure 4.2 and Table 4.2 respectively. The analysis showed a nearly ideal atomic ratio of Ni:S with minor iron impurities at 0.49 wt.%.

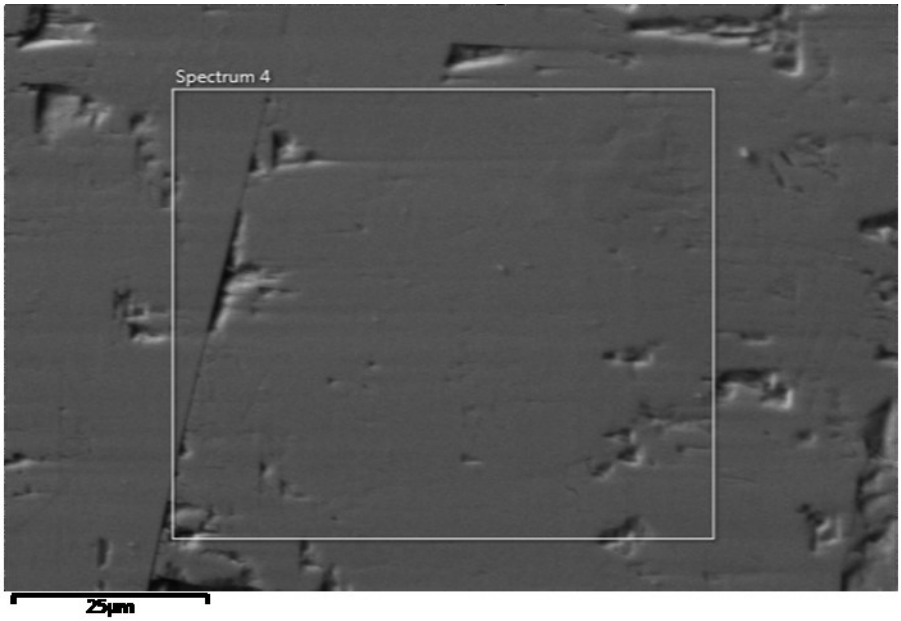

Figure 4.2 SEM image of millerite electrode surface

Table 4.2 EDX analysis of millerite electrode surface

Millerite EDX Analysis		
Elem:	**Wt%**	**Atomic%**
S	37.56	52.40
Fe	0.49	0.39
Ni	61.95	47.21
Total	100	100

4.2.2 Electrochemistry Cell

Electrolyte solutions were prepared from 200 ml of deionized milli-Q water. A buffer of pH 9 was achieved from 0.025 M sodium tetraborate decahydrate and 0.1 M hydrochloric acid. For pH 12 buffer preparation, 0.2 M potassium chloride and 0.2 M of sodium hydroxide were used.

A three-electrode setup comprising of a working electrode, a reference electrode and a counter electrode was used for electrochemical studies, and a schematic of the setup is shown in Figure 4.3. The working electrode is the millerite electrode. Prior to each measurement the electrode surface was hand polished by 600, 900 and 1200 grit silicon carbide paper respectively to remove the oxidation layers. After polishing, the millerite electrode was washed with deionized water and immersed immediately in the electrolyte solution. The reference electrode used is a standard silver chloride electrode (Ag/AgCl) filled with saturated KCl solution. Measured experimental data was corrected to the standard hydrogen electrode (SHE) potential by adding 0.197 V. The counter electrode used was a platinum wire mesh. Prior to experimentation, the solution cell was purged with nitrogen for 20 min to remove oxygen in the electrolyte.

Electrochemical measurements were made using Metrohm potentiosat (PGSTAT302N) connected to Autolab for control of cyclic voltammetry parameters. Cyclic voltammetry was conducted at pH 9 and pH 12 with and without the addition of potassium ethyl xanthate (KEX). The sweep rate was kept constant at 0.25 V/s and sweep direction was set in the positive direction.

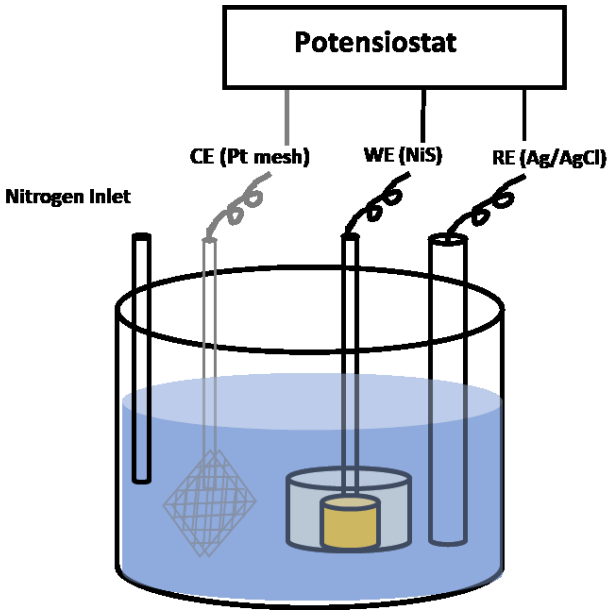

Figure 4.3: Schematic of the electrochemical setup for cyclic voltammetry study

4.2.3 Contact Angle Measurements

Contact measurements was conducted for electrochemically modified millerite electrode surface using an Attension theta optical tensiometer connected to the oneattension software. For each contact angle measurement, the electrode is scanned in the positive sweep direction from the lower potential limit to the desired potential.

For i) collectorless contact angle measurements, the electrode surface was maintained at each desired potential for 5 min, after which the electrode was taken out of the solution and blown dry by nitrogen and contact angle measurements were taken immediately after.

For contact angle measurement with KEX addition the effect of conditioning time was considered. The millerite electrode was tested at ii) 0.01 M KEX with no pre-conditioning and iii) 1.4×10^{-4} M KEX with 5 min pre-conditioning at the desired overpotential prior to KEX addition. The electrode surface was

maintained at each desired potential for 10 min in total, after which the electrode is taken out and blown dry with nitrogen and contact angle measurements was immediately taken.

The contact mode was set to sessile drop technique to observe the contact angle of a 6 µL deionized water droplet on millerite surface at each condition. For each condition, five different spots were measured, and the results are then averaged to give the mean and standard deviation.

4.2.4 FTIR-ATR Setup

Spectroscopic studies of xanthate adsorption have been extensively studied for many different mineral and xanthate systems (Bozkurt, Xu, & Finch, 1998a; Leppinen, 1990; Sui, Brienne, Xu, & Finch, 1997; Talonen, Rastas, & Leppinen, 1991). To gain a better understanding of the interaction of millerite with xanthate (KEX) spectroscopic investigation was utilized to study xanthate adsorption on millerite surface.

Spectroscopic analysis was conducted on electrochemically modified millerite electrode surface using Nicolet iS50 FTIR spectrometer with ATR mode. Electrochemically modified millerite electrode surface was prepared in the same way as described above, spectroscopic measurements were then taken ex-situ with spectra collected at 4 cm^{-1} resolution by co-adding 32 scans. After each analysis at the desired potential, the electrode was re-polished and the same procedure was repeated for the next set of spectroscopic analysis. Analysis of absorption bands was conducted using Omnic software, and the peaks was identified by setting the sensitivity threshold to 50.

4.3 Results and Discussion

4.3.1 Cyclic Voltammogram of Millerite

Reactions of xanthate with sulphide minerals have been a topic of research for many years. Xanthate adsorption is a mixed potential mechanism with anodic oxidation of xanthate coupled with a cathodic counterpart, which is typically provided through the reduction of oxygen (Ronald Woods, 1996). The interaction of xanthate on the sulphide mineral can occur through various pathways, and the anodic oxidation of xanthate could yield chemisorbed xanthate ion (X^-), metal xanthate (MX) or dixanthogen (X_2). To illustrate the possible xanthate adsorption mechanisms on millerite surface, reactions for the formation of nickel (II) ethyl xanthate (NiX_2) and dixanthogen (X_2) are listed below:

Formation of nickel (II) ethyl xanthate given by (Smith et al., 2011):

$$NiS + 2X^- \rightarrow NiX_2 + S + 2e^- \quad E_H = -0.11 - 0.0591\, log[X^-] \tag{4.1}$$

The oxidation of xanthate to dixanthogen given by (Hepel & Pomianowski, 1977):

$$2X^- \rightarrow X_2 + 2e^- \qquad E_H = -0.070 - 0.0591\, log[X^-] \tag{4.2}$$

Due to the electrochemical nature of the interaction of xanthate with sulphide minerals, electrochemical investigations could be used to study the adsorption mechanism of xanthate with millerite. The electrochemical reactions of millerite were studied in the presence and absence of 0.01 M KEX at pH 9 and pH 12 conditions, the resulting voltammograms are depicted in Figure 4.4 (left) and Figure 4.5 (left) respectively. The voltammograms show the effects that pH, Eh and collector addition have on the electrochemistry of the millerite surface. Collectorless voltammograms at pH 9 and pH 12 outline the characteristic redox reactions that millerite surface undergoes at the given condition. With the addition of KEX to the system, any differences observed in the voltammogram are characteristics of the

interactions of xanthate with millerite and can be used to identify when xanthate adsorption takes place on millerite surface.

For $[X^-]$ = 0.01 M, equations (4.1) and (4.2) yields standard redox potentials of 0.008 and 0.0482 V respectively for the formation of NiX_2 and X_2. Since both equations listed are not dependent on pH, the values remain constant for both pH 9 and pH 12 conditions.

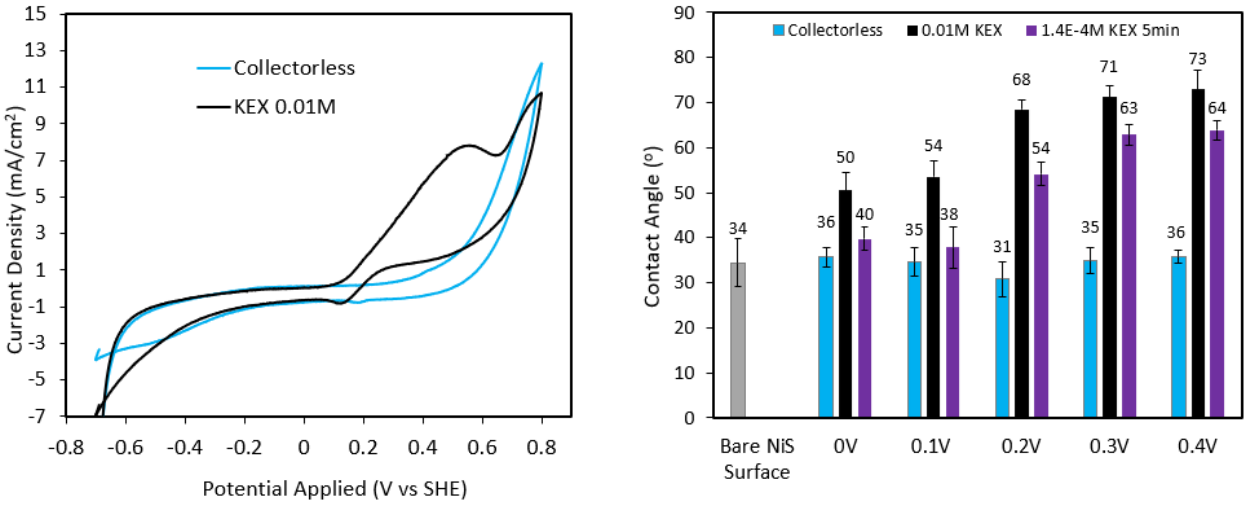

Figure 4.4: Cyclic voltammograms (left) and contact angle measurements (right) for millerite conditioned at pH 9 for i) collectorless condition ii) 0.01 M KEX and iii) 1.4 x 10^{-4} M KEX with 5 min pre-conditioning at the desired overpotential prior to KEX addition.

Figure 4.4 (left) depicts the voltammogram of millerite surface conditioned at pH 9 for collectorless and 0.01 M KEX conditions. At pH 9, compared to the voltammogram with no collector addition, a new distinct anodic peak could be observed for the voltammogram conditioned in 0.01 M KEX. The new anodic peak observed corresponds to KEX reacting with millerite. At pH 9 with KEX addition, anodic current associated with oxidation reaction was first observed at - 0.055 V potential. At - 0.055 V potential, the anodic current of the voltammogram first reached a positive value. However, no distinguishable anodic peak was observed until potential reached > 0 V; and from this potential onward,

the anodic oxidation peak increased rapidly. Correlating the voltammetry results to calculated potential for NiX_2 and X_2, it could be assumed that the initial anodic current observed (at close to 0 V) arises from the formation of nickel (II) ethyl xanthate. The steep increase in current at higher potentials in the voltammogram could be explained by the formation of dixanthogen at above 0.05 V. The formation potentials of nickel (II) ethyl xanthate and dixanthogen shown in the voltammogram are very close to the formation potential predicted from thermodynamics at pH 9.

Contact angle measurements were conducted to supplement the electrochemical investigations of xanthate adsorption on millerite surface. The wettability of millerite surface was determined between 0 V to 0.4 V potential for pH 9 for i) collectorless condition ii) 0.01 M KEX and iii) 1.4 x 10^{-4}M KEX with 5min pre-conditioning at the desired overpotential prior to KEX addition and is shown in Figure 4.4 (right).

A good correlation could be observed between the electrochemical and contact angle measurements at pH 9 shown on Figure 4.4 (right) it could be observed that for collectorless condition (blue bar) the contact angle did not vary by much. But with the addition of 0.01 M KEX to the system (black bar) the contact angle increased greatly above the formation potential for dixanthogen. Contact angle at 0 V and 0.1 V with 0.01 M KEX addition showed an increase when compared to the contact angle measured for bare millerite surface. However, it could be observed that contact angle remained mostly stationary within the potential ranges of 0 V to 0.1 V but increased greatly from 0.1 V onwards. This could be explained by the initial formation of nickel (II) xanthate at lower potentials which imparts a slight hydrophobicity to millerite. At higher potentials above the reversible potential for dixanthogen, formation of dixanthogen occurs on millerite surface which could be reflected by the significant increase in contact angle measured.

A similar trend could be observed for the lower concentration condition with 5 min pre-conditioning (purple bar), at 1.4 x 10^{-4} M KEX the calculated formation potential for NiX_2 and X_2 are 0.12 V and 0.16 V respectively. From contact angle measurements it could be seen that when compared to

collectorless condition, no significant increase in contact angle occurred until past 0.1 V. Above the formation potential for nickel xanthate and dixanthogen, contact angle increased greatly, which is an indication of xanthate adsorption onto the millerite surface. In addition, it could be seen that the 5 min pre-conditioning at pH 9 does not seem to play a big role in xanthate adsorption mechanism since at pH 9 no significant redox reactions occur between 0 to 0.4 V potential as reflected by the near constant collectorless contact angle.

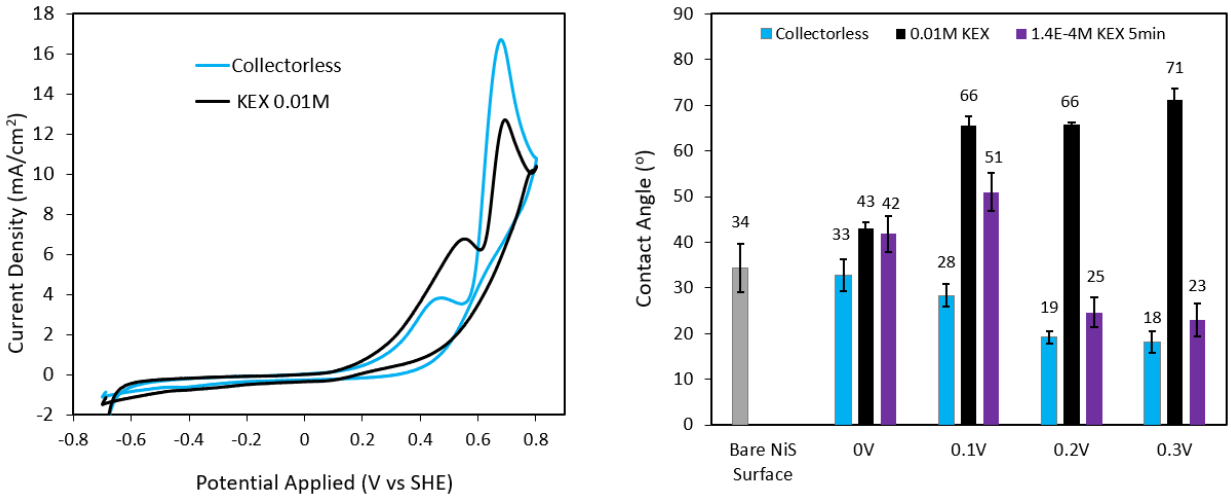

Figure 4.5: Cyclic voltammograms (left) and contact angle measurements (right) for millerite conditioned at pH 12 for i) collectorless condition ii) 0.01 M KEX and iii) 1.4 x 10^{-4} M KEX with 5 min pre-conditioning at the desired overpotential prior to KEX addition.

Figure 4.5 (left) depicts the voltammogram of millerite surface conditioned at pH 12 for collectorless and 0.01 M KEX conditions. There are two anodic oxidation peaks observed at pH 12 for collectorless condition, starting at 0.1 V and 0.6 V respectively. Due to the more complex redox reactions in the voltammogram for collectorless condition at pH 12, the identification of peaks characteristic of KEX reaction with millerite becomes more difficult. In addition, due to oxidation reactions occurring at 0.1 V,

the effect of pre-conditioning becomes significant since the millerite surface can be altered at this potential onwards for collectorless conditions. With 0.01 M KEX addition to the system at pH 12, the lower anodic peaks become amplified in the presence of KEX when compared to the collectorless condition. This is an indication of xanthate interaction on the millerite surface. At pH 12 with KEX addition, anodic current associated with oxidation reaction was first observed at 0 V potential. At 0 V potential, the current of the voltammogram first reached a positive value. However, separation of the overlap between voltammograms recorded in the presence and absence of xanthate does not occur until 0.1 V potential onwards. Following the same convention for pH 9 conditions, it is assumed that the anodic peak first arises from nickel (II) ethyl xanthate formation and is followed by an increase of current at a higher potential due to the formation of dixanthogen.

Contact angle measurements were also conducted for pH 12 at different conditions. The wettability of millerite surface was determined between 0 V to 0.3 V potential for pH 12 for i) collectorless condition ii) 0.01 M KEX and iii) 1.4×10^{-4} M KEX with 5 min pre-conditioning at the desired overpotential prior to KEX addition and is shown in Figure 4.5 (right).

A good correlation could be observed between the electrochemical and contact angle measurements at pH 12 as shown on Figure 4.5 (right). It could be observed that for collectorless condition (blue bar) the contact angle showed a decreasing trend from 0 to 0.3 V. Correlating this to the collectorless voltammogram for millerite at pH 12, it could be seen that oxidation reaction occurred starting from 0.1 V onwards. This indicates that the oxidation reaction renders the millerite surface more hydrophilic.

For pH 12 with 0.01 M KEX addition (black bar), from 0.1 V to 0.3 V the trend of contact angle measured follows closely to those observed at pH 9, the xanthate adsorption mechanism within this region is assumed to be the same as those described at pH 9.

Contrary to the contact angle measurement obtained for 0.01 M KEX, the contact angle results for 1.4 x 10^{-4} M KEX with 5 min pre-conditioning (purple bar) does not show a similar trend. This could be reflected by the contact angle measurement results for 0.2 V and 0.3 V. At 0.2 and 0.3 V, the contact angle measured for 1.4 x 10^{-4} M KEX with 5 min pre-conditioning is much lower when compared to the contact angle measured for 0.01 M conditions. This indicates that no xanthate adsorption occurred when 5 min pre-conditioning was employed prior to xanthate adsorption at 0.2 V and 0.3 V and the contact angle measured was similar to the collectorless condition. A possible explanation for this phenomenon is that at pH 12, anodic oxidation occurs close to 0.1 V and may interfere with the adsorption of xanthate at this potential. To fully understand this phenomenon, detailed surface characterization will be carried out via XPS to identify the oxidation products at this potential.

4.3.2 Spectroscopic Investigations

To supplement the electrochemical and wettability studies of xanthate adsorption on millerite surface, Fourier transform infrared spectroscopy with attenuated total reflectance (FTIR-ATR) was used to study the surface species formed during interaction of xanthate on millerite surface. Infrared spectra of millerite surface conditioned at different potentials in the presence of 0.01 M KEX and 1.4 x 10^{-4} M KEX (with 5 min pre-conditioning) for pH 9 and pH 12 was taken ex-situ and recorded.

Figure 4.6 depicts the infrared spectra for millerite conditioned in pH 9 solution with 0.01 M KEX in wavenumber range of 900 to 1400 cm^{-1}. At 0.1 V potential no apparent peak was observed for the millerite surface, the spectra recorded are characteristic of bare millerite surface. No distinguishable peak was observed until potential becomes greater than 0.1 V, the signals recorded at 0.2 V potential occur at approximately the same wavelength as nickel (II) ethyl xanthate with the strongest signals at 1026 and 1269 cm^{-1} (Watt & Mccormick, 1964). From 0.3 V potential onwards an increase in the infrared spectra

intensity could be observed, which indicates an increased xanthate adsorption. There are two distinct infrared spectra recorded at 0.3 V. Infrared spectra for 0.3 V spot 1 is characteristic of dixanthogen with major peaks at 1020, 1240 and 1262 cm^{-1} (Leppinen, 1990). The infrared spectra for 0.3 V spot 2 have major peaks at 1026, 1105 and 1263 cm^{-1}, this suggests that dixanthogen is unlikely to be the sole species formed on millerite surface. Nickel (II) ethyl xanthates have strong absorption bands at 1025, 1115, 1268 and 1369 cm^{-1} (Watt & Mccormick, 1964). Upon close examination of the infrared spectra for 0.3 V spot 2 it could be seen that the spectra have characteristic peaks of both dixanthogen and nickel (II) ethyl xanthate. Therefore, it is highly possible that both species were present on the surface at 0.3 V. The subsequent infrared spectra taken at 0.4 V also closely resembles the spectra for 0.3 V spot 2. Thus, it could be concluded both nickel (II) ethyl xanthate and dixanthogen formation occur on millerite surface. This finding is consistent with results observed from electrochemical investigation. However, contrary to the electrochemical investigations, infrared analysis could not observe distinct xanthate adsorption peaks until after 0.1 V. This is most likely due to the lower sensitivity of the FTIR-ATR technique relative to electrochemical techniques which requires more significant adsorption of xanthate before detection could be made.

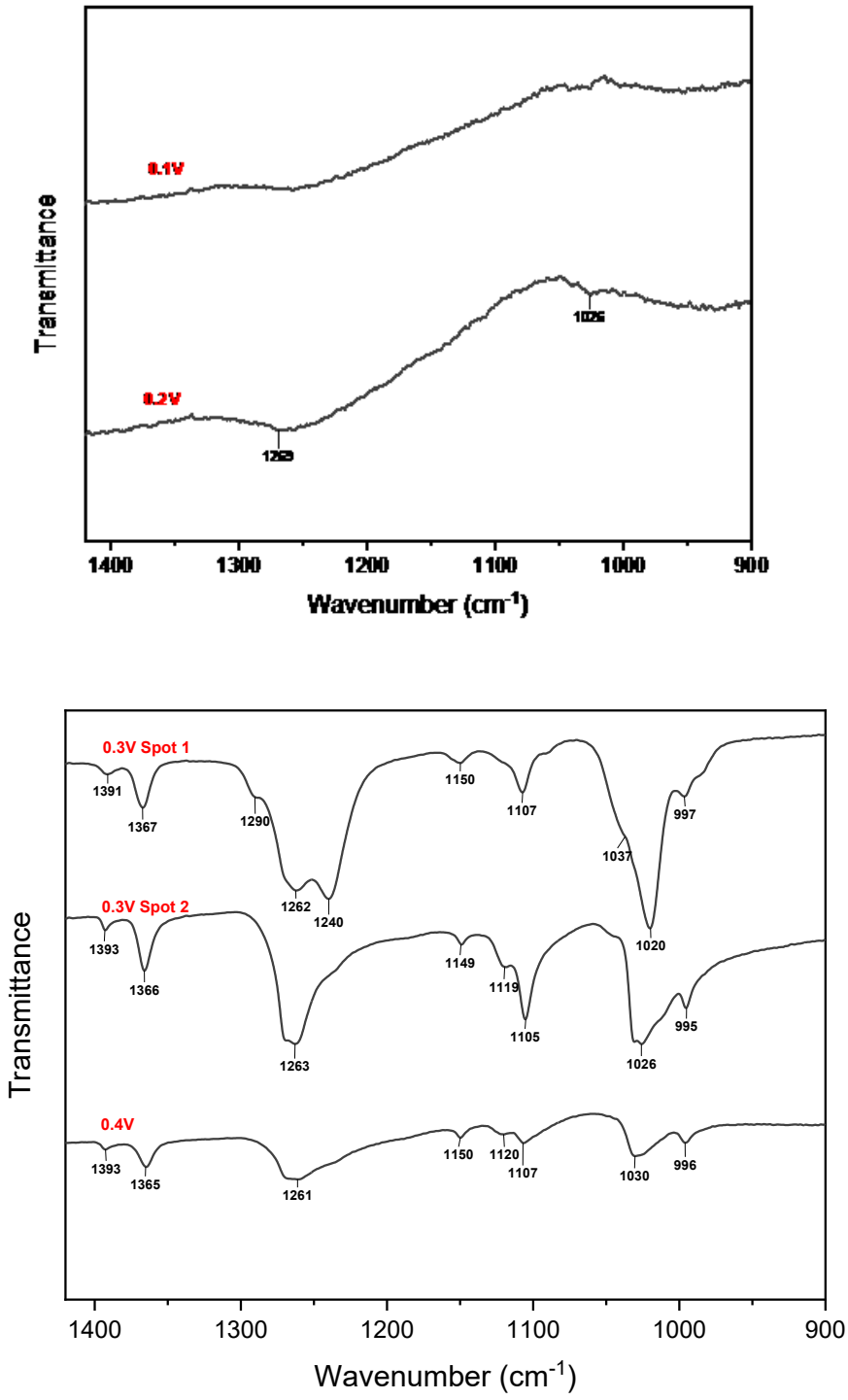

Figure 4.6: FTIR-ATR spectra of millerite surface conditioned in pH 9 buffer solution with 0.01 M KEX at various overpotentials.

Figure 4.7 presents the infrared spectra for millerite conditioned in pH 9 buffer solution with 5 min pre-conditioning at the desired overpotential prior to 1.4 x 10^{-4} M KEX addition in wavenumber range of 900 to 1400 cm^{-1}. Similar to 0.01 M condition, no distinguishable peak was observed until potential becomes greater than 0.1 V. Weak signal was recorded at 0.2 V at 1026 cm^{-1}, the spectra recorded at 0.2 V is most likely due to nickel (II) xanthate. At 0.3 V, an increase in signal intensity was observed with increased xanthate adsorption, and the spectra recorded have approximately the same wavelength as nickel (II) ethyl xanthate with the strongest signals at 1026 and 1269 cm^{-1} (Watt & Mccormick, 1964). There are two distinct infrared spectra recorded at 0.4 V. The infrared spectra for 0.4 V spot 1 have characteristic peaks of both dixanthogen and nickel (II) ethyl xanthate while the spectra for 0.4 V spot 2 is characteristic of dixanthogen.

The overall trend for FTIR spectra recorded with 5 min pre-conditioning at 1.4 x 10^{-4} M KEX follows very closely to those observed for 0.01 M KEX. The differences between the two conditions could be mostly explained by the different concentration of KEX used in the two tests. At a lower KEX concentration, formation potential becomes higher for nickel (II) ethyl xanthate and dixanthogen. This finding is consistent with the electrochemical and wettability studies conducted for pH 9 conditions. At pH 9, initially formation of nickel (II) xanthate occurs at lower potential which imparts a slight hydrophobicity to millerite. As potential is increased above the reversible potential for dixanthogen, the formation of dixanthogen occurs on millerite surface which could be reflected by the significant increase in contact angle measured and also dixanthogen spectra being detected. This indicates that at pH 9 dixanthogen is the species responsible for the increased hydrophobicity of millerite at higher potentials.

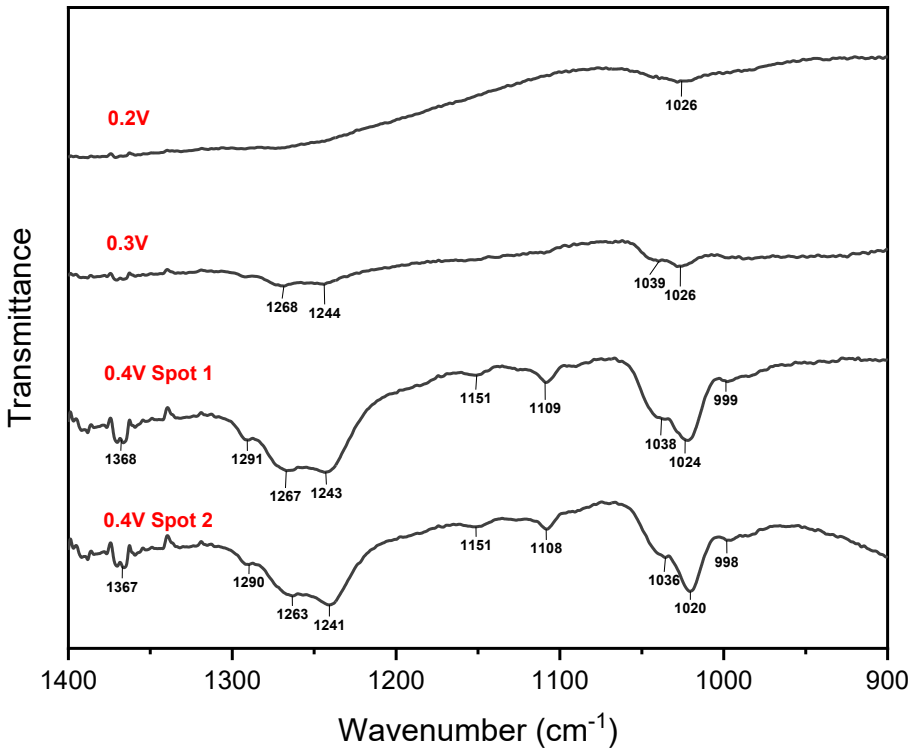

Figure 4.7: FTIR-ATR spectra of millerite surface conditioned in pH 9 buffer solution with 5 min pre-conditioning at the desired overpotential prior to 1.4 x 10^{-4} M KEX addition.

For comparison to pH 9 conditions, infrared spectra were taken for 0.01 M KEX solution from 0 to 0.4 V at pH 12.

Figure 4.8 presents the infrared spectra for millerite conditioned in pH 12 solution with 0.01 M KEX. No apparent peak formation was observed until potential becomes greater than 0.2 V. Adsorption bands were observed from 0.2 V onwards, and at 0.3 V the peaks observed for pH 12 was similar to the peaks recorded for pH 9 conditions. This indicates that the formation of both dixanthogen and nickel (II) ethyl xanthate occurred at 0.3 V potential on millerite surface at pH 12. This indicates that at pH 12 with no pre-conditioning, the formation of both nickel (II) xanthate and dixanthogen occurred on millerite surface.

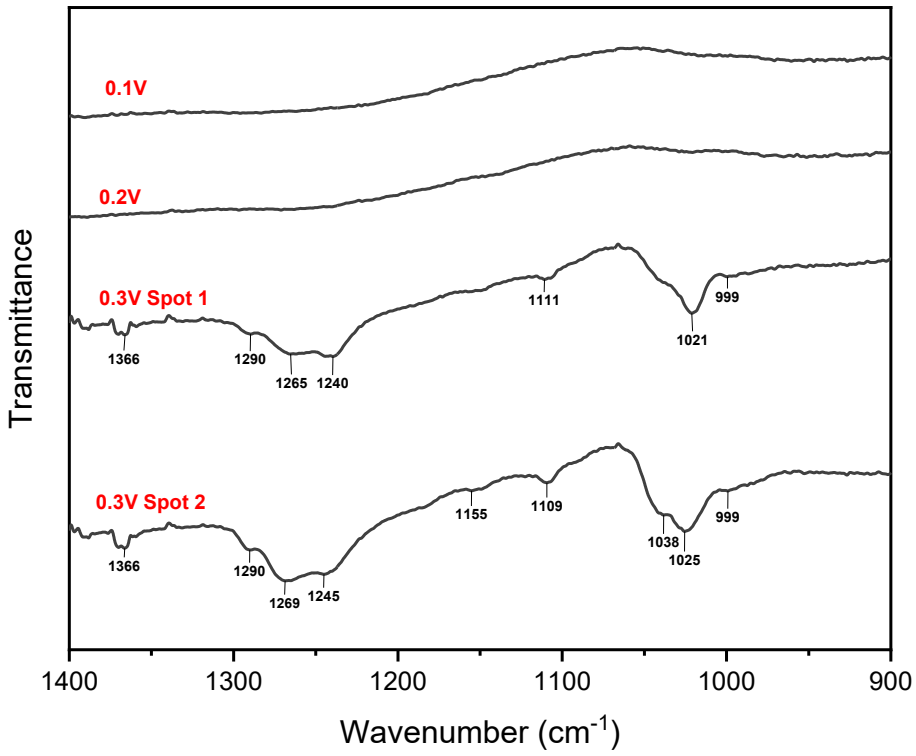

Figure 4.8 FTIR-ATR spectra of millerite surface conditioned in pH 12 buffer solution with 0.01 M KEX at various overpotentials.

To determine the effect of pre-conditioning on xanthate adsorption, infrared spectra was taken for millerite surface conditioned in pH 12 buffer solution with 5 min pre-conditioning at 0 to 0.3 V potential prior to 1.4 x 10^{-4} M KEX addition. The infrared spectra is shown below in Figure 4.9. It was observed that no xanthate adsorption occurred between the ranges of 0 to 0.3 V. This finding is consistent with contact angle measurement results, showing that oxidation of millerite surface inhibits xanthate adsorption at pH 12.

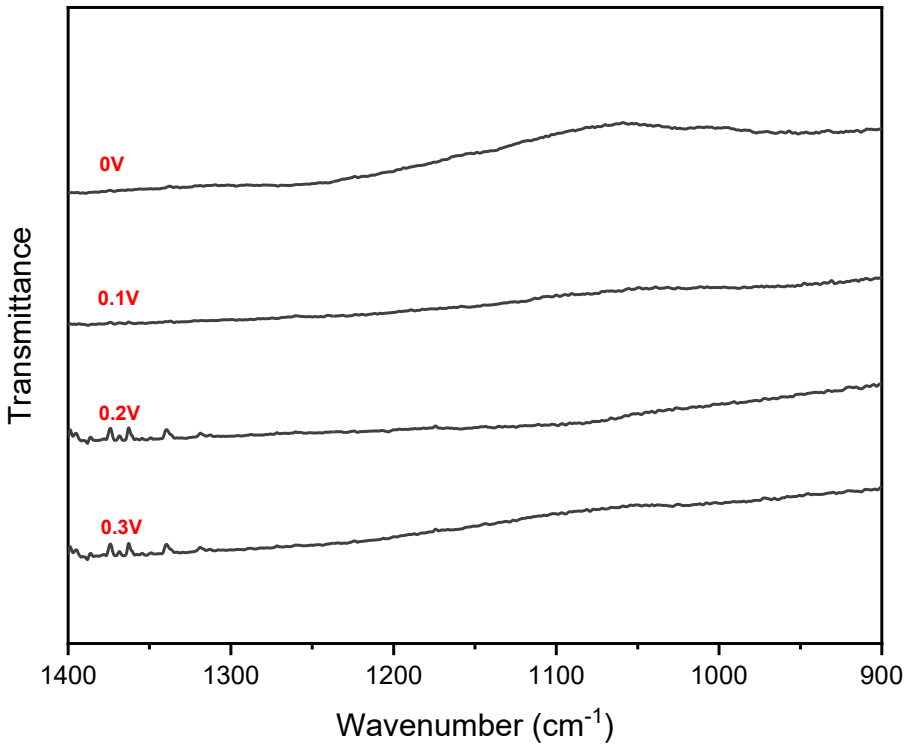

Figure 4.9 FTIR-ATR spectra of millerite surface conditioned in pH 12 buffer solution with 5min pre-conditioning at the desired overpotential prior to 1.4 x 10^{-4} M KEX addition.

FTIR-ATR investigations suggested that both nickel (II) ethyl xanthate and dixanthogen formation occur on millerite surface at pH 9 and pH 12 with no pre-conditioning. Electrochemical and wettability observations suggest that nickel (II) ethyl xanthate forms initially at lower potentials and is responsible for imparting a slight hydrophobicity to millerite surface. As the potential is increased above the reversible potential for dixanthogen formation, a steep increase in anodic current along with increased hydrophobicity is observed. This indicates that at higher potentials dixanthogen becomes the predominate species formed and is responsible for increased hydrophobicity observed for millerite.

However, when pre-conditioning step is added, oxidation effects of the surface must be considered. Wettability and spectroscopic analysis shows that oxidized millerite surface at pH 12 becomes

hydrophilic and inhibits xanthate adsorption. This discovery provides a possible method for depression of millerite at pH 12.

Supplementary spectroscopic spectra for dixanthogen and nickel (II) ethyl xanthate are shown below in Figure 4.10 and Figure 4.11 respectively.

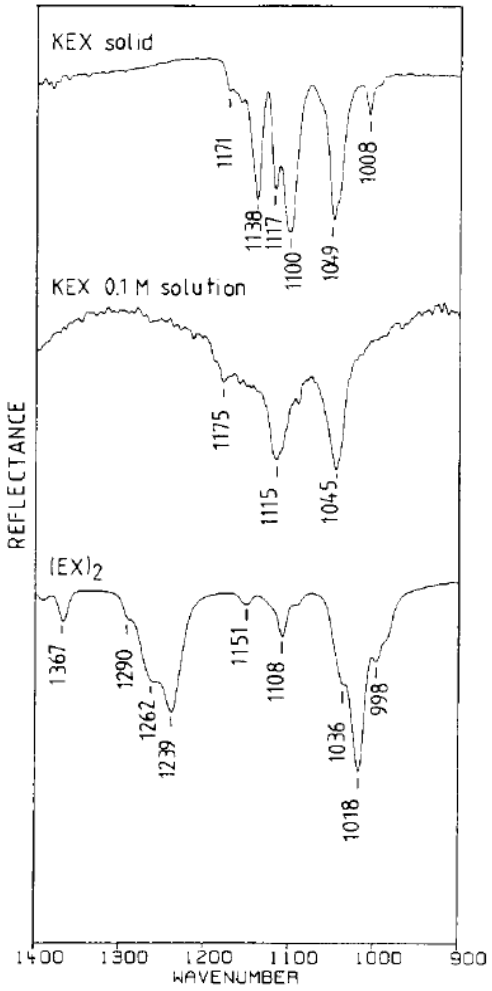

Figure 4.10: FTIR reflection spectra of KEX (solid), 0.1 M KEX solution and $(EX)_2$ solution (Leppinen, 1990)

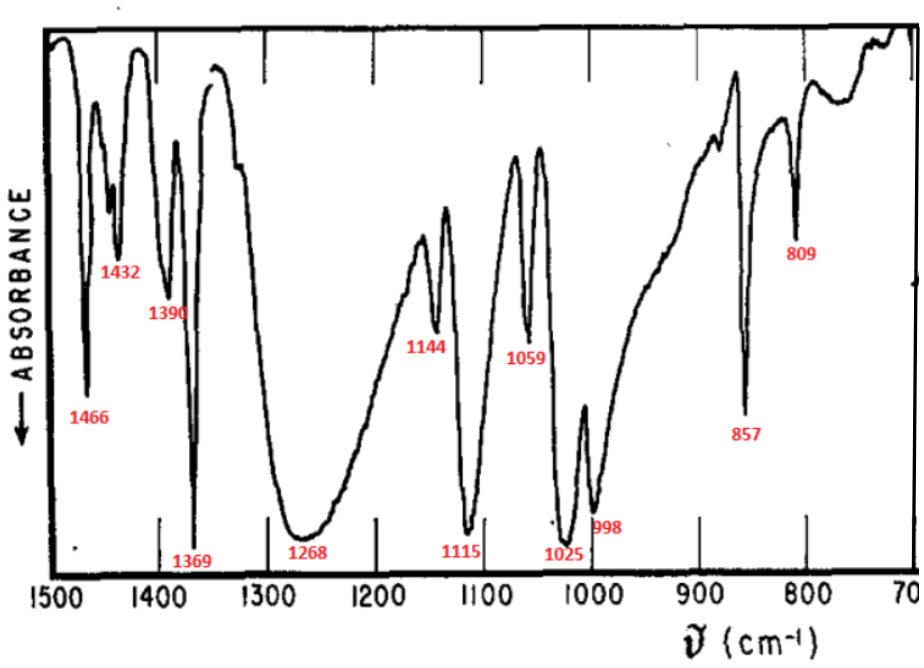

Figure 4.11: The infrared spectrum of nickel ethyl xanthate (Watt & Mccormick, 1964)

4.3.3 XPS Analysis

Previously, it was hypothesized that at pH 12 conditions, millerite surface becomes oxidized at higher potentials and a hydrophilic layer forms on millerite surface which inhibits the xanthate adsorption process. To capture the surface chemical changes after subjecting the millerite electrode to electrochemical treatment, XPS analysis were conducted on millerite electrodes conditioned under different potentials at pH 12. Two millerite electrode were used for XPS analysis, and one electrode was conditioned at OCPT (open circuit potential) which serves as the baseline for the analysis while the other electrode was conditioned at 0.4 V overpotential. After conditioning at the desired potential for 10 minutes, the millerite electrodes were transferred via a vacuum chamber and loaded into the XPS chamber for analysis. For the XPS analysis a monochromatized AlKα X-ray source (1487eV) was used. The

XPS spectrums were calibrated using C 1s at 284.6 eV and analyzed using reference parameters from (Legrand, Nesbitt, & Bancroft, 1998).

Figure 4.12 depicts the XPS narrow region spectrums of Ni $2p_{3/2}$ and S 2p for millerite electrode conditioned in pH 12 buffer solution at OCPT. The Ni $2p_{3/2}$ spectrum of millerite was fitted with two peaks at 852.9 eV and 855.7 eV. The peaks were attributed to NiS and $Ni(OH)_2$ respectively based on the binding energy values. The satellite peaks of NiS and $Ni(OH)_2$ were also used to fit the region between 858 - 865 eV in the spectrum. Asides from NiS and $Ni(OH)_2$ and their satellites peaks, an additional contribution was required to fully fit the spectrum, which was assigned to NiO at 854.2 eV. The major peak for this spectrum is the NiS peak located at 852.9 eV, and this peak and its satellite peak accounted for 61.7% of the total area. This indicates that at pH 12 under OCPT condition the surface layer of the millerite electrode consists mostly of unaltered NiS. However, the presence of $Ni(OH)_2$ and NiO indicates that the surface layer of millerite is slightly oxidized at OCPT conditions.

For S 2p, the spectrum was fitted with two doublet peaks at 161.4 eV and 162.0 eV. The peak at 161.4 eV was assigned to NiS based on the binding energy value. The region between 162 - 165 eV is where polysulfide and elemental sulfur occurs (Legrand et al., 1998). Therefore, the peak within this region was assigned to polysulfide and elemental sulfur. For the S 2p spectrum, unaltered NiS accounted for 61.5% of the total area while polysulfide accounted for 38.5%.

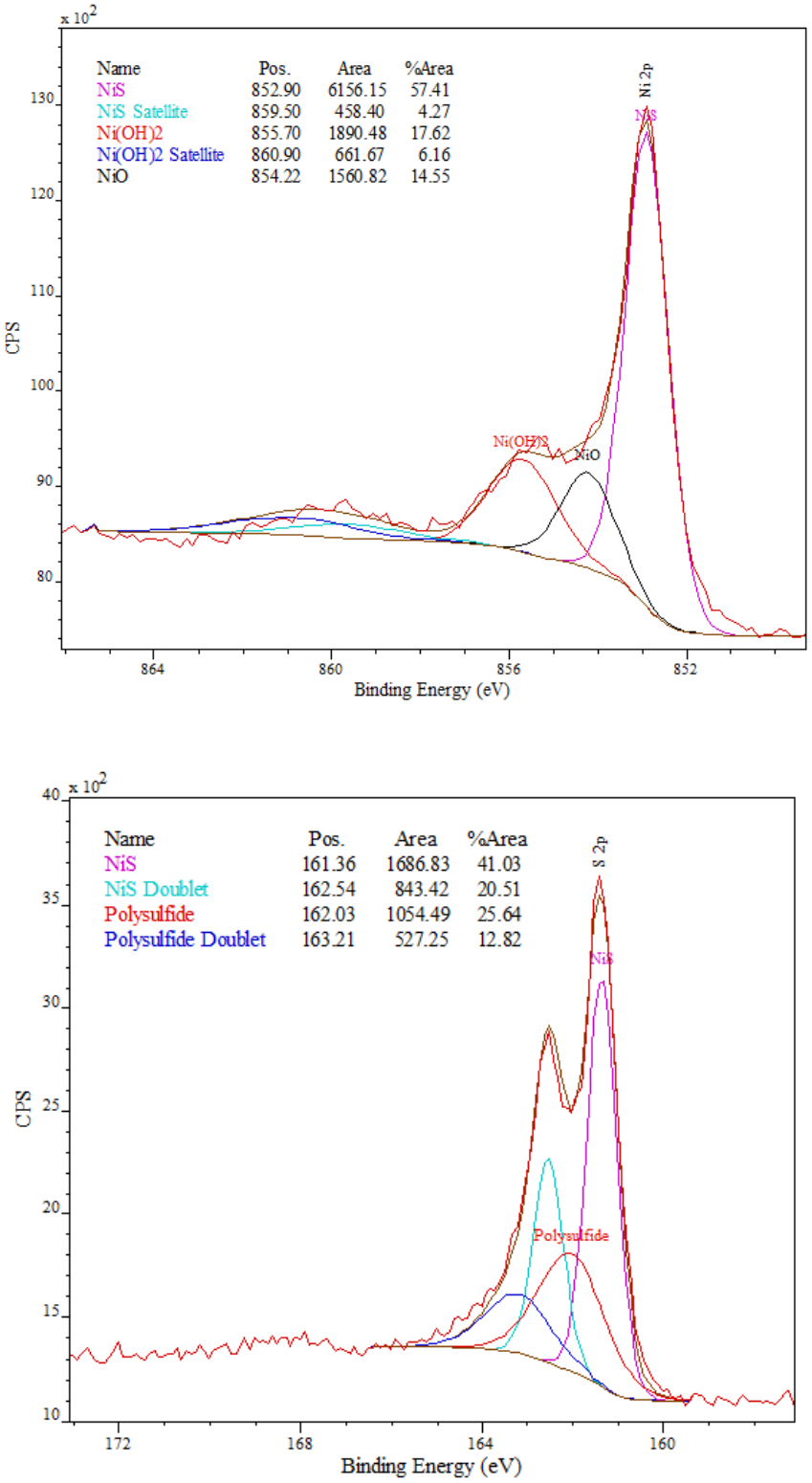

Figure 4.12: XPS Ni $2p_{3/2}$ (top) and S 2p (bottom) narrow region scans of millerite electrode conditioned in pH 12 buffer solution at OCPT.

Figure 4.13 depicts the XPS narrow region spectrums of Ni $2p_{3/2}$ and S 2p for millerite electrode conditioned in pH 12 buffer solution at 0.4 V overpotential. From observation of the Ni $2p_{3/2}$ spectrum, it could be seen that compared to the spectrum for OCPT condition, the major peak was shifted to the left to around 856 eV. For this spectrum, only a very small contribution was observed to be due to NiS. The NiS peak was fitted at 853.2 eV, this peak along with its satellite accounted for 5% of the total area. The major peak at about 856 eV showed a very broad signal, which is an indication of a composite peak. This peak were fitted with $Ni(OH)_2$ at 855.7 eV and $NiSO_4$ at 867.1 eV based on their binding energies. The signals observed between 858 - 865 eV were fitted using satellite peaks. The contributions from $Ni(OH)_2$, $NiSO_4$ and their satellite peaks represent approximately 95% of the total Ni $p_{3/2}$ intensity. This indicated that at 0.4 V overpotential, the surface layer of millerite electrode consists mostly of $Ni(OH)_2$ and $NiSO_4$ with neglectable amount of unaltered NiS.

Observations of the S 2p spectrum showed the appearance of a new major peak at around 168 eV when compared to the previous spectrum at OCPT condition, this peak was assigned to $NiSO_4$ at 168.5 eV. Similar to the previous analysis at OCPT, two doublet peaks were used to fit the region between 160 - 165 eV. The peak at 161.7 eV was assigned to NiS and the peak at 162.9 eV was assigned to polysulfide. Finally, an additional doublet peak at around 166 - 167 eV was required to fully fit the spectrum, and this peak was assigned to thiosulfate at 167.5 eV.

From the XPS analysis of the millerite electrode, it could be concluded that at pH 12, when an oxidizing potential is applied, millerite oxidizes to form $Ni(OH)_2$ and $NiSO_4$ at higher potential. These species coat on the surface of millerite and provides a hydrophilic layer on the surface which impedes xanthate adsorption.

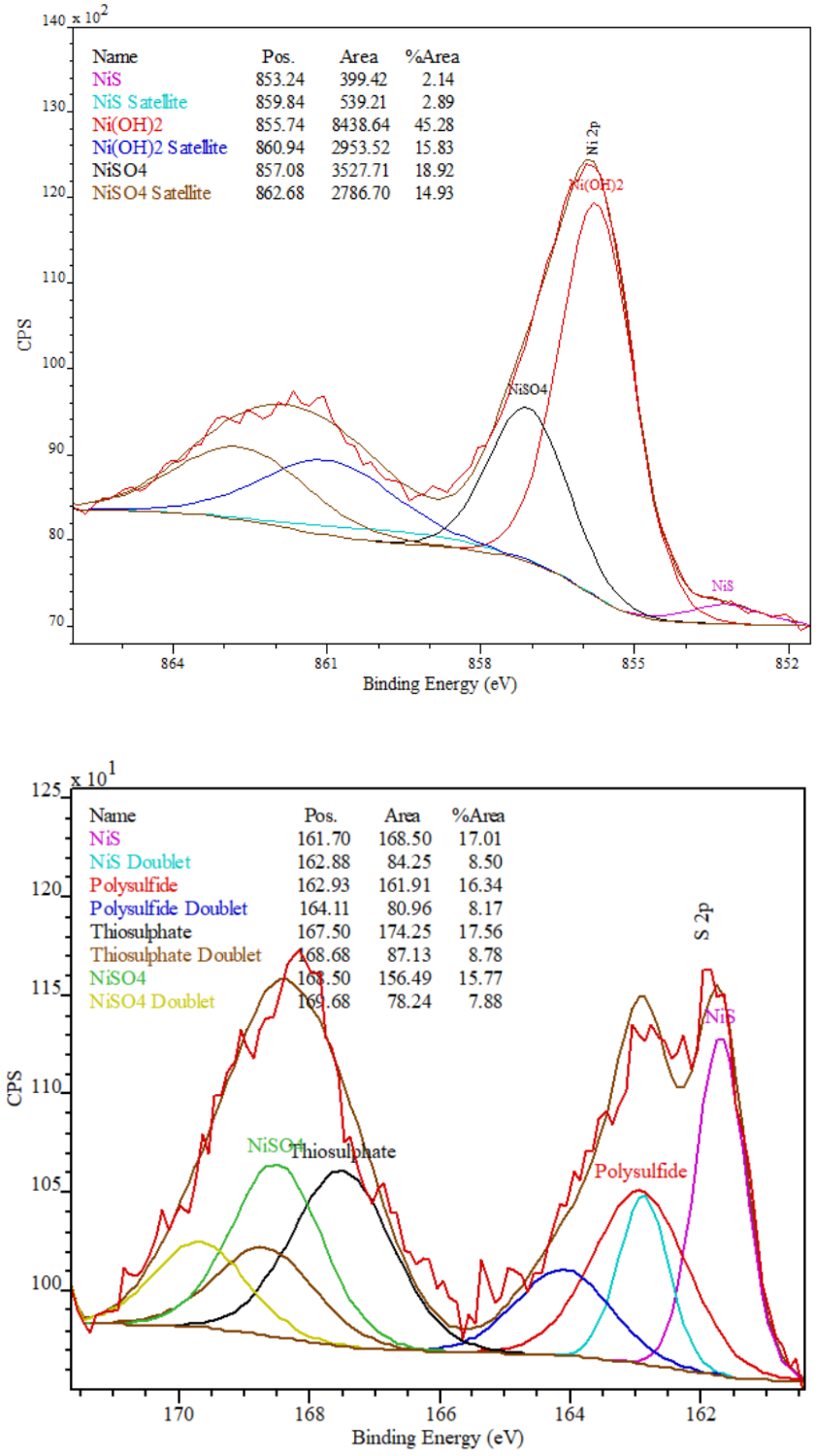

Figure 4.13: XPS Ni $2p_{3/2}$ (top) and S 2p (bottom) narrow region scans of millerite electrode conditioned in pH 12 buffer solution at 0.4 V.

4.4 Conclusion

In this study, the wettability and electrochemical properties of millerite were investigated using cyclic voltammetry coupled with FTIR and contact angle measurements under different pulp potentials and pHs. In addition, the xanthate adsorption mechanism on millerite surface was elucidated by CV, FTIR, and contact angle measurements. Observations from electrochemical, spectroscopic and contact angle studies showed that at lower potentials nickel (II) xanthate adsorption occurs and imparts a slight hydrophobicity to millerite surface. As potential is increased above the reversible potential of formation for dixanthogen, a steep increase in current occurred and hydrophobicity is greatly increased.

From investigations of millerite with KEX at pH 9, dixanthogen appeared to be the predominate species formed on the surface of millerite and is responsible for the hydrophobicity increase at higher potentials. For pH 12, conditioning time plays an important role in xanthate adsorption due to oxidation reactions occurring from 0.1 V potential onwards. No redox reactions occurred for collectorless millerite at pH 9 from 0 to 0.4 V. Therefore, the pre-conditioning step did not interfere with xanthate adsorption mechanism at pH 9 investigated in this study. However, for pH 12 conditions, millerite electrode becomes oxidized from pre-conditioning, which impedes the xanthate adsorption. XPS analysis of millerite electrode conditioned at 0.4 V showed that the millerite surface becomes coated with $Ni(OH)_2$ and $NiSO_4$ at pH 12 with neglectable amount of unaltered NiS. This hydrophilic coating inhibits xanthate adsorption. This finding provides a new pathway for investigations into millerite depression.

4.5 References

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Chapter 5 Flotation

5.1 Introduction

In copper-nickel flotation circuits, nickel impurities were found to be present in the copper concentrate. These nickel impurities reduce the economic value of copper concentrate due to penalties applied on Ni% from smelters. Therefore, separation of nickel bearing minerals from the copper bearing minerals is desired. Recently with the emergence of higher millerite bearing ores in the Sudbury region, an understanding of the surface properties and flotation chemistry of millerite is becoming important for the successful depression of millerite from chalcopyrite in copper-nickel separation.

Depression of millerite from chalcopyrite is desired to improve copper concentrate quality as well as to ensure that nickel value is not lost in the copper concentrate. The flotation behavior of both chalcopyrite and pentlandite have been well studied in the past (Bozkurt, 1998; Fairthorne, 1997; Hodgson, 1989; Luttrell, 1984; Ralston, 1991; Senior, 1994). Previously, from the electrochemical and wettability studies of millerite surface, it was discovered that dixanthogen is the predominately species responsible for increased hydrophobicity of millerite surface at pH 9. For pH 12, millerite surface becomes oxidized at higher potential and a hydrophilic coating is formed on the surface that impedes xanthate adsorption. From the previous findings, it could be seen that selective flotation of millerite from chalcopyrite could theoretically be achieved through manipulation of flotation parameters.

In this study, single mineral flotation studies were conducted on millerite to support previous findings. In addition, preliminary mixed mineral floatation of chalcopyrite and millerite was conducted at pH 12 to test the separation efficiency of millerite from chalcopyrite at different potentials.

5.2 Experimental

5.2.1 Materials

High grade millerite ore used in micro-flotation studies was purchased from Kaygeedee minerals, and the mineral was originally sourced from Levack mine, Sudbury, ON. Phase analysis by XRD and XRF analysis indicated that the sample consists mainly of millerite with slight chalcopyrite impurities. High purity chalcopyrite used in micro-flotation studies was obtained from Fisher Scientific. The mineral samples were first crushed using a BB200 Jaw Crusher to around 5 mm in diameter, then impurities were picked out from the crushed sample. This was followed by further grinding and screening to obtain the final 38 - 74 µm size fraction used for micro-flotation studies. To avoid contamination, the machines were thoroughly cleaned between each mineral preparation.

After grinding, the mineral powders were cleaned ultrasonically. The mineral powders were poured into a beaker and filled with DI water, the minerals were sonicated for 1 min and allowed to settle for 1 min. After that, the DI water along with the contaminants were disposed and the beaker was refilled with clean DI water. This process was repeated until the DI water became clear after the settling process. The sample was then freeze dried and stored in vacuum sealed bags in the refrigerator.

XRF analysis was conducted on the final millerite and chalcopyrite samples obtained and is shown in Table 5.1 and Table 5.2 below. The final purity of the millerite sample was determined to be 91.2 wt.% with 7.0 wt.% chalcopyrite impurities. The final purity of the chalcopyrite sample was determined to be 92.52 wt.%.

Table 5.1: XRF analysis of chalcopyrite

Element	Spot #1 wt%	Spot #2 wt%	Spot #3 wt%	Average wt%
S	37.3	38.0	37.0	37.4
Ca	0.9	0.6	1.1	0.8
Fe	28.1	27.8	28.6	28.2
Cu	32.6	32.4	32.8	32.6
Zn	1.2	1.2	0.5	1.0
Total	100	100	100	100

Table 5.2: XRF analysis of millerite

Element	Spot #1 wt%	Spot #2 wt%	Spot #3 wt%	Average wt%
Si	0.9	1.2	1.1	1.0
S	33.5	33.5	33.4	33.5
Fe	3.5	3.4	3.7	3.5
Co	0.3	0.3	0.3	0.3
Ni	59.2	59.1	58.7	59.0
Cu	2.7	2.7	2.8	2.7
Total	100	100	100	100

Potassium ethyl xanthate (KEX) was the sole collector used in the micro-flotation studies. A dilute solution of 0.1 M KEX was prepared each day and added to the micro-flotation tube to make up 1.4×10^{-4} M KEX. Buffer solutions was prepared using Milli-Q water. A buffer of pH 9.2 was achieved from 0.025 M sodium tetraborate decahydrate. For pH 12, 0.2 M potassium chloride along with sodium hydroxide was used for the buffer preparation. Pulp potential was chemically controlled using sodium dithionite ($Na_2S_2O_4$) and sodium hypochlorite (NaOCl). Ultra-pure nitrogen gas was used during the conditioning stage and for flotation.

5.2.2 Experimental Procedures

A modified flotation tube was used for electrochemical flotation in this study; and the modified tube is shown in Figure *5.1*. In this study, micro-flotation tests were carried out using mineral particles of size ranges between 38 - 74 µm with 120 mL of buffered solutions at the desired pH values.

For single mineral flotation 1.2 g of mineral sample was used, and for mixed mineral flotation 1.6 g of sample was used. Prior to experimentation, the buffered solutions were first purged for 1 hr. with nitrogen to remove all oxygen from the system. Mineral powders used in the experiment were sonicated for 5 minutes to remove the oxidation layer. The buffered solution was then transferred along with the mineral powder into the modified electrochemical flotation tube. The pulp potential of the micro-flotation cell was adjusted using sodium dithionite and sodium hypochlorite. Once the desired potential was reached, the mineral particles were conditioned in the flotation tube at the desired potential for 5 min. Nitrogen was purged in from the upper nitrogen inlet during this period to maintain oxygen free environment in the tube:

- For collectorless flotation, after conditioning at the desired potential, flotation was initiated by setting the flowmeter to 20 sccm, flotation time was recorded when the first bubble was observed in the flotation tube. The stirring speed of the stir bar was set to 700 rpm during flotation. After the desired flotation time, the flowmeter was set to 0 sccm and the floated portion (concentrate) and the bottom portion (tails) was collected, filtered and weighed the next day.
- For electrochemical flotation with collectors added, after conditioning at the desired potential, collector was added to the system to a final concentration of 1.4×10^{-4} M KEX and the system was conditioned for an additional 5 min at the set potential. Flotation was initiated by setting the flowmeter to 20 sccm, flotation time was recorded when the first bubble was

observed in the flotation tube. The stirring speed of the stir bar is set to 700 rpm during flotation. After the desired flotation time, the flowmeter was set to 0 sccm and the floated portion (concentrate) and the bottom portion (tails) was collected, filtered and weighed the next day.

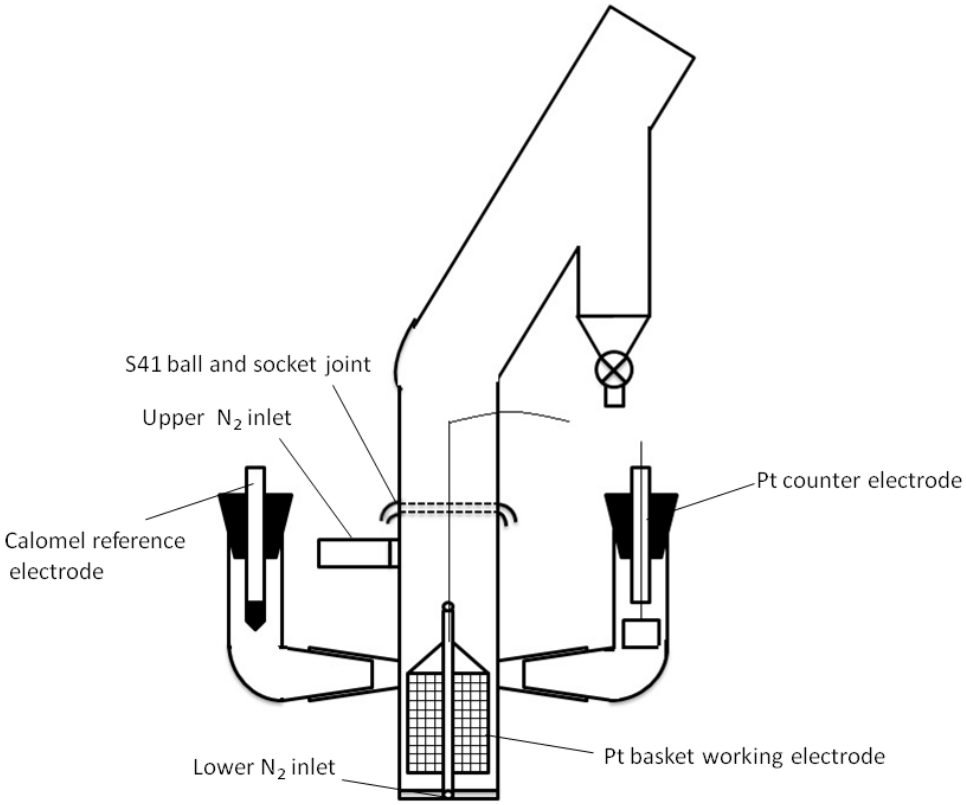

Figure 5.1: Schematic of the modified Hallimond flotation tube (Zhang, 2015)

Flotation recovery was calculated using the Equation (5.1) below:

$$Recovery\ (\%) = \frac{Concentrate}{Concentrate+Tails} * 100\% \quad (5.1)$$

For mixed flotation, XRF was conducted to determine the amount of millerite and chalcopyrite recovered in the concentrate and tails.

5.3 Results and Discussion

5.3.1 Single Mineral Flotation for Millerite

Single mineral flotation studies were conducted on both millerite and chalcopyrite samples under collectorless conditions and with the addition of 1.4 x 10^{-4} M KEX. The effect of pulp potential and pH on flotation recovery was investigated by varying pH and Eh.

Figure *5.2* shows the single mineral flotation for millerite under different potentials for collectorless conditions. At reducing potential, millerite under both pH 9.2 and pH 12 exhibited poor floatability. Under oxidizing conditions, floatation recovery of millerite showed poor floatability without collectors for pH 9.2. This result is consistent with what was observed previously from contact angle measurements.

For pH 12 under oxidizing condition, millerite floatability showed a decreasing trend from 0 V potential onwards to 0.3 V. At close to 0 V, around 47% recovery was observed. Collectorless floatability of minerals has been investigated previously for many sulphide minerals (Fuerstenau & Sabacky, 1981; Gardner & Woods, 1979; Heyes & Trahar, 1977). The studies showed that many sulfide minerals can exhibit collectorless floatability under certain conditions, and the reason for collectorless floatability varies. It has been established that sulphide minerals is able to oxidize through a continuum of metal deficient sulphides to elemental sulfur (Wills & Napier-munn, 2006). The sulfur rich metal deficient layers formed have been proposed to be able to render mineral surfaces hydrophobic (Buckley, Hamilton, & Woods, 1985). For pH 12, it is likely that elemental sulfur is accountable for the higher than average flotation recovery at close to 0 V potential when millerite becomes slightly oxidized. However, as potential is further increased to more oxidizing conditions, the formation of metal hydroxide and metal sulphate occurred which produced a hydrophilic surface and rendered the mineral hydrophilic. This result is

consistent with what was observed with contact angle measurements. This indicates that under oxidizing conditions at pH 12, the surface oxidation products of millerite is hydrophilic and impedes flotation recovery.

Figure *5.3* shows the single mineral flotation for millerite under different potential with 1.4 x 10^{-4}M KEX for pH 9.2 and pH 12. When compared to the collectorless flotation recovery, it could be observed that for pH 9.2, flotation recovery of millerite increased greatly under oxidizing potential with the addition of KEX to the system. The increased flotation recovery is most likely due to the formation of metal xanthate and dixanthogen at higher potentials which contributed to increased hydrophobicity. Previously, the wettability and surface properties of millerite were investigated with KEX addition at pH 9, and it was observed that dixanthogen appeared to be predominate species formed on millerite surface and can be accounted for the increased hydrophobicity at higher potentials. The flotation studies conducted agrees with previous results, and it could be seen that a rapid increase in flotation recovery occurred after the formation potential for dixanthogen which is at 0.16 V for the concentration of KEX used in this study.

The single mineral flotation for millerite under different potential with 1.4 x 10^{-4} M KEX was also investigated for pH 12 conditions and is depicted in Figure *5.3*. Similar to the collectorless condition, the flotation recovery for millerite at pH 12 with KEX addition also showed a decreasing trend starting from positive potential onwards. At around - 0.04 V, 59% recovery was achieved, and as potential is increased in the positive direction, flotation recovery showed a decreasing trend and reached 11.3% recovery at 0.36 V. This finding is consistent with previous investigations on surface properties by FTIR and contact angle measurement. At pH 12, the millerite surface becomes oxidized at higher potentials to form $Ni(OH)_2$ and $NiSO_4$, this process creates a hydrophilic layer that covers the millerite surface and impedes xanthate adsorption process. As a result, millerite floatability shows a decreasing trend with increasing potential. This finding provides a possible depression strategy for millerite from chalcopyrite through potential manipulation.

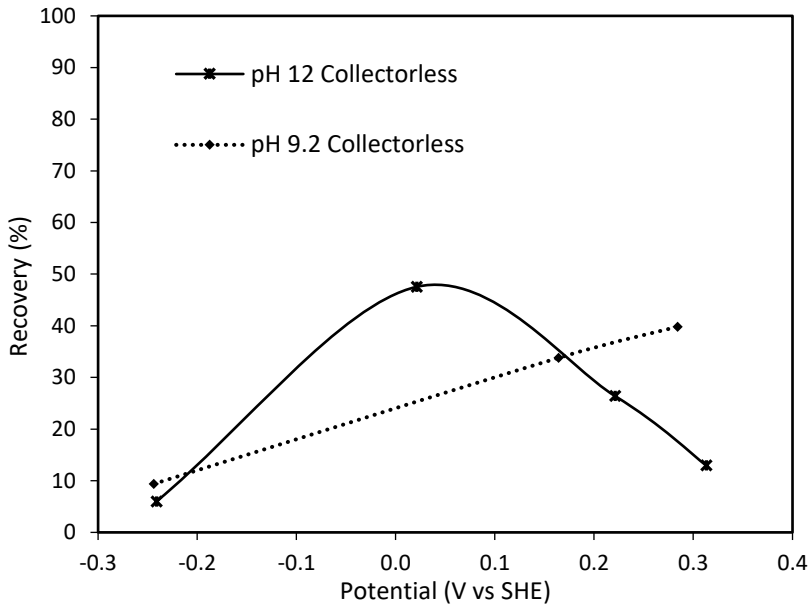

Figure 5.2: Single mineral flotation recovery of millerite at 5 min as a function of potential under collectorless conditions at pH 9.2 and pH 12.

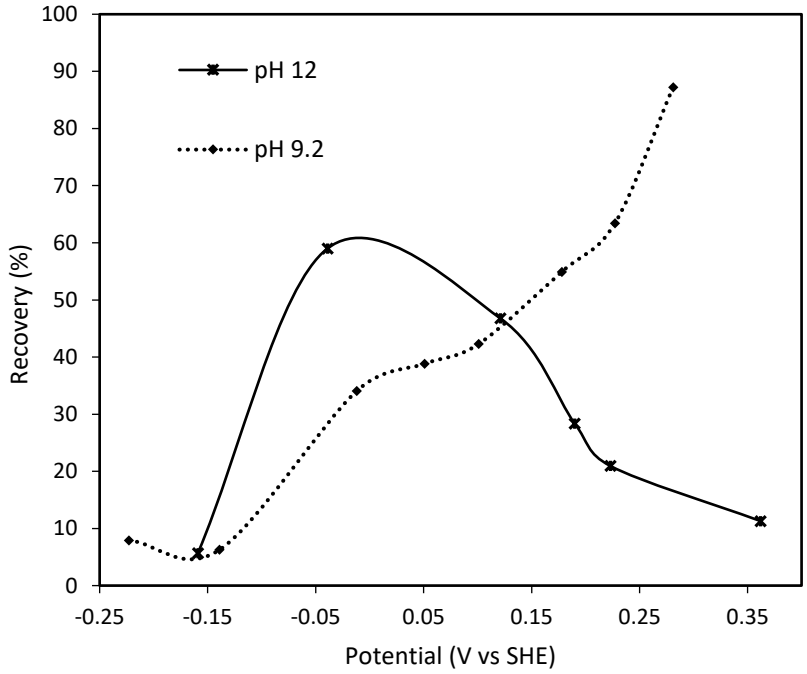

Figure 5.3: Single mineral flotation recovery of millerite at 5 min as a function of potential with 1.4 x 10^{-4} M KEX conditions at pH 9.2 and pH 12.

5.3.2 Single Mineral Flotation Comparison for Millerite and Chalcopyrite

To better compare the floatability of millerite with chalcopyrite, the flotation recovery of millerite was replotted with flotation data for chalcopyrite. Millerite and chalcopyrite floatability were plotted against pulp potential at pH 9.2 and pH 12 in Figure 5.4 and Figure 5.5 respectively.

Figure 5.4 depicts the single mineral flotation response of millerite and chalcopyrite at pH 9.2 with 1.4×10^{-4} M KEX. Comparison of the flotation of chalcopyrite with millerite under this condition shows that the curves showed overlap between the potential ranges tested. This indicates that selective flotation of chalcopyrite from millerite cannot be achieved at this pH value by alteration of pulp potential.

Figure 5.5 depicts the single mineral flotation response of millerite and chalcopyrite at pH 12 with 1.4×10^{-4} M KEX. From this graph it could be observed that the chalcopyrite and millerite flotation curves overlaps initially at reducing potential. However, as potential is increased to oxidizing conditions, a large separation is observed between chalcopyrite recovery curve when compared to millerite recovery curve. The graph shows that millerite could be potentially depressed and separated from chalcopyrite at pH 12 when an oxidizing potential is applied. At close to 0.2 V overpotential, chalcopyrite recovery is at 88.8% while millerite recovery is at 20.9%. This finding indicates that a large Eh range exists in the oxidizing potential region where chalcopyrite can be potentially separated from millerite. To test the effectiveness of this method, flotation study was conducted on mixed millerite and chalcopyrite samples.

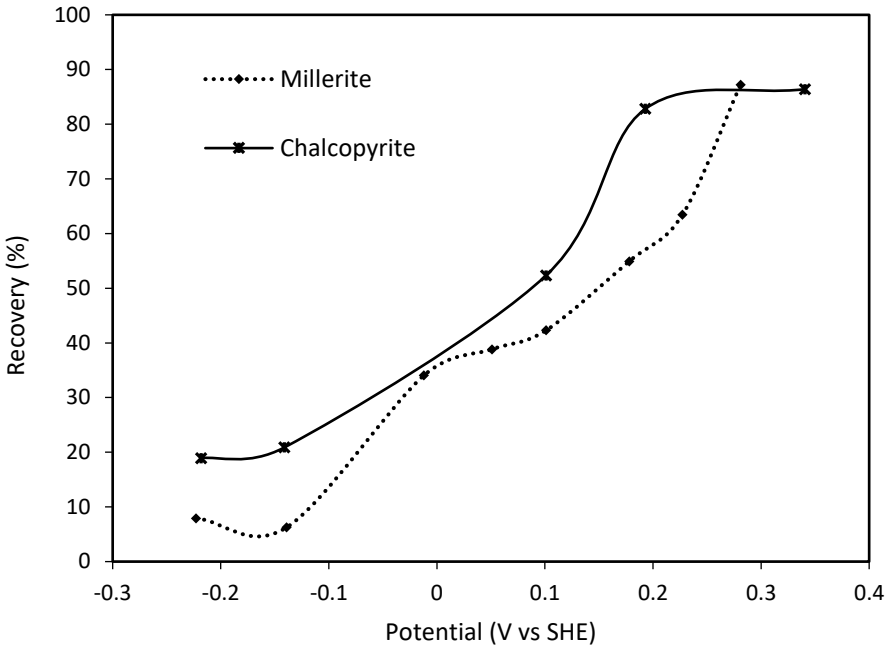

Figure 5.4 Single mineral flotation recovery for millerite and chalcopyrite at 5 min as a function of potential at pH 9.2 with 1.4 x 10^{-4} M KEX

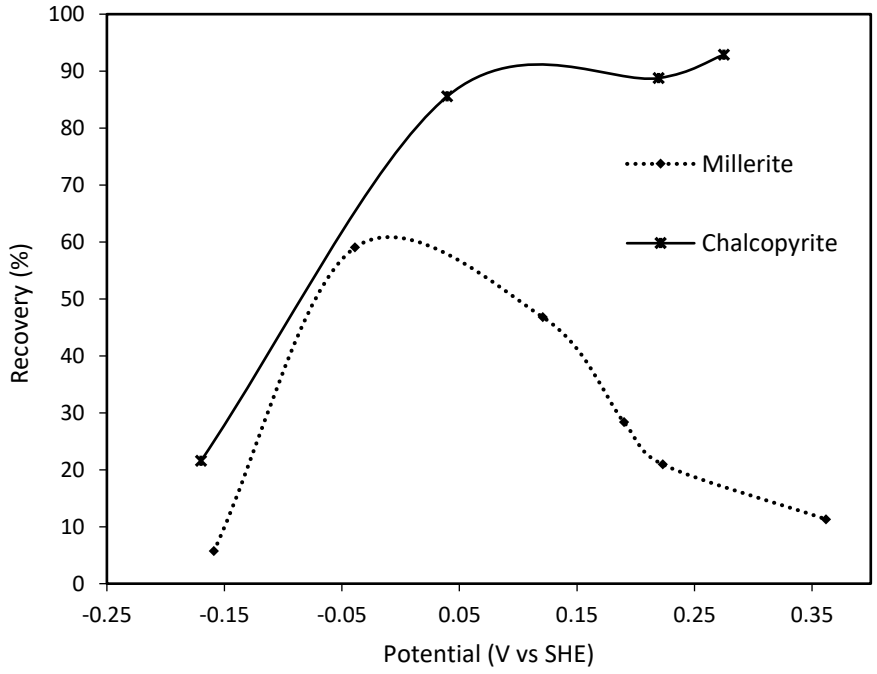

Figure 5.5 Single mineral flotation recovery for millerite 5 min and chalcopyrite at 10 min as a function of potential at pH 12 with 1.4 x 10^{-4} M KEX

5.3.3 Mixed Mineral Flotation Study of Millerite and Chalcopyrite

Two different mixed mineral feeds comprising of different proportions of millerite and chalcopyrite were tested in this section. Samples of 1.6 g of mixed feed was first conditioned in the flotation tube for 5 min at the desired potential prior to xanthate addition. After conditioning, KEX was introduced to the system and allowed to interact with the mixed feed for 5 min. Flotation was initiated by setting the flowmeter to 20 sccm. After flotation, the concentrate and tails were filtered, dried and weighted to determine the percent recovery. To determine the elemental composition, XRF analysis was conducted on the concentrate and tails fraction. Conversion between elemental analyses to mineral composition was conducted using stoichiometric compositions of millerite and chalcopyrite.

The first mixed feed tested consists of 0.8 g of millerite mixed with 0.8 g of chalcopyrite. Table *5.3* depicts the mineral composition of the mixed mineral flotation. While Figure *5.6* shows the flotation recovery of the mixed mineral feed with respect to different pulp potentials with 1.4 x 10^{-4} M KEX addition at pH 12.

From Table *5.3* it could be seen that as potential is increased to more oxidizing potential from initial open circuit potential (OCPT) the weight percentage of millerite decreases drastically in the floated concentrate. Figure *5.6* provides a visual view of the mineral recovery, and it could be seen that as potential is increased, separation of millerite occurred from chalcopyrite. At 0.32 V, the recovery of millerite is at 19.1% while chalcopyrite is at 85.7%. This indicates that millerite can be successfully depressed from chalcopyrite by alteration of pulp potential to oxidizing environment at pH 12.

To reaffirm the mixed mineral flotation results, a second mixed feed consisting of higher chalcopyrite and lower millerite composition was tested. The second mixed feed tested consists of 0.4 g of millerite mixed with 1.2 g of chalcopyrite. Table *5.4* and Figure *5.7* shows the mineral composition and

flotation recovery of the mixed mineral feed at different pulp potentials with 1.4 x 10^{-4} M KEX addition at pH 12.

Similar to as observed for the first mixed feed, from Table 5.4 it could be seen that as potential is increased, the millerite recovery in the concentrate portion is greatly decreased. From Figure 5.7 observations show that at OCPT conditions both millerite and chalcopyrite are strongly floatable; however, as potential is increased millerite becomes depressed while chalcopyrite remains strongly floatable. At 0.27 V, the final recovery of millerite is at 18.4% compared to 94.7% for chalcopyrite. This result shows that through manipulation of Eh at pH 12, the selective flotation of chalcopyrite from millerite could be achieved.

Table 5.3: Mineral composition of mixed mineral flotation (0.8 g millerite + 0.8 g chalcopyrite) at different pulp potentials at pH 12 with 1.4 x 10^{-4} M KEX

	Mixed Feed (wt%)	OCPT Conc (wt%)	OCPT Tails (wt%)	0.2V Conc (wt%)	0.2V Tails (wt%)	0.3V Conc (wt%)	0.3V Tails (wt%)
Millerite	45.60	43.72	3.75	15.07	28.61	11.84	33.40
Chalcopyrite	50.20	48.85	2.09	50.20	3.99	45.13	7.54

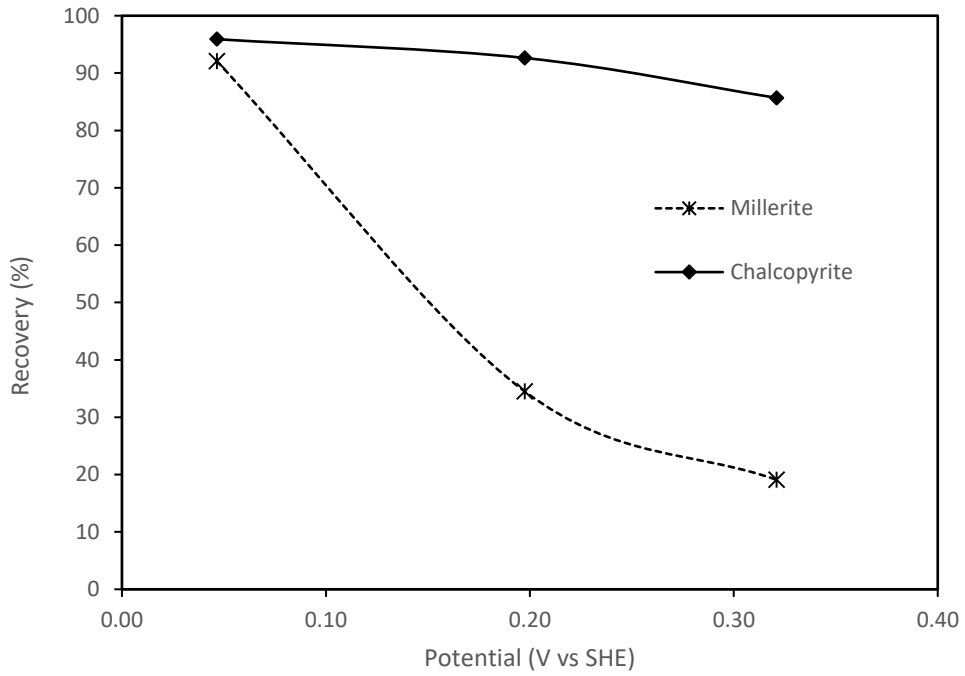

Figure 5.6 10 min flotation of mixed mineral feed (0.8 g millerite + 0.8 g chalcopyrite) at different pulp potentials at pH 12 with 1.4 x 10^{-4} M KEX

Table 5.4 Mineral composition of mixed mineral flotation (0.4 g millerite + 1.2 g chalcopyrite) at different pulp potentials at pH 12 with 1.4 x 10^{-4} M KEX

	Mixed Feed (wt%)	OCPT Conc (wt%)	OCPT Tails (wt%)	0.2V Conc (wt%)	0.2V Tails (wt%)	0.3V Conc (wt%)	0.3V Tails (wt%)
Millerite	22.80	22.20	2.40	11.82	9.01	3.97	17.63
Chalcopyrite	71.36	69.63	4.50	73.74	3.51	72.42	4.06

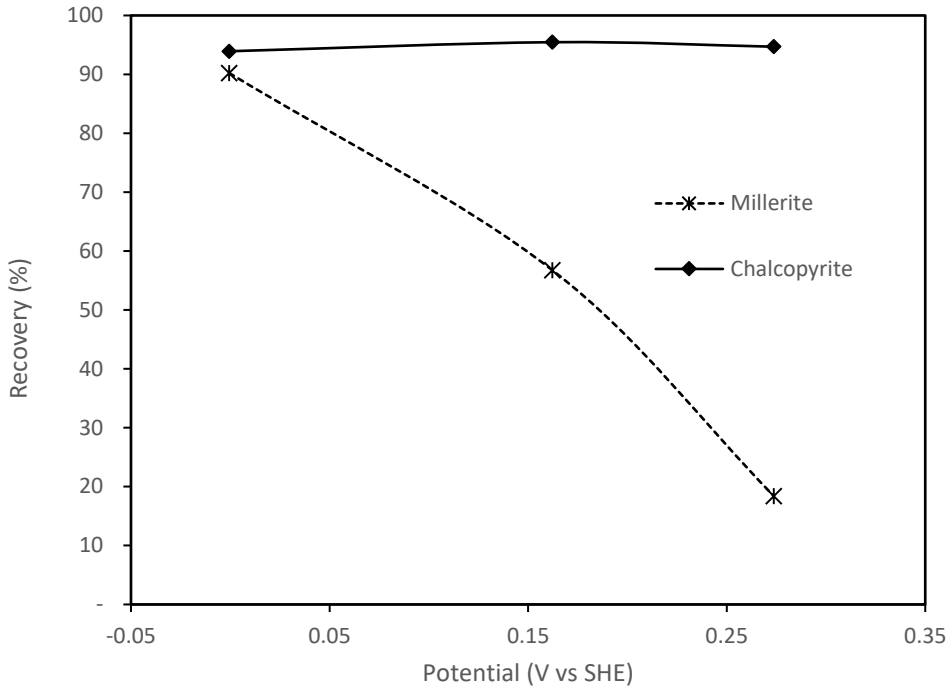

Figure 5.7 10 min flotation recovery of mixed mineral feed (0.4 g millerite + 1.2 g chalcopyrite) at different pulp potentials at pH 12 with 1.4 x 10^{-4} M KEX

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Chapter 6 Conclusion and Future Work

6.1 Conclusion

In this study, the wettability and electrochemical properties of millerite were investigated using cyclic voltammetry coupled with FTIR and contact angle measurements under different pulp potentials and pHs. In addition, the xanthate adsorption mechanism on millerite surface was elucidated by CV, FTIR, and contact angle measurements. XPS analysis was conducted to determine the surface species present on millerite surface after oxidation reactions. Finally, single mineral and mixed mineral flotation studies were conducted to investigate the possibility of using potential control for separation of millerite from chalcopyrite. The major conclusions are summarized below:

1.) Observations from electrochemical, spectroscopic and contact angle studies showed that at pH 9 the formation of nickel (II) xanthate occurs and imparts a slight hydrophobicity to millerite surface at lower potentials. As potential is increased above the reversible potential of formation for dixanthogen, a steep increase in current occurred and hydrophobicity increased greatly for pH 9. From investigations of millerite with KEX at pH 9, dixanthogen appeared to be the predominate species formed on the surface of millerite and is responsible for the hydrophobicity increase at higher potentials.

2.) For pH 12, conditioning time plays an important role in xanthate adsorption process due to oxidation reactions occurring from 0.1 V potential onwards. No redox reactions occurred for collectorless millerite at pH 9 between 0 to 0.4 V; therefore, the pre-conditioning step did not interfere with xanthate adsorption mechanism at pH 9 investigated in this study. However, for pH 12 conditions, millerite electrode becomes oxidized from pre-conditioning, which impedes the xanthate adsorption mechanism. This finding provides a new pathway for investigations into millerite depression.

3.) XPS analysis of millerite electrode at pH 12 at 0.4 V potential indicated that as millerite surface is oxidized, $Ni(OH)_2$ and $NiSO_4$ formation occurs. This process creates a hydrophilic layer that covers the millerite surface and renders millerite hydrophilic. This conclusion is supported by flotation studies of millerite at pH 12.

4.) Single mineral flotation was conducted for millerite and chalcopyrite at pH 9.2 and pH 12 at various potentials in the presence of 1.4×10^{-4} M KEX. From the single mineral flotation, it was determined that a range of potential exists (> 0.2 V) at pH 12 where millerite showed very poor floatability while chalcopyrite maintained good floatability. This finding was reaffirmed with mixed mineral flotation of chalcopyrite and millerite at different compositions. The mixed mineral flotation studies showed that depression of millerite occurred under oxidizing potential, with final recovery of millerite at close to about 20% at 0.3 V while chalcopyrite recovery is about 95%.

6.2 Future Work

Additional study on millerite surface is required. Some suggestions are listed below.

1.) In this study, the millerite particles were first oxidized prior to xanthate addition. Using this methodology, depression of millerite from chalcopyrite was achieved in mixed mineral flotation at pH 12. However, it is also important to investigate a depression strategy for millerite particles that might have collectors pre-adsorbed, which is close to practical flotation condition.

2.) For pH 12, at OCPT condition a very high recovery for millerite was observed for both collectorless conditions and with the addition of KEX. This phenomenon was attributed to the polysulphide species formed due to slight oxidation of the millerite particle. However, further investigations should be conducted to support this claim.

3.) Copper ions typically provide an activation effect for minerals, the effect of copper ions on millerite flotation should be explored to determine the effect of copper activation on millerite flotation.

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Appendix

Please refer to the tables below for selected original data from various experimentations conducted

Table 7.1: Cyclic voltammetry results for millerite electrode in pH 9 buffer solution in the presence and absence of 0.01M KEX

Collectorless			**KEX 0.01M**		
Scan	Potential (V)	Current Density (mA/cm^2)	Scan	Potential (V)	Current Density (mA/cm^2)
1.0	-0.698	-18.049	1.0	-0.698	-22.007
1.0	-0.695	-14.807	1.0	-0.695	-17.709
1.0	-0.693	-12.820	1.0	-0.693	-14.866
1.0	-0.690	-11.402	1.0	-0.690	-12.850
1.0	-0.688	-10.324	1.0	-0.688	-11.329
1.0	-0.685	-9.453	1.0	-0.685	-10.125
1.0	-0.683	-8.744	1.0	-0.683	-9.143
1.0	-0.680	-8.131	1.0	-0.680	-8.308
1.0	-0.678	-7.607	1.0	-0.678	-7.629
1.0	-0.676	-7.149	1.0	-0.676	-7.038
1.0	-0.673	-6.728	1.0	-0.673	-6.536
1.0	-0.671	-6.351	1.0	-0.671	-6.085
1.0	-0.668	-6.019	1.0	-0.668	-5.709
1.0	-0.666	-5.716	1.0	-0.666	-5.376
1.0	-0.663	-5.443	1.0	-0.663	-5.051
1.0	-0.661	-5.177	1.0	-0.661	-4.778
1.0	-0.658	-4.955	1.0	-0.658	-4.534
1.0	-0.656	-4.719	1.0	-0.656	-4.298
1.0	-0.654	-4.520	1.0	-0.654	-4.099
1.0	-0.651	-4.342	1.0	-0.651	-3.921
1.0	-0.649	-4.172	1.0	-0.649	-3.744
1.0	-0.646	-4.017	1.0	-0.646	-3.574
1.0	-0.644	-3.862	1.0	-0.644	-3.434
1.0	-0.641	-3.722	1.0	-0.641	-3.301
1.0	-0.639	-3.589	1.0	-0.639	-3.183
1.0	-0.636	-3.464	1.0	-0.636	-3.057
1.0	-0.634	-3.360	1.0	-0.634	-2.947
1.0	-0.632	-3.249	1.0	-0.632	-2.858
1.0	-0.629	-3.139	1.0	-0.629	-2.755
1.0	-0.627	-3.043	1.0	-0.627	-2.673
1.0	-0.624	-2.954	1.0	-0.624	-2.585
1.0	-0.622	-2.858	1.0	-0.622	-2.511
1.0	-0.619	-2.777	1.0	-0.619	-2.437
1.0	-0.617	-2.703	1.0	-0.617	-2.385
1.0	-0.615	-2.629	1.0	-0.615	-2.319
1.0	-0.612	-2.555	1.0	-0.612	-2.245
1.0	-0.610	-2.489	1.0	-0.610	-2.171
1.0	-0.607	-2.422	1.0	-0.607	-2.119
1.0	-0.605	-2.363	1.0	-0.605	-2.068
1.0	-0.602	-2.311	1.0	-0.602	-2.023
1.0	-0.600	-2.252	1.0	-0.600	-1.964
1.0	-0.597	-2.208	1.0	-0.597	-1.913

1.0	-0.595	-2.149	1.0	-0.595	-1.868
1.0	-0.593	-2.097	1.0	-0.593	-1.831
1.0	-0.590	-2.068	1.0	-0.590	-1.787
1.0	-0.588	-2.016	1.0	-0.588	-1.735
1.0	-0.585	-1.987	1.0	-0.585	-1.713
1.0	-0.583	-1.935	1.0	-0.583	-1.676
1.0	-0.580	-1.891	1.0	-0.580	-1.632
1.0	-0.578	-1.861	1.0	-0.578	-1.603
1.0	-0.575	-1.809	1.0	-0.575	-1.566
1.0	-0.573	-1.780	1.0	-0.573	-1.551
1.0	-0.571	-1.750	1.0	-0.571	-1.507
1.0	-0.568	-1.721	1.0	-0.568	-1.477
1.0	-0.566	-1.676	1.0	-0.566	-1.462
1.0	-0.563	-1.654	1.0	-0.563	-1.433
1.0	-0.561	-1.647	1.0	-0.561	-1.411
1.0	-0.558	-1.603	1.0	-0.558	-1.374
1.0	-0.556	-1.588	1.0	-0.556	-1.351
1.0	-0.553	-1.558	1.0	-0.553	-1.337
1.0	-0.551	-1.521	1.0	-0.551	-1.315
1.0	-0.549	-1.492	1.0	-0.549	-1.300
1.0	-0.546	-1.470	1.0	-0.546	-1.278
1.0	-0.544	-1.447	1.0	-0.544	-1.248
1.0	-0.541	-1.425	1.0	-0.541	-1.233
1.0	-0.539	-1.403	1.0	-0.539	-1.219
1.0	-0.536	-1.388	1.0	-0.536	-1.196
1.0	-0.534	-1.366	1.0	-0.534	-1.174
1.0	-0.532	-1.337	1.0	-0.532	-1.159
1.0	-0.529	-1.322	1.0	-0.529	-1.123
1.0	-0.527	-1.307	1.0	-0.527	-1.123
1.0	-0.524	-1.285	1.0	-0.524	-1.108
1.0	-0.522	-1.278	1.0	-0.522	-1.086
1.0	-0.519	-1.255	1.0	-0.519	-1.071
1.0	-0.517	-1.241	1.0	-0.517	-1.071
1.0	-0.514	-1.211	1.0	-0.514	-1.034
1.0	-0.512	-1.196	1.0	-0.512	-1.012
1.0	-0.510	-1.174	1.0	-0.510	-1.004
1.0	-0.507	-1.167	1.0	-0.507	-0.997
1.0	-0.505	-1.145	1.0	-0.505	-1.004
1.0	-0.502	-1.137	1.0	-0.502	-0.975
1.0	-0.500	-1.123	1.0	-0.500	-0.960
1.0	-0.497	-1.108	1.0	-0.497	-0.953
1.0	-0.495	-1.086	1.0	-0.495	-0.938
1.0	-0.492	-1.071	1.0	-0.492	-0.916
1.0	-0.490	-1.063	1.0	-0.490	-0.916
1.0	-0.488	-1.041	1.0	-0.488	-0.901
1.0	-0.485	-1.027	1.0	-0.485	-0.894
1.0	-0.483	-1.019	1.0	-0.483	-0.886
1.0	-0.480	-1.004	1.0	-0.480	-0.857
1.0	-0.478	-0.997	1.0	-0.478	-0.857
1.0	-0.475	-0.982	1.0	-0.475	-0.849
1.0	-0.473	-0.967	1.0	-0.473	-0.834
1.0	-0.470	-0.953	1.0	-0.470	-0.834
1.0	-0.468	-0.938	1.0	-0.468	-0.820
1.0	-0.466	-0.931	1.0	-0.466	-0.805
1.0	-0.463	-0.908	1.0	-0.463	-0.790
1.0	-0.461	-0.908	1.0	-0.461	-0.775

1.0	-0.458	-0.886	1.0	-0.458	-0.768
1.0	-0.456	-0.879	1.0	-0.456	-0.753
1.0	-0.453	-0.871	1.0	-0.453	-0.753
1.0	-0.451	-0.857	1.0	-0.451	-0.738
1.0	-0.448	-0.842	1.0	-0.448	-0.731
1.0	-0.446	-0.842	1.0	-0.446	-0.731
1.0	-0.444	-0.820	1.0	-0.444	-0.724
1.0	-0.441	-0.812	1.0	-0.441	-0.716
1.0	-0.439	-0.798	1.0	-0.439	-0.694
1.0	-0.436	-0.783	1.0	-0.436	-0.694
1.0	-0.434	-0.783	1.0	-0.434	-0.687
1.0	-0.431	-0.753	1.0	-0.431	-0.679
1.0	-0.429	-0.761	1.0	-0.429	-0.665
1.0	-0.427	-0.746	1.0	-0.427	-0.665
1.0	-0.424	-0.746	1.0	-0.424	-0.665
1.0	-0.422	-0.738	1.0	-0.422	-0.650
1.0	-0.419	-0.731	1.0	-0.419	-0.642
1.0	-0.417	-0.709	1.0	-0.417	-0.635
1.0	-0.414	-0.694	1.0	-0.414	-0.628
1.0	-0.412	-0.694	1.0	-0.412	-0.628
1.0	-0.409	-0.679	1.0	-0.409	-0.606
1.0	-0.407	-0.679	1.0	-0.407	-0.606
1.0	-0.405	-0.657	1.0	-0.405	-0.591
1.0	-0.402	-0.657	1.0	-0.402	-0.583
1.0	-0.400	-0.650	1.0	-0.400	-0.576
1.0	-0.397	-0.628	1.0	-0.397	-0.561
1.0	-0.395	-0.628	1.0	-0.395	-0.554
1.0	-0.392	-0.620	1.0	-0.392	-0.546
1.0	-0.390	-0.620	1.0	-0.390	-0.539
1.0	-0.387	-0.598	1.0	-0.387	-0.546
1.0	-0.385	-0.591	1.0	-0.385	-0.524
1.0	-0.383	-0.583	1.0	-0.383	-0.524
1.0	-0.380	-0.576	1.0	-0.380	-0.502
1.0	-0.378	-0.569	1.0	-0.378	-0.510
1.0	-0.375	-0.546	1.0	-0.375	-0.502
1.0	-0.373	-0.539	1.0	-0.373	-0.487
1.0	-0.370	-0.524	1.0	-0.370	-0.487
1.0	-0.368	-0.524	1.0	-0.368	-0.480
1.0	-0.365	-0.524	1.0	-0.365	-0.473
1.0	-0.363	-0.510	1.0	-0.363	-0.473
1.0	-0.361	-0.502	1.0	-0.361	-0.458
1.0	-0.358	-0.487	1.0	-0.358	-0.465
1.0	-0.356	-0.480	1.0	-0.356	-0.450
1.0	-0.353	-0.465	1.0	-0.353	-0.443
1.0	-0.351	-0.480	1.0	-0.351	-0.436
1.0	-0.348	-0.473	1.0	-0.348	-0.428
1.0	-0.346	-0.465	1.0	-0.346	-0.428
1.0	-0.344	-0.443	1.0	-0.344	-0.406
1.0	-0.341	-0.443	1.0	-0.341	-0.406
1.0	-0.339	-0.428	1.0	-0.339	-0.406
1.0	-0.336	-0.414	1.0	-0.336	-0.399
1.0	-0.334	-0.406	1.0	-0.334	-0.391
1.0	-0.331	-0.399	1.0	-0.331	-0.384
1.0	-0.329	-0.399	1.0	-0.329	-0.384
1.0	-0.326	-0.391	1.0	-0.326	-0.377
1.0	-0.324	-0.377	1.0	-0.324	-0.369

1.0	-0.322	-0.369	1.0	-0.322	-0.369
1.0	-0.319	-0.369	1.0	-0.319	-0.362
1.0	-0.317	-0.377	1.0	-0.317	-0.362
1.0	-0.314	-0.354	1.0	-0.314	-0.354
1.0	-0.312	-0.340	1.0	-0.312	-0.347
1.0	-0.309	-0.332	1.0	-0.309	-0.354
1.0	-0.307	-0.325	1.0	-0.307	-0.347
1.0	-0.304	-0.318	1.0	-0.304	-0.340
1.0	-0.302	-0.325	1.0	-0.302	-0.318
1.0	-0.300	-0.295	1.0	-0.300	-0.325
1.0	-0.297	-0.303	1.0	-0.297	-0.318
1.0	-0.295	-0.288	1.0	-0.295	-0.295
1.0	-0.292	-0.273	1.0	-0.292	-0.303
1.0	-0.290	-0.288	1.0	-0.290	-0.295
1.0	-0.287	-0.273	1.0	-0.287	-0.295
1.0	-0.285	-0.258	1.0	-0.285	-0.295
1.0	-0.282	-0.266	1.0	-0.282	-0.288
1.0	-0.280	-0.244	1.0	-0.280	-0.281
1.0	-0.278	-0.236	1.0	-0.278	-0.266
1.0	-0.275	-0.229	1.0	-0.275	-0.258
1.0	-0.273	-0.222	1.0	-0.273	-0.258
1.0	-0.270	-0.207	1.0	-0.270	-0.266
1.0	-0.268	-0.222	1.0	-0.268	-0.244
1.0	-0.265	-0.207	1.0	-0.265	-0.251
1.0	-0.263	-0.207	1.0	-0.263	-0.251
1.0	-0.261	-0.199	1.0	-0.261	-0.236
1.0	-0.258	-0.192	1.0	-0.258	-0.236
1.0	-0.256	-0.199	1.0	-0.256	-0.236
1.0	-0.253	-0.177	1.0	-0.253	-0.229
1.0	-0.251	-0.162	1.0	-0.251	-0.236
1.0	-0.248	-0.155	1.0	-0.248	-0.222
1.0	-0.246	-0.148	1.0	-0.246	-0.229
1.0	-0.243	-0.140	1.0	-0.243	-0.214
1.0	-0.241	-0.133	1.0	-0.241	-0.214
1.0	-0.239	-0.133	1.0	-0.239	-0.199
1.0	-0.236	-0.126	1.0	-0.236	-0.192
1.0	-0.234	-0.118	1.0	-0.234	-0.192
1.0	-0.231	-0.126	1.0	-0.231	-0.199
1.0	-0.229	-0.111	1.0	-0.229	-0.177
1.0	-0.226	-0.111	1.0	-0.226	-0.170
1.0	-0.224	-0.103	1.0	-0.224	-0.170
1.0	-0.221	-0.103	1.0	-0.221	-0.185
1.0	-0.219	-0.096	1.0	-0.219	-0.170
1.0	-0.217	-0.081	1.0	-0.217	-0.162
1.0	-0.214	-0.096	1.0	-0.214	-0.155
1.0	-0.212	-0.081	1.0	-0.212	-0.148
1.0	-0.209	-0.089	1.0	-0.209	-0.140
1.0	-0.207	-0.066	1.0	-0.207	-0.140
1.0	-0.204	-0.059	1.0	-0.204	-0.148
1.0	-0.202	-0.052	1.0	-0.202	-0.133
1.0	-0.199	-0.044	1.0	-0.199	-0.126
1.0	-0.197	-0.052	1.0	-0.197	-0.133
1.0	-0.195	-0.052	1.0	-0.195	-0.118
1.0	-0.192	-0.030	1.0	-0.192	-0.111
1.0	-0.190	-0.037	1.0	-0.190	-0.126
1.0	-0.187	-0.030	1.0	-0.187	-0.096

1.0	-0.185	-0.030	1.0	-0.185	-0.096
1.0	-0.182	-0.015	1.0	-0.182	-0.096
1.0	-0.180	-0.015	1.0	-0.180	-0.089
1.0	-0.178	0.000	1.0	-0.178	-0.089
1.0	-0.175	0.000	1.0	-0.175	-0.096
1.0	-0.173	0.007	1.0	-0.173	-0.074
1.0	-0.170	0.022	1.0	-0.170	-0.081
1.0	-0.168	0.022	1.0	-0.168	-0.074
1.0	-0.165	0.030	1.0	-0.165	-0.074
1.0	-0.163	0.037	1.0	-0.163	-0.089
1.0	-0.160	0.030	1.0	-0.160	-0.066
1.0	-0.158	0.037	1.0	-0.158	-0.059
1.0	-0.156	0.037	1.0	-0.156	-0.066
1.0	-0.153	0.044	1.0	-0.153	-0.044
1.0	-0.151	0.052	1.0	-0.151	-0.052
1.0	-0.148	0.052	1.0	-0.148	-0.059
1.0	-0.146	0.059	1.0	-0.146	-0.052
1.0	-0.143	0.052	1.0	-0.143	-0.044
1.0	-0.141	0.059	1.0	-0.141	-0.037
1.0	-0.138	0.052	1.0	-0.138	-0.037
1.0	-0.136	0.059	1.0	-0.136	-0.044
1.0	-0.134	0.059	1.0	-0.134	-0.037
1.0	-0.131	0.066	1.0	-0.131	-0.030
1.0	-0.129	0.074	1.0	-0.129	-0.022
1.0	-0.126	0.059	1.0	-0.126	-0.030
1.0	-0.124	0.059	1.0	-0.124	-0.030
1.0	-0.121	0.074	1.0	-0.121	-0.022
1.0	-0.119	0.066	1.0	-0.119	-0.022
1.0	-0.116	0.081	1.0	-0.116	-0.022
1.0	-0.114	0.074	1.0	-0.114	-0.022
1.0	-0.112	0.074	1.0	-0.112	-0.015
1.0	-0.109	0.066	1.0	-0.109	-0.015
1.0	-0.107	0.081	1.0	-0.107	-0.022
1.0	-0.104	0.081	1.0	-0.104	-0.015
1.0	-0.102	0.081	1.0	-0.102	-0.007
1.0	-0.099	0.074	1.0	-0.099	-0.007
1.0	-0.097	0.089	1.0	-0.097	0.000
1.0	-0.094	0.089	1.0	-0.094	-0.022
1.0	-0.092	0.089	1.0	-0.092	-0.022
1.0	-0.090	0.096	1.0	-0.090	-0.015
1.0	-0.087	0.096	1.0	-0.087	-0.015
1.0	-0.085	0.103	1.0	-0.085	0.000
1.0	-0.082	0.103	1.0	-0.082	-0.007
1.0	-0.080	0.096	1.0	-0.080	-0.007
1.0	-0.077	0.103	1.0	-0.077	-0.007
1.0	-0.075	0.103	1.0	-0.075	-0.007
1.0	-0.073	0.096	1.0	-0.073	0.007
1.0	-0.070	0.096	1.0	-0.070	0.007
1.0	-0.068	0.103	1.0	-0.068	0.000
1.0	-0.065	0.103	1.0	-0.065	0.007
1.0	-0.063	0.111	1.0	-0.063	0.000
1.0	-0.060	0.096	1.0	-0.060	-0.007
1.0	-0.058	0.103	1.0	-0.058	0.007
1.0	-0.055	0.103	1.0	-0.055	0.000
1.0	-0.053	0.103	1.0	-0.053	0.015
1.0	-0.051	0.118	1.0	-0.051	0.015

1.0	-0.048	0.126	1.0	-0.048	0.007
1.0	-0.046	0.126	1.0	-0.046	0.007
1.0	-0.043	0.126	1.0	-0.043	0.015
1.0	-0.041	0.126	1.0	-0.041	0.015
1.0	-0.038	0.103	1.0	-0.038	0.007
1.0	-0.036	0.118	1.0	-0.036	0.015
1.0	-0.033	0.111	1.0	-0.033	0.022
1.0	-0.031	0.111	1.0	-0.031	0.022
1.0	-0.029	0.118	1.0	-0.029	0.030
1.0	-0.026	0.126	1.0	-0.026	0.015
1.0	-0.024	0.118	1.0	-0.024	0.022
1.0	-0.021	0.118	1.0	-0.021	0.030
1.0	-0.019	0.111	1.0	-0.019	0.037
1.0	-0.016	0.118	1.0	-0.016	0.030
1.0	-0.014	0.126	1.0	-0.014	0.037
1.0	-0.011	0.126	1.0	-0.011	0.030
1.0	-0.009	0.133	1.0	-0.009	0.037
1.0	-0.007	0.126	1.0	-0.007	0.044
1.0	-0.004	0.126	1.0	-0.004	0.037
1.0	-0.002	0.126	1.0	-0.002	0.037
1.0	0.001	0.133	1.0	0.001	0.052
1.0	0.003	0.118	1.0	0.003	0.044
1.0	0.006	0.126	1.0	0.006	0.052
1.0	0.008	0.126	1.0	0.008	0.044
1.0	0.010	0.118	1.0	0.010	0.044
1.0	0.013	0.126	1.0	0.013	0.044
1.0	0.015	0.140	1.0	0.015	0.044
1.0	0.018	0.148	1.0	0.018	0.037
1.0	0.020	0.133	1.0	0.020	0.044
1.0	0.023	0.133	1.0	0.023	0.044
1.0	0.025	0.133	1.0	0.025	0.066
1.0	0.028	0.133	1.0	0.028	0.066
1.0	0.030	0.133	1.0	0.030	0.066
1.0	0.032	0.133	1.0	0.032	0.066
1.0	0.035	0.133	1.0	0.035	0.066
1.0	0.037	0.133	1.0	0.037	0.074
1.0	0.040	0.140	1.0	0.040	0.081
1.0	0.042	0.133	1.0	0.042	0.081
1.0	0.045	0.133	1.0	0.045	0.074
1.0	0.047	0.140	1.0	0.047	0.059
1.0	0.050	0.140	1.0	0.050	0.066
1.0	0.052	0.155	1.0	0.052	0.089
1.0	0.054	0.155	1.0	0.054	0.089
1.0	0.057	0.148	1.0	0.057	0.103
1.0	0.059	0.148	1.0	0.059	0.096
1.0	0.062	0.148	1.0	0.062	0.103
1.0	0.064	0.148	1.0	0.064	0.118
1.0	0.067	0.155	1.0	0.067	0.118
1.0	0.069	0.148	1.0	0.069	0.118
1.0	0.072	0.155	1.0	0.072	0.126
1.0	0.074	0.155	1.0	0.074	0.133
1.0	0.076	0.148	1.0	0.076	0.140
1.0	0.079	0.148	1.0	0.079	0.148
1.0	0.081	0.162	1.0	0.081	0.148
1.0	0.084	0.155	1.0	0.084	0.162
1.0	0.086	0.155	1.0	0.086	0.177

1.0	0.089	0.155	1.0	0.089	0.177
1.0	0.091	0.148	1.0	0.091	0.185
1.0	0.093	0.170	1.0	0.093	0.199
1.0	0.096	0.162	1.0	0.096	0.214
1.0	0.098	0.162	1.0	0.098	0.214
1.0	0.101	0.162	1.0	0.101	0.214
1.0	0.103	0.155	1.0	0.103	0.236
1.0	0.106	0.155	1.0	0.106	0.244
1.0	0.108	0.155	1.0	0.108	0.258
1.0	0.111	0.155	1.0	0.111	0.281
1.0	0.113	0.155	1.0	0.113	0.288
1.0	0.115	0.162	1.0	0.115	0.295
1.0	0.118	0.162	1.0	0.118	0.318
1.0	0.120	0.155	1.0	0.120	0.332
1.0	0.123	0.155	1.0	0.123	0.347
1.0	0.125	0.170	1.0	0.125	0.377
1.0	0.128	0.162	1.0	0.128	0.399
1.0	0.130	0.162	1.0	0.130	0.406
1.0	0.133	0.162	1.0	0.133	0.436
1.0	0.135	0.155	1.0	0.135	0.458
1.0	0.137	0.170	1.0	0.137	0.487
1.0	0.140	0.170	1.0	0.140	0.510
1.0	0.142	0.177	1.0	0.142	0.539
1.0	0.145	0.170	1.0	0.145	0.569
1.0	0.147	0.177	1.0	0.147	0.598
1.0	0.150	0.177	1.0	0.150	0.628
1.0	0.152	0.177	1.0	0.152	0.665
1.0	0.155	0.185	1.0	0.155	0.679
1.0	0.157	0.185	1.0	0.157	0.724
1.0	0.159	0.185	1.0	0.159	0.761
1.0	0.162	0.185	1.0	0.162	0.805
1.0	0.164	0.185	1.0	0.164	0.849
1.0	0.167	0.185	1.0	0.167	0.894
1.0	0.169	0.185	1.0	0.169	0.938
1.0	0.172	0.192	1.0	0.172	0.982
1.0	0.174	0.185	1.0	0.174	1.041
1.0	0.177	0.192	1.0	0.177	1.078
1.0	0.179	0.192	1.0	0.179	1.130
1.0	0.181	0.177	1.0	0.181	1.167
1.0	0.184	0.177	1.0	0.184	1.219
1.0	0.186	0.177	1.0	0.186	1.270
1.0	0.189	0.185	1.0	0.189	1.322
1.0	0.191	0.199	1.0	0.191	1.359
1.0	0.194	0.199	1.0	0.194	1.418
1.0	0.196	0.199	1.0	0.196	1.462
1.0	0.198	0.199	1.0	0.198	1.529
1.0	0.201	0.199	1.0	0.201	1.573
1.0	0.203	0.207	1.0	0.203	1.617
1.0	0.206	0.214	1.0	0.206	1.654
1.0	0.208	0.207	1.0	0.208	1.699
1.0	0.211	0.199	1.0	0.211	1.750
1.0	0.213	0.214	1.0	0.213	1.802
1.0	0.216	0.207	1.0	0.216	1.846
1.0	0.218	0.207	1.0	0.218	1.883
1.0	0.220	0.229	1.0	0.220	1.927
1.0	0.223	0.229	1.0	0.223	1.979

1.0	0.225	0.229	1.0	0.225	2.023
1.0	0.228	0.236	1.0	0.228	2.060
1.0	0.230	0.222	1.0	0.230	2.105
1.0	0.233	0.229	1.0	0.233	2.164
1.0	0.235	0.229	1.0	0.235	2.215
1.0	0.238	0.236	1.0	0.238	2.267
1.0	0.240	0.244	1.0	0.240	2.304
1.0	0.242	0.244	1.0	0.242	2.356
1.0	0.245	0.244	1.0	0.245	2.407
1.0	0.247	0.244	1.0	0.247	2.452
1.0	0.250	0.251	1.0	0.250	2.496
1.0	0.252	0.251	1.0	0.252	2.555
1.0	0.255	0.258	1.0	0.255	2.585
1.0	0.257	0.258	1.0	0.257	2.636
1.0	0.260	0.266	1.0	0.260	2.703
1.0	0.262	0.273	1.0	0.262	2.718
1.0	0.264	0.281	1.0	0.264	2.769
1.0	0.267	0.273	1.0	0.267	2.814
1.0	0.269	0.288	1.0	0.269	2.865
1.0	0.272	0.288	1.0	0.272	2.924
1.0	0.274	0.288	1.0	0.274	2.976
1.0	0.277	0.295	1.0	0.277	3.013
1.0	0.279	0.310	1.0	0.279	3.065
1.0	0.281	0.295	1.0	0.281	3.116
1.0	0.284	0.318	1.0	0.284	3.176
1.0	0.286	0.325	1.0	0.286	3.235
1.0	0.289	0.332	1.0	0.289	3.279
1.0	0.291	0.332	1.0	0.291	3.316
1.0	0.294	0.340	1.0	0.294	3.360
1.0	0.296	0.340	1.0	0.296	3.419
1.0	0.299	0.340	1.0	0.299	3.464
1.0	0.301	0.354	1.0	0.301	3.530
1.0	0.303	0.362	1.0	0.303	3.574
1.0	0.306	0.369	1.0	0.306	3.619
1.0	0.308	0.377	1.0	0.308	3.685
1.0	0.311	0.384	1.0	0.311	3.744
1.0	0.313	0.399	1.0	0.313	3.840
1.0	0.316	0.399	1.0	0.316	3.862
1.0	0.318	0.406	1.0	0.318	3.899
1.0	0.321	0.414	1.0	0.321	3.944
1.0	0.323	0.421	1.0	0.323	3.973
1.0	0.325	0.421	1.0	0.325	4.040
1.0	0.328	0.436	1.0	0.328	4.106
1.0	0.330	0.443	1.0	0.330	4.150
1.0	0.333	0.458	1.0	0.333	4.187
1.0	0.335	0.465	1.0	0.335	4.254
1.0	0.338	0.480	1.0	0.338	4.313
1.0	0.340	0.495	1.0	0.340	4.365
1.0	0.343	0.487	1.0	0.343	4.401
1.0	0.345	0.502	1.0	0.345	4.461
1.0	0.347	0.517	1.0	0.347	4.512
1.0	0.350	0.532	1.0	0.350	4.557
1.0	0.352	0.546	1.0	0.352	4.616
1.0	0.355	0.546	1.0	0.355	4.675
1.0	0.357	0.546	1.0	0.357	4.719
1.0	0.360	0.554	1.0	0.360	4.771

1.0	0.362	0.576	1.0	0.362	4.815
1.0	0.364	0.591	1.0	0.364	4.889
1.0	0.367	0.598	1.0	0.367	4.933
1.0	0.369	0.606	1.0	0.369	4.985
1.0	0.372	0.628	1.0	0.372	5.037
1.0	0.374	0.635	1.0	0.374	5.096
1.0	0.377	0.657	1.0	0.377	5.162
1.0	0.379	0.672	1.0	0.379	5.199
1.0	0.382	0.687	1.0	0.382	5.258
1.0	0.384	0.702	1.0	0.384	5.339
1.0	0.386	0.716	1.0	0.386	5.376
1.0	0.389	0.738	1.0	0.389	5.457
1.0	0.391	0.753	1.0	0.391	5.494
1.0	0.394	0.775	1.0	0.394	5.539
1.0	0.396	0.783	1.0	0.396	5.620
1.0	0.399	0.812	1.0	0.399	5.657
1.0	0.401	0.842	1.0	0.401	5.709
1.0	0.404	0.864	1.0	0.404	5.760
1.0	0.406	0.879	1.0	0.406	5.805
1.0	0.408	0.908	1.0	0.408	5.841
1.0	0.411	0.931	1.0	0.411	5.886
1.0	0.413	0.953	1.0	0.413	5.923
1.0	0.416	0.967	1.0	0.416	5.982
1.0	0.418	0.997	1.0	0.418	6.026
1.0	0.421	1.012	1.0	0.421	6.093
1.0	0.423	1.012	1.0	0.423	6.130
1.0	0.426	1.034	1.0	0.426	6.189
1.0	0.428	1.049	1.0	0.428	6.240
1.0	0.430	1.056	1.0	0.430	6.285
1.0	0.433	1.078	1.0	0.433	6.329
1.0	0.435	1.093	1.0	0.435	6.366
1.0	0.438	1.108	1.0	0.438	6.418
1.0	0.440	1.130	1.0	0.440	6.469
1.0	0.443	1.145	1.0	0.443	6.506
1.0	0.445	1.152	1.0	0.445	6.543
1.0	0.447	1.174	1.0	0.447	6.580
1.0	0.450	1.204	1.0	0.450	6.646
1.0	0.452	1.219	1.0	0.452	6.691
1.0	0.455	1.255	1.0	0.455	6.720
1.0	0.457	1.263	1.0	0.457	6.750
1.0	0.460	1.270	1.0	0.460	6.794
1.0	0.462	1.300	1.0	0.462	6.831
1.0	0.465	1.322	1.0	0.465	6.868
1.0	0.467	1.344	1.0	0.467	6.927
1.0	0.469	1.366	1.0	0.469	6.964
1.0	0.472	1.396	1.0	0.472	6.994
1.0	0.474	1.411	1.0	0.474	7.030
1.0	0.477	1.433	1.0	0.477	7.075
1.0	0.479	1.470	1.0	0.479	7.097
1.0	0.482	1.492	1.0	0.482	7.141
1.0	0.484	1.514	1.0	0.484	7.274
1.0	0.487	1.536	1.0	0.487	7.289
1.0	0.489	1.558	1.0	0.489	7.296
1.0	0.491	1.580	1.0	0.491	7.333
1.0	0.494	1.617	1.0	0.494	7.363
1.0	0.496	1.647	1.0	0.496	7.385

1.0	0.499	1.669	1.0	0.499	7.422
1.0	0.501	1.706	1.0	0.501	7.481
1.0	0.504	1.735	1.0	0.504	7.510
1.0	0.506	1.758	1.0	0.506	7.533
1.0	0.509	1.795	1.0	0.509	7.555
1.0	0.511	1.831	1.0	0.511	7.584
1.0	0.513	1.854	1.0	0.513	7.607
1.0	0.516	1.883	1.0	0.516	7.621
1.0	0.518	1.920	1.0	0.518	7.643
1.0	0.521	1.957	1.0	0.521	7.673
1.0	0.523	1.994	1.0	0.523	7.680
1.0	0.526	2.038	1.0	0.526	7.703
1.0	0.528	2.068	1.0	0.528	7.725
1.0	0.531	2.097	1.0	0.531	7.739
1.0	0.533	2.149	1.0	0.533	7.739
1.0	0.535	2.179	1.0	0.535	7.769
1.0	0.538	2.230	1.0	0.538	7.784
1.0	0.540	2.267	1.0	0.540	7.784
1.0	0.543	2.311	1.0	0.543	7.799
1.0	0.545	2.348	1.0	0.545	7.806
1.0	0.548	2.400	1.0	0.548	7.821
1.0	0.550	2.452	1.0	0.550	7.813
1.0	0.552	2.496	1.0	0.552	7.813
1.0	0.555	2.555	1.0	0.555	7.821
1.0	0.557	2.607	1.0	0.557	7.828
1.0	0.560	2.651	1.0	0.560	7.813
1.0	0.562	2.710	1.0	0.562	7.828
1.0	0.565	2.762	1.0	0.565	7.813
1.0	0.567	2.814	1.0	0.567	7.806
1.0	0.570	2.873	1.0	0.570	7.799
1.0	0.572	2.932	1.0	0.572	7.799
1.0	0.574	2.991	1.0	0.574	7.791
1.0	0.577	3.050	1.0	0.577	7.776
1.0	0.579	3.109	1.0	0.579	7.776
1.0	0.582	3.176	1.0	0.582	7.762
1.0	0.584	3.249	1.0	0.584	7.739
1.0	0.587	3.316	1.0	0.587	7.725
1.0	0.589	3.375	1.0	0.589	7.710
1.0	0.592	3.449	1.0	0.592	7.673
1.0	0.594	3.523	1.0	0.594	7.666
1.0	0.596	3.589	1.0	0.596	7.651
1.0	0.599	3.670	1.0	0.599	7.636
1.0	0.601	3.744	1.0	0.601	7.599
1.0	0.604	3.818	1.0	0.604	7.584
1.0	0.606	3.907	1.0	0.606	7.562
1.0	0.609	3.973	1.0	0.609	7.547
1.0	0.611	4.054	1.0	0.611	7.525
1.0	0.614	4.128	1.0	0.614	7.503
1.0	0.616	4.224	1.0	0.616	7.474
1.0	0.618	4.305	1.0	0.618	7.459
1.0	0.621	4.394	1.0	0.621	7.429
1.0	0.623	4.483	1.0	0.623	7.422
1.0	0.626	4.571	1.0	0.626	7.392
1.0	0.628	4.660	1.0	0.628	7.370
1.0	0.631	4.756	1.0	0.631	7.355
1.0	0.633	4.852	1.0	0.633	7.341

1.0	0.635	4.948	1.0	0.635	7.326
1.0	0.638	5.037	1.0	0.638	7.311
1.0	0.640	5.140	1.0	0.640	7.311
1.0	0.643	5.236	1.0	0.643	7.296
1.0	0.645	5.347	1.0	0.645	7.289
1.0	0.648	5.450	1.0	0.648	7.282
1.0	0.650	5.539	1.0	0.650	7.296
1.0	0.653	5.649	1.0	0.653	7.304
1.0	0.655	5.775	1.0	0.655	7.304
1.0	0.657	5.886	1.0	0.657	7.311
1.0	0.660	5.974	1.0	0.660	7.326
1.0	0.662	6.078	1.0	0.662	7.341
1.0	0.665	6.211	1.0	0.665	7.370
1.0	0.667	6.329	1.0	0.667	7.392
1.0	0.670	6.432	1.0	0.670	7.429
1.0	0.672	6.536	1.0	0.672	7.481
1.0	0.675	6.661	1.0	0.675	7.518
1.0	0.677	6.779	1.0	0.677	7.547
1.0	0.679	6.898	1.0	0.679	7.614
1.0	0.682	7.016	1.0	0.682	7.666
1.0	0.684	7.126	1.0	0.684	7.725
1.0	0.687	7.245	1.0	0.687	7.784
1.0	0.689	7.385	1.0	0.689	7.843
1.0	0.692	7.503	1.0	0.692	7.931
1.0	0.694	7.629	1.0	0.694	7.991
1.0	0.697	7.747	1.0	0.697	8.064
1.0	0.699	7.865	1.0	0.699	8.138
1.0	0.701	7.983	1.0	0.701	8.219
1.0	0.704	8.101	1.0	0.704	8.301
1.0	0.706	8.219	1.0	0.706	8.389
1.0	0.709	8.345	1.0	0.709	8.478
1.0	0.711	8.478	1.0	0.711	8.559
1.0	0.714	8.581	1.0	0.714	8.633
1.0	0.716	8.692	1.0	0.716	8.722
1.0	0.718	8.825	1.0	0.718	8.818
1.0	0.721	8.951	1.0	0.721	8.899
1.0	0.723	9.061	1.0	0.723	8.980
1.0	0.726	9.187	1.0	0.726	9.054
1.0	0.728	9.305	1.0	0.728	9.150
1.0	0.731	9.431	1.0	0.731	9.224
1.0	0.733	9.556	1.0	0.733	9.305
1.0	0.736	9.682	1.0	0.736	9.386
1.0	0.738	9.792	1.0	0.738	9.453
1.0	0.740	9.903	1.0	0.740	9.527
1.0	0.743	10.021	1.0	0.743	9.600
1.0	0.745	10.132	1.0	0.745	9.667
1.0	0.748	10.250	1.0	0.748	9.741
1.0	0.750	10.361	1.0	0.750	9.800
1.0	0.753	10.472	1.0	0.753	9.866
1.0	0.755	10.583	1.0	0.755	9.918
1.0	0.758	10.693	1.0	0.758	9.992
1.0	0.760	10.789	1.0	0.760	10.029
1.0	0.762	10.900	1.0	0.762	10.088
1.0	0.765	10.996	1.0	0.765	10.140
1.0	0.767	11.100	1.0	0.767	10.184
1.0	0.770	11.196	1.0	0.770	10.236

1.0	0.772	11.306	1.0	0.772	10.272
1.0	0.775	11.395	1.0	0.775	10.324
1.0	0.777	11.491	1.0	0.777	10.361
1.0	0.780	11.587	1.0	0.780	10.391
1.0	0.782	11.676	1.0	0.782	10.450
1.0	0.784	11.757	1.0	0.784	10.472
1.0	0.787	11.845	1.0	0.787	10.516
1.0	0.789	11.927	1.0	0.789	10.538
1.0	0.792	12.015	1.0	0.792	10.575
1.0	0.794	12.089	1.0	0.794	10.605
1.0	0.797	12.163	1.0	0.797	10.642
1.0	0.799	12.252	1.0	0.799	10.664
1.0	0.802	12.311	1.0	0.802	10.686
1.0	0.799	12.045	1.0	0.799	10.405
1.0	0.797	11.794	1.0	0.797	10.110
1.0	0.794	11.535	1.0	0.794	9.829
1.0	0.792	11.277	1.0	0.792	9.586
1.0	0.789	11.033	1.0	0.789	9.342
1.0	0.787	10.782	1.0	0.787	9.106
1.0	0.784	10.538	1.0	0.784	8.877
1.0	0.782	10.302	1.0	0.782	8.670
1.0	0.780	10.058	1.0	0.780	8.463
1.0	0.777	9.822	1.0	0.777	8.271
1.0	0.775	9.593	1.0	0.775	8.079
1.0	0.772	9.372	1.0	0.772	7.902
1.0	0.770	9.150	1.0	0.770	7.725
1.0	0.767	8.936	1.0	0.767	7.555
1.0	0.765	8.736	1.0	0.765	7.400
1.0	0.762	8.515	1.0	0.762	7.252
1.0	0.760	8.315	1.0	0.760	7.104
1.0	0.758	8.123	1.0	0.758	6.964
1.0	0.755	7.931	1.0	0.755	6.824
1.0	0.753	7.747	1.0	0.753	6.683
1.0	0.750	7.555	1.0	0.750	6.565
1.0	0.748	7.363	1.0	0.748	6.432
1.0	0.745	7.186	1.0	0.745	6.299
1.0	0.743	7.008	1.0	0.743	6.181
1.0	0.740	6.838	1.0	0.740	6.070
1.0	0.738	6.669	1.0	0.738	5.967
1.0	0.736	6.506	1.0	0.736	5.849
1.0	0.733	6.358	1.0	0.733	5.738
1.0	0.731	6.196	1.0	0.731	5.649
1.0	0.728	6.034	1.0	0.728	5.553
1.0	0.726	5.901	1.0	0.726	5.457
1.0	0.723	5.760	1.0	0.723	5.361
1.0	0.721	5.598	1.0	0.721	5.280
1.0	0.718	5.465	1.0	0.718	5.192
1.0	0.716	5.325	1.0	0.716	5.110
1.0	0.714	5.184	1.0	0.714	5.022
1.0	0.711	5.051	1.0	0.711	4.948
1.0	0.709	4.933	1.0	0.709	4.874
1.0	0.706	4.808	1.0	0.706	4.800
1.0	0.704	4.682	1.0	0.704	4.726
1.0	0.701	4.564	1.0	0.701	4.645
1.0	0.699	4.438	1.0	0.699	4.579
1.0	0.697	4.335	1.0	0.697	4.520

1.0	0.694	4.232	1.0	0.694	4.453
1.0	0.692	4.113	1.0	0.692	4.387
1.0	0.689	3.988	1.0	0.689	4.320
1.0	0.687	3.877	1.0	0.687	4.269
1.0	0.684	3.774	1.0	0.684	4.209
1.0	0.682	3.670	1.0	0.682	4.150
1.0	0.679	3.582	1.0	0.679	4.091
1.0	0.677	3.478	1.0	0.677	4.040
1.0	0.675	3.382	1.0	0.675	3.995
1.0	0.672	3.301	1.0	0.672	3.936
1.0	0.670	3.198	1.0	0.670	3.892
1.0	0.667	3.116	1.0	0.667	3.825
1.0	0.665	3.028	1.0	0.665	3.788
1.0	0.662	2.939	1.0	0.662	3.737
1.0	0.660	2.851	1.0	0.660	3.685
1.0	0.657	2.777	1.0	0.657	3.648
1.0	0.655	2.703	1.0	0.655	3.604
1.0	0.653	2.614	1.0	0.653	3.560
1.0	0.650	2.540	1.0	0.650	3.515
1.0	0.648	2.467	1.0	0.648	3.478
1.0	0.645	2.393	1.0	0.645	3.434
1.0	0.643	2.319	1.0	0.643	3.397
1.0	0.640	2.245	1.0	0.640	3.353
1.0	0.638	2.179	1.0	0.638	3.316
1.0	0.635	2.112	1.0	0.635	3.279
1.0	0.633	2.053	1.0	0.633	3.242
1.0	0.631	1.987	1.0	0.631	3.212
1.0	0.628	1.913	1.0	0.628	3.161
1.0	0.626	1.854	1.0	0.626	3.124
1.0	0.623	1.795	1.0	0.623	3.102
1.0	0.621	1.728	1.0	0.621	3.057
1.0	0.618	1.676	1.0	0.618	3.028
1.0	0.616	1.625	1.0	0.616	2.998
1.0	0.614	1.566	1.0	0.614	2.969
1.0	0.611	1.514	1.0	0.611	2.932
1.0	0.609	1.462	1.0	0.609	2.902
1.0	0.606	1.403	1.0	0.606	2.880
1.0	0.604	1.359	1.0	0.604	2.836
1.0	0.601	1.315	1.0	0.601	2.792
1.0	0.599	1.270	1.0	0.599	2.769
1.0	0.596	1.196	1.0	0.596	2.755
1.0	0.594	1.174	1.0	0.594	2.718
1.0	0.592	1.123	1.0	0.592	2.703
1.0	0.589	1.086	1.0	0.589	2.666
1.0	0.587	1.041	1.0	0.587	2.636
1.0	0.584	0.990	1.0	0.584	2.614
1.0	0.582	0.953	1.0	0.582	2.600
1.0	0.579	0.901	1.0	0.579	2.563
1.0	0.577	0.871	1.0	0.577	2.533
1.0	0.574	0.834	1.0	0.574	2.518
1.0	0.572	0.798	1.0	0.572	2.489
1.0	0.570	0.768	1.0	0.570	2.467
1.0	0.567	0.724	1.0	0.567	2.444
1.0	0.565	0.694	1.0	0.565	2.422
1.0	0.562	0.657	1.0	0.562	2.407
1.0	0.560	0.620	1.0	0.560	2.378

1.0	0.557	0.591	1.0	0.557	2.348
1.0	0.555	0.569	1.0	0.555	2.334
1.0	0.552	0.532	1.0	0.552	2.304
1.0	0.550	0.510	1.0	0.550	2.289
1.0	0.548	0.480	1.0	0.548	2.267
1.0	0.545	0.450	1.0	0.545	2.238
1.0	0.543	0.414	1.0	0.543	2.215
1.0	0.540	0.384	1.0	0.540	2.201
1.0	0.538	0.362	1.0	0.538	2.171
1.0	0.535	0.340	1.0	0.535	2.164
1.0	0.533	0.310	1.0	0.533	2.134
1.0	0.531	0.288	1.0	0.531	2.119
1.0	0.528	0.266	1.0	0.528	2.105
1.0	0.526	0.236	1.0	0.526	2.090
1.0	0.523	0.222	1.0	0.523	2.068
1.0	0.521	0.192	1.0	0.521	2.046
1.0	0.518	0.192	1.0	0.518	2.031
1.0	0.516	0.155	1.0	0.516	2.016
1.0	0.513	0.148	1.0	0.513	2.001
1.0	0.511	0.133	1.0	0.511	1.972
1.0	0.509	0.118	1.0	0.509	1.950
1.0	0.506	0.089	1.0	0.506	1.942
1.0	0.504	0.074	1.0	0.504	1.927
1.0	0.501	0.052	1.0	0.501	1.913
1.0	0.499	0.022	1.0	0.499	1.891
1.0	0.496	0.007	1.0	0.496	1.876
1.0	0.494	0.000	1.0	0.494	1.861
1.0	0.491	-0.015	1.0	0.491	1.839
1.0	0.489	-0.037	1.0	0.489	1.831
1.0	0.487	-0.052	1.0	0.487	1.809
1.0	0.484	-0.066	1.0	0.484	1.802
1.0	0.482	-0.089	1.0	0.482	1.787
1.0	0.479	-0.089	1.0	0.479	1.780
1.0	0.477	-0.096	1.0	0.477	1.772
1.0	0.474	-0.111	1.0	0.474	1.750
1.0	0.472	-0.133	1.0	0.472	1.743
1.0	0.469	-0.140	1.0	0.469	1.735
1.0	0.467	-0.155	1.0	0.467	1.728
1.0	0.465	-0.170	1.0	0.465	1.713
1.0	0.462	-0.185	1.0	0.462	1.691
1.0	0.460	-0.192	1.0	0.460	1.684
1.0	0.457	-0.207	1.0	0.457	1.662
1.0	0.455	-0.214	1.0	0.455	1.662
1.0	0.452	-0.222	1.0	0.452	1.647
1.0	0.450	-0.236	1.0	0.450	1.639
1.0	0.447	-0.236	1.0	0.447	1.632
1.0	0.445	-0.251	1.0	0.445	1.617
1.0	0.443	-0.251	1.0	0.443	1.617
1.0	0.440	-0.266	1.0	0.440	1.610
1.0	0.438	-0.281	1.0	0.438	1.595
1.0	0.435	-0.288	1.0	0.435	1.595
1.0	0.433	-0.288	1.0	0.433	1.580
1.0	0.430	-0.288	1.0	0.430	1.573
1.0	0.428	-0.318	1.0	0.428	1.558
1.0	0.426	-0.318	1.0	0.426	1.551
1.0	0.423	-0.332	1.0	0.423	1.543

1.0	0.421	-0.325	1.0	0.421	1.529
1.0	0.418	-0.332	1.0	0.418	1.529
1.0	0.416	-0.347	1.0	0.416	1.514
1.0	0.413	-0.354	1.0	0.413	1.499
1.0	0.411	-0.362	1.0	0.411	1.514
1.0	0.408	-0.384	1.0	0.408	1.499
1.0	0.406	-0.384	1.0	0.406	1.492
1.0	0.404	-0.384	1.0	0.404	1.484
1.0	0.401	-0.399	1.0	0.401	1.477
1.0	0.399	-0.414	1.0	0.399	1.470
1.0	0.396	-0.414	1.0	0.396	1.470
1.0	0.394	-0.421	1.0	0.394	1.462
1.0	0.391	-0.421	1.0	0.391	1.470
1.0	0.389	-0.436	1.0	0.389	1.447
1.0	0.386	-0.436	1.0	0.386	1.440
1.0	0.384	-0.436	1.0	0.384	1.440
1.0	0.382	-0.443	1.0	0.382	1.433
1.0	0.379	-0.450	1.0	0.379	1.425
1.0	0.377	-0.458	1.0	0.377	1.418
1.0	0.374	-0.450	1.0	0.374	1.418
1.0	0.372	-0.458	1.0	0.372	1.396
1.0	0.369	-0.465	1.0	0.369	1.396
1.0	0.367	-0.465	1.0	0.367	1.388
1.0	0.364	-0.480	1.0	0.364	1.388
1.0	0.362	-0.480	1.0	0.362	1.366
1.0	0.360	-0.480	1.0	0.360	1.374
1.0	0.357	-0.473	1.0	0.357	1.366
1.0	0.355	-0.480	1.0	0.355	1.359
1.0	0.352	-0.495	1.0	0.352	1.366
1.0	0.350	-0.495	1.0	0.350	1.366
1.0	0.347	-0.502	1.0	0.347	1.351
1.0	0.345	-0.502	1.0	0.345	1.344
1.0	0.343	-0.517	1.0	0.343	1.337
1.0	0.340	-0.517	1.0	0.340	1.329
1.0	0.338	-0.524	1.0	0.338	1.322
1.0	0.335	-0.532	1.0	0.335	1.322
1.0	0.333	-0.524	1.0	0.333	1.307
1.0	0.330	-0.532	1.0	0.330	1.307
1.0	0.328	-0.539	1.0	0.328	1.300
1.0	0.325	-0.539	1.0	0.325	1.285
1.0	0.323	-0.546	1.0	0.323	1.285
1.0	0.321	-0.539	1.0	0.321	1.278
1.0	0.318	-0.539	1.0	0.318	1.270
1.0	0.316	-0.546	1.0	0.316	1.263
1.0	0.313	-0.546	1.0	0.313	1.263
1.0	0.311	-0.554	1.0	0.311	1.255
1.0	0.308	-0.546	1.0	0.308	1.241
1.0	0.306	-0.554	1.0	0.306	1.226
1.0	0.303	-0.554	1.0	0.303	1.226
1.0	0.301	-0.561	1.0	0.301	1.211
1.0	0.299	-0.569	1.0	0.299	1.204
1.0	0.296	-0.569	1.0	0.296	1.196
1.0	0.294	-0.569	1.0	0.294	1.189
1.0	0.291	-0.561	1.0	0.291	1.174
1.0	0.289	-0.569	1.0	0.289	1.159
1.0	0.286	-0.569	1.0	0.286	1.152

1.0	0.284	-0.569	1.0	0.284	1.137
1.0	0.281	-0.554	1.0	0.281	1.130
1.0	0.279	-0.569	1.0	0.279	1.115
1.0	0.277	-0.569	1.0	0.277	1.108
1.0	0.274	-0.576	1.0	0.274	1.086
1.0	0.272	-0.583	1.0	0.272	1.071
1.0	0.269	-0.576	1.0	0.269	1.049
1.0	0.267	-0.583	1.0	0.267	1.041
1.0	0.264	-0.583	1.0	0.264	1.019
1.0	0.262	-0.583	1.0	0.262	1.012
1.0	0.260	-0.598	1.0	0.260	0.975
1.0	0.257	-0.591	1.0	0.257	0.953
1.0	0.255	-0.598	1.0	0.255	0.931
1.0	0.252	-0.591	1.0	0.252	0.923
1.0	0.250	-0.591	1.0	0.250	0.894
1.0	0.247	-0.591	1.0	0.247	0.871
1.0	0.245	-0.591	1.0	0.245	0.834
1.0	0.242	-0.598	1.0	0.242	0.812
1.0	0.240	-0.598	1.0	0.240	0.783
1.0	0.238	-0.606	1.0	0.238	0.753
1.0	0.235	-0.613	1.0	0.235	0.731
1.0	0.233	-0.606	1.0	0.233	0.694
1.0	0.230	-0.613	1.0	0.230	0.672
1.0	0.228	-0.606	1.0	0.228	0.642
1.0	0.225	-0.613	1.0	0.225	0.591
1.0	0.223	-0.620	1.0	0.223	0.554
1.0	0.220	-0.613	1.0	0.220	0.532
1.0	0.218	-0.628	1.0	0.218	0.502
1.0	0.216	-0.642	1.0	0.216	0.458
1.0	0.213	-0.635	1.0	0.213	0.421
1.0	0.211	-0.650	1.0	0.211	0.377
1.0	0.208	-0.657	1.0	0.208	0.332
1.0	0.206	-0.679	1.0	0.206	0.295
1.0	0.203	-0.694	1.0	0.203	0.251
1.0	0.201	-0.702	1.0	0.201	0.214
1.0	0.198	-0.709	1.0	0.198	0.162
1.0	0.196	-0.724	1.0	0.196	0.118
1.0	0.194	-0.738	1.0	0.194	0.074
1.0	0.191	-0.753	1.0	0.191	0.037
1.0	0.189	-0.753	1.0	0.189	0.000
1.0	0.186	-0.753	1.0	0.186	-0.037
1.0	0.184	-0.753	1.0	0.184	-0.081
1.0	0.181	-0.761	1.0	0.181	-0.126
1.0	0.179	-0.746	1.0	0.179	-0.170
1.0	0.177	-0.746	1.0	0.177	-0.207
1.0	0.174	-0.753	1.0	0.174	-0.266
1.0	0.172	-0.746	1.0	0.172	-0.295
1.0	0.169	-0.731	1.0	0.169	-0.340
1.0	0.167	-0.731	1.0	0.167	-0.369
1.0	0.164	-0.716	1.0	0.164	-0.421
1.0	0.162	-0.716	1.0	0.162	-0.450
1.0	0.159	-0.724	1.0	0.159	-0.487
1.0	0.157	-0.709	1.0	0.157	-0.524
1.0	0.155	-0.694	1.0	0.155	-0.569
1.0	0.152	-0.687	1.0	0.152	-0.591
1.0	0.150	-0.687	1.0	0.150	-0.620

1.0	0.147	-0.672	1.0	0.147	-0.657
1.0	0.145	-0.672	1.0	0.145	-0.679
1.0	0.142	-0.657	1.0	0.142	-0.709
1.0	0.140	-0.672	1.0	0.140	-0.724
1.0	0.137	-0.665	1.0	0.137	-0.753
1.0	0.135	-0.657	1.0	0.135	-0.761
1.0	0.133	-0.657	1.0	0.133	-0.775
1.0	0.130	-0.650	1.0	0.130	-0.783
1.0	0.128	-0.650	1.0	0.128	-0.805
1.0	0.125	-0.642	1.0	0.125	-0.805
1.0	0.123	-0.665	1.0	0.123	-0.798
1.0	0.120	-0.650	1.0	0.120	-0.798
1.0	0.118	-0.650	1.0	0.118	-0.798
1.0	0.115	-0.642	1.0	0.115	-0.798
1.0	0.113	-0.650	1.0	0.113	-0.783
1.0	0.111	-0.657	1.0	0.111	-0.783
1.0	0.108	-0.650	1.0	0.108	-0.775
1.0	0.106	-0.657	1.0	0.106	-0.746
1.0	0.103	-0.665	1.0	0.103	-0.731
1.0	0.101	-0.657	1.0	0.101	-0.716
1.0	0.098	-0.665	1.0	0.098	-0.716
1.0	0.096	-0.657	1.0	0.096	-0.702
1.0	0.093	-0.657	1.0	0.093	-0.687
1.0	0.091	-0.665	1.0	0.091	-0.679
1.0	0.089	-0.657	1.0	0.089	-0.672
1.0	0.086	-0.665	1.0	0.086	-0.665
1.0	0.084	-0.657	1.0	0.084	-0.642
1.0	0.081	-0.657	1.0	0.081	-0.635
1.0	0.079	-0.665	1.0	0.079	-0.628
1.0	0.076	-0.672	1.0	0.076	-0.620
1.0	0.074	-0.672	1.0	0.074	-0.613
1.0	0.072	-0.672	1.0	0.072	-0.620
1.0	0.069	-0.687	1.0	0.069	-0.620
1.0	0.067	-0.679	1.0	0.067	-0.613
1.0	0.064	-0.679	1.0	0.064	-0.606
1.0	0.062	-0.687	1.0	0.062	-0.598
1.0	0.059	-0.694	1.0	0.059	-0.591
1.0	0.057	-0.694	1.0	0.057	-0.598
1.0	0.054	-0.702	1.0	0.054	-0.598
1.0	0.052	-0.687	1.0	0.052	-0.598
1.0	0.050	-0.694	1.0	0.050	-0.598
1.0	0.047	-0.694	1.0	0.047	-0.598
1.0	0.045	-0.702	1.0	0.045	-0.598
1.0	0.042	-0.709	1.0	0.042	-0.598
1.0	0.040	-0.694	1.0	0.040	-0.591
1.0	0.037	-0.694	1.0	0.037	-0.606
1.0	0.035	-0.702	1.0	0.035	-0.606
1.0	0.032	-0.702	1.0	0.032	-0.613
1.0	0.030	-0.702	1.0	0.030	-0.598
1.0	0.028	-0.709	1.0	0.028	-0.606
1.0	0.025	-0.716	1.0	0.025	-0.613
1.0	0.023	-0.709	1.0	0.023	-0.628
1.0	0.020	-0.709	1.0	0.020	-0.613
1.0	0.018	-0.724	1.0	0.018	-0.613
1.0	0.015	-0.724	1.0	0.015	-0.606
1.0	0.013	-0.716	1.0	0.013	-0.613

1.0	0.010	-0.731	1.0	0.010	-0.620
1.0	0.008	-0.731	1.0	0.008	-0.613
1.0	0.006	-0.731	1.0	0.006	-0.620
1.0	0.003	-0.738	1.0	0.003	-0.628
1.0	0.001	-0.753	1.0	0.001	-0.620
1.0	-0.002	-0.746	1.0	-0.002	-0.628
1.0	-0.004	-0.761	1.0	-0.004	-0.628
1.0	-0.007	-0.746	1.0	-0.007	-0.635
1.0	-0.009	-0.746	1.0	-0.009	-0.642
1.0	-0.011	-0.753	1.0	-0.011	-0.642
1.0	-0.014	-0.753	1.0	-0.014	-0.642
1.0	-0.016	-0.768	1.0	-0.016	-0.635
1.0	-0.019	-0.768	1.0	-0.019	-0.642
1.0	-0.021	-0.775	1.0	-0.021	-0.657
1.0	-0.024	-0.768	1.0	-0.024	-0.657
1.0	-0.026	-0.775	1.0	-0.026	-0.657
1.0	-0.029	-0.775	1.0	-0.029	-0.665
1.0	-0.031	-0.768	1.0	-0.031	-0.679
1.0	-0.033	-0.783	1.0	-0.033	-0.672
1.0	-0.036	-0.783	1.0	-0.036	-0.679
1.0	-0.038	-0.798	1.0	-0.038	-0.679
1.0	-0.041	-0.798	1.0	-0.041	-0.672
1.0	-0.043	-0.798	1.0	-0.043	-0.679
1.0	-0.046	-0.790	1.0	-0.046	-0.679
1.0	-0.048	-0.790	1.0	-0.048	-0.694
1.0	-0.051	-0.805	1.0	-0.051	-0.702
1.0	-0.053	-0.812	1.0	-0.053	-0.702
1.0	-0.055	-0.820	1.0	-0.055	-0.702
1.0	-0.058	-0.812	1.0	-0.058	-0.702
1.0	-0.060	-0.820	1.0	-0.060	-0.709
1.0	-0.063	-0.827	1.0	-0.063	-0.702
1.0	-0.065	-0.827	1.0	-0.065	-0.716
1.0	-0.068	-0.827	1.0	-0.068	-0.716
1.0	-0.070	-0.827	1.0	-0.070	-0.716
1.0	-0.073	-0.834	1.0	-0.073	-0.724
1.0	-0.075	-0.834	1.0	-0.075	-0.731
1.0	-0.077	-0.827	1.0	-0.077	-0.746
1.0	-0.080	-0.834	1.0	-0.080	-0.731
1.0	-0.082	-0.842	1.0	-0.082	-0.731
1.0	-0.085	-0.842	1.0	-0.085	-0.746
1.0	-0.087	-0.849	1.0	-0.087	-0.738
1.0	-0.090	-0.849	1.0	-0.090	-0.738
1.0	-0.092	-0.857	1.0	-0.092	-0.753
1.0	-0.094	-0.864	1.0	-0.094	-0.761
1.0	-0.097	-0.864	1.0	-0.097	-0.746
1.0	-0.099	-0.864	1.0	-0.099	-0.768
1.0	-0.102	-0.864	1.0	-0.102	-0.783
1.0	-0.104	-0.871	1.0	-0.104	-0.783
1.0	-0.107	-0.879	1.0	-0.107	-0.783
1.0	-0.109	-0.871	1.0	-0.109	-0.783
1.0	-0.112	-0.879	1.0	-0.112	-0.790
1.0	-0.114	-0.879	1.0	-0.114	-0.790
1.0	-0.116	-0.894	1.0	-0.116	-0.798
1.0	-0.119	-0.901	1.0	-0.119	-0.805
1.0	-0.121	-0.894	1.0	-0.121	-0.812
1.0	-0.124	-0.894	1.0	-0.124	-0.812

1.0	-0.126	-0.901	1.0	-0.126	-0.805
1.0	-0.129	-0.901	1.0	-0.129	-0.827
1.0	-0.131	-0.908	1.0	-0.131	-0.827
1.0	-0.134	-0.931	1.0	-0.134	-0.827
1.0	-0.136	-0.938	1.0	-0.136	-0.827
1.0	-0.138	-0.938	1.0	-0.138	-0.842
1.0	-0.141	-0.931	1.0	-0.141	-0.849
1.0	-0.143	-0.960	1.0	-0.143	-0.849
1.0	-0.146	-0.953	1.0	-0.146	-0.857
1.0	-0.148	-0.967	1.0	-0.148	-0.864
1.0	-0.151	-0.967	1.0	-0.151	-0.879
1.0	-0.153	-0.967	1.0	-0.153	-0.871
1.0	-0.156	-0.982	1.0	-0.156	-0.894
1.0	-0.158	-0.982	1.0	-0.158	-0.901
1.0	-0.160	-0.990	1.0	-0.160	-0.886
1.0	-0.163	-0.997	1.0	-0.163	-0.901
1.0	-0.165	-1.012	1.0	-0.165	-0.901
1.0	-0.168	-1.012	1.0	-0.168	-0.901
1.0	-0.170	-1.027	1.0	-0.170	-0.916
1.0	-0.173	-1.034	1.0	-0.173	-0.916
1.0	-0.175	-1.041	1.0	-0.175	-0.931
1.0	-0.178	-1.056	1.0	-0.178	-0.923
1.0	-0.180	-1.056	1.0	-0.180	-0.923
1.0	-0.182	-1.056	1.0	-0.182	-0.931
1.0	-0.185	-1.071	1.0	-0.185	-0.938
1.0	-0.187	-1.078	1.0	-0.187	-0.953
1.0	-0.190	-1.093	1.0	-0.190	-0.960
1.0	-0.192	-1.093	1.0	-0.192	-0.967
1.0	-0.195	-1.100	1.0	-0.195	-0.967
1.0	-0.197	-1.108	1.0	-0.197	-0.960
1.0	-0.199	-1.130	1.0	-0.199	-0.975
1.0	-0.202	-1.130	1.0	-0.202	-0.990
1.0	-0.204	-1.145	1.0	-0.204	-0.990
1.0	-0.207	-1.159	1.0	-0.207	-1.004
1.0	-0.209	-1.167	1.0	-0.209	-1.004
1.0	-0.212	-1.174	1.0	-0.212	-1.027
1.0	-0.214	-1.182	1.0	-0.214	-1.034
1.0	-0.217	-1.189	1.0	-0.217	-1.041
1.0	-0.219	-1.219	1.0	-0.219	-1.041
1.0	-0.221	-1.211	1.0	-0.221	-1.049
1.0	-0.224	-1.219	1.0	-0.224	-1.063
1.0	-0.226	-1.226	1.0	-0.226	-1.071
1.0	-0.229	-1.241	1.0	-0.229	-1.078
1.0	-0.231	-1.248	1.0	-0.231	-1.093
1.0	-0.234	-1.263	1.0	-0.234	-1.108
1.0	-0.236	-1.270	1.0	-0.236	-1.108
1.0	-0.239	-1.285	1.0	-0.239	-1.115
1.0	-0.241	-1.307	1.0	-0.241	-1.130
1.0	-0.243	-1.307	1.0	-0.243	-1.145
1.0	-0.246	-1.322	1.0	-0.246	-1.145
1.0	-0.248	-1.322	1.0	-0.248	-1.159
1.0	-0.251	-1.329	1.0	-0.251	-1.167
1.0	-0.253	-1.344	1.0	-0.253	-1.174
1.0	-0.256	-1.366	1.0	-0.256	-1.174
1.0	-0.258	-1.366	1.0	-0.258	-1.182
1.0	-0.261	-1.381	1.0	-0.261	-1.204

1.0	-0.263	-1.396	1.0	-0.263	-1.211
1.0	-0.265	-1.403	1.0	-0.265	-1.219
1.0	-0.268	-1.425	1.0	-0.268	-1.233
1.0	-0.270	-1.455	1.0	-0.270	-1.241
1.0	-0.273	-1.440	1.0	-0.273	-1.248
1.0	-0.275	-1.455	1.0	-0.275	-1.263
1.0	-0.278	-1.470	1.0	-0.278	-1.263
1.0	-0.280	-1.492	1.0	-0.280	-1.292
1.0	-0.282	-1.499	1.0	-0.282	-1.300
1.0	-0.285	-1.514	1.0	-0.285	-1.315
1.0	-0.287	-1.529	1.0	-0.287	-1.329
1.0	-0.290	-1.551	1.0	-0.290	-1.337
1.0	-0.292	-1.558	1.0	-0.292	-1.351
1.0	-0.295	-1.573	1.0	-0.295	-1.351
1.0	-0.297	-1.580	1.0	-0.297	-1.374
1.0	-0.300	-1.603	1.0	-0.300	-1.388
1.0	-0.302	-1.632	1.0	-0.302	-1.396
1.0	-0.304	-1.639	1.0	-0.304	-1.403
1.0	-0.307	-1.639	1.0	-0.307	-1.418
1.0	-0.309	-1.669	1.0	-0.309	-1.440
1.0	-0.312	-1.676	1.0	-0.312	-1.447
1.0	-0.314	-1.691	1.0	-0.314	-1.455
1.0	-0.317	-1.721	1.0	-0.317	-1.470
1.0	-0.319	-1.735	1.0	-0.319	-1.477
1.0	-0.322	-1.743	1.0	-0.322	-1.492
1.0	-0.324	-1.765	1.0	-0.324	-1.514
1.0	-0.326	-1.795	1.0	-0.326	-1.536
1.0	-0.329	-1.802	1.0	-0.329	-1.551
1.0	-0.331	-1.817	1.0	-0.331	-1.558
1.0	-0.334	-1.824	1.0	-0.334	-1.580
1.0	-0.336	-1.839	1.0	-0.336	-1.595
1.0	-0.339	-1.861	1.0	-0.339	-1.603
1.0	-0.341	-1.876	1.0	-0.341	-1.617
1.0	-0.344	-1.883	1.0	-0.344	-1.632
1.0	-0.346	-1.905	1.0	-0.346	-1.654
1.0	-0.348	-1.920	1.0	-0.348	-1.662
1.0	-0.351	-1.942	1.0	-0.351	-1.669
1.0	-0.353	-1.950	1.0	-0.353	-1.691
1.0	-0.356	-1.972	1.0	-0.356	-1.735
1.0	-0.358	-1.994	1.0	-0.358	-1.743
1.0	-0.361	-2.016	1.0	-0.361	-1.750
1.0	-0.363	-2.031	1.0	-0.363	-1.765
1.0	-0.365	-2.046	1.0	-0.365	-1.787
1.0	-0.368	-2.060	1.0	-0.368	-1.809
1.0	-0.370	-2.090	1.0	-0.370	-1.824
1.0	-0.373	-2.105	1.0	-0.373	-1.839
1.0	-0.375	-2.119	1.0	-0.375	-1.854
1.0	-0.378	-2.149	1.0	-0.378	-1.876
1.0	-0.380	-2.156	1.0	-0.380	-1.883
1.0	-0.383	-2.179	1.0	-0.383	-1.913
1.0	-0.385	-2.201	1.0	-0.385	-1.942
1.0	-0.387	-2.223	1.0	-0.387	-1.950
1.0	-0.390	-2.223	1.0	-0.390	-1.964
1.0	-0.392	-2.245	1.0	-0.392	-1.994
1.0	-0.395	-2.267	1.0	-0.395	-2.016
1.0	-0.397	-2.282	1.0	-0.397	-2.038

1.0	-0.400	-2.311	1.0	-0.400	-2.053
1.0	-0.402	-2.319	1.0	-0.402	-2.090
1.0	-0.405	-2.334	1.0	-0.405	-2.097
1.0	-0.407	-2.348	1.0	-0.407	-2.134
1.0	-0.409	-2.371	1.0	-0.409	-2.156
1.0	-0.412	-2.393	1.0	-0.412	-2.171
1.0	-0.414	-2.407	1.0	-0.414	-2.193
1.0	-0.417	-2.422	1.0	-0.417	-2.223
1.0	-0.419	-2.437	1.0	-0.419	-2.238
1.0	-0.422	-2.459	1.0	-0.422	-2.260
1.0	-0.424	-2.474	1.0	-0.424	-2.289
1.0	-0.427	-2.496	1.0	-0.427	-2.319
1.0	-0.429	-2.518	1.0	-0.429	-2.341
1.0	-0.431	-2.526	1.0	-0.431	-2.371
1.0	-0.434	-2.555	1.0	-0.434	-2.393
1.0	-0.436	-2.563	1.0	-0.436	-2.415
1.0	-0.439	-2.585	1.0	-0.439	-2.452
1.0	-0.441	-2.600	1.0	-0.441	-2.474
1.0	-0.444	-2.614	1.0	-0.444	-2.503
1.0	-0.446	-2.629	1.0	-0.446	-2.518
1.0	-0.448	-2.644	1.0	-0.448	-2.548
1.0	-0.451	-2.666	1.0	-0.451	-2.577
1.0	-0.453	-2.681	1.0	-0.453	-2.614
1.0	-0.456	-2.696	1.0	-0.456	-2.644
1.0	-0.458	-2.703	1.0	-0.458	-2.681
1.0	-0.461	-2.725	1.0	-0.461	-2.703
1.0	-0.463	-2.732	1.0	-0.463	-2.725
1.0	-0.466	-2.747	1.0	-0.466	-2.755
1.0	-0.468	-2.777	1.0	-0.468	-2.792
1.0	-0.470	-2.769	1.0	-0.470	-2.814
1.0	-0.473	-2.792	1.0	-0.473	-2.843
1.0	-0.475	-2.806	1.0	-0.475	-2.873
1.0	-0.478	-2.814	1.0	-0.478	-2.895
1.0	-0.480	-2.828	1.0	-0.480	-2.932
1.0	-0.483	-2.828	1.0	-0.483	-2.961
1.0	-0.485	-2.843	1.0	-0.485	-2.991
1.0	-0.488	-2.858	1.0	-0.488	-3.020
1.0	-0.490	-2.865	1.0	-0.490	-3.043
1.0	-0.492	-2.895	1.0	-0.492	-3.080
1.0	-0.495	-2.895	1.0	-0.495	-3.116
1.0	-0.497	-2.902	1.0	-0.497	-3.146
1.0	-0.500	-2.917	1.0	-0.500	-3.168
1.0	-0.502	-2.932	1.0	-0.502	-3.190
1.0	-0.505	-2.939	1.0	-0.505	-3.227
1.0	-0.507	-2.954	1.0	-0.507	-3.249
1.0	-0.510	-2.961	1.0	-0.510	-3.294
1.0	-0.512	-2.969	1.0	-0.512	-3.308
1.0	-0.514	-2.998	1.0	-0.514	-3.360
1.0	-0.517	-3.006	1.0	-0.517	-3.397
1.0	-0.519	-3.020	1.0	-0.519	-3.419
1.0	-0.522	-3.020	1.0	-0.522	-3.464
1.0	-0.524	-3.035	1.0	-0.524	-3.486
1.0	-0.527	-3.050	1.0	-0.527	-3.530
1.0	-0.529	-3.050	1.0	-0.529	-3.560
1.0	-0.532	-3.057	1.0	-0.532	-3.589
1.0	-0.534	-3.057	1.0	-0.534	-3.619

1.0	-0.536	-3.080	1.0	-0.536	-3.656
1.0	-0.539	-3.072	1.0	-0.539	-3.685
1.0	-0.541	-3.087	1.0	-0.541	-3.722
1.0	-0.544	-3.087	1.0	-0.544	-3.752
1.0	-0.546	-3.109	1.0	-0.546	-3.796
1.0	-0.549	-3.109	1.0	-0.549	-3.833
1.0	-0.551	-3.109	1.0	-0.551	-3.855
1.0	-0.553	-3.131	1.0	-0.553	-3.892
1.0	-0.556	-3.131	1.0	-0.556	-3.929
1.0	-0.558	-3.139	1.0	-0.558	-3.966
1.0	-0.561	-3.146	1.0	-0.561	-4.003
1.0	-0.563	-3.153	1.0	-0.563	-4.047
1.0	-0.566	-3.176	1.0	-0.566	-4.076
1.0	-0.568	-3.168	1.0	-0.568	-4.113
1.0	-0.571	-3.183	1.0	-0.571	-4.143
1.0	-0.573	-3.183	1.0	-0.573	-4.187
1.0	-0.575	-3.198	1.0	-0.575	-4.224
1.0	-0.578	-3.190	1.0	-0.578	-4.283
1.0	-0.580	-3.205	1.0	-0.580	-4.320
1.0	-0.583	-3.212	1.0	-0.583	-4.357
1.0	-0.585	-3.227	1.0	-0.585	-4.401
1.0	-0.588	-3.227	1.0	-0.588	-4.446
1.0	-0.590	-3.242	1.0	-0.590	-4.468
1.0	-0.593	-3.257	1.0	-0.593	-4.512
1.0	-0.595	-3.264	1.0	-0.595	-4.564
1.0	-0.597	-3.272	1.0	-0.597	-4.601
1.0	-0.600	-3.294	1.0	-0.600	-4.653
1.0	-0.602	-3.294	1.0	-0.602	-4.697
1.0	-0.605	-3.301	1.0	-0.605	-4.734
1.0	-0.607	-3.308	1.0	-0.607	-4.778
1.0	-0.610	-3.323	1.0	-0.610	-4.830
1.0	-0.612	-3.331	1.0	-0.612	-4.867
1.0	-0.615	-3.360	1.0	-0.615	-4.918
1.0	-0.617	-3.353	1.0	-0.617	-4.955
1.0	-0.619	-3.368	1.0	-0.619	-5.007
1.0	-0.622	-3.382	1.0	-0.622	-5.044
1.0	-0.624	-3.382	1.0	-0.624	-5.096
1.0	-0.627	-3.404	1.0	-0.627	-5.155
1.0	-0.629	-3.427	1.0	-0.629	-5.199
1.0	-0.632	-3.427	1.0	-0.632	-5.251
1.0	-0.634	-3.441	1.0	-0.634	-5.302
1.0	-0.636	-3.471	1.0	-0.636	-5.347
1.0	-0.639	-3.471	1.0	-0.639	-5.413
1.0	-0.641	-3.486	1.0	-0.641	-5.450
1.0	-0.644	-3.493	1.0	-0.644	-5.509
1.0	-0.646	-3.500	1.0	-0.646	-5.561
1.0	-0.649	-3.530	1.0	-0.649	-5.620
1.0	-0.651	-3.530	1.0	-0.651	-5.664
1.0	-0.654	-3.545	1.0	-0.654	-5.723
1.0	-0.656	-3.567	1.0	-0.656	-5.790
1.0	-0.658	-3.582	1.0	-0.658	-5.856
1.0	-0.661	-3.596	1.0	-0.661	-5.901
1.0	-0.663	-3.611	1.0	-0.663	-5.974
1.0	-0.666	-3.619	1.0	-0.666	-6.019
1.0	-0.668	-3.648	1.0	-0.668	-6.085
1.0	-0.671	-3.663	1.0	-0.671	-6.152

1.0	-0.673	-3.685	1.0	-0.673	-6.203
1.0	-0.676	-3.692	1.0	-0.676	-6.277
1.0	-0.678	-3.707	1.0	-0.678	-6.336
1.0	-0.680	-3.729	1.0	-0.680	-6.410
1.0	-0.683	-3.744	1.0	-0.683	-6.462
1.0	-0.685	-3.766	1.0	-0.685	-6.536
1.0	-0.688	-3.788	1.0	-0.688	-6.602
1.0	-0.690	-3.803	1.0	-0.690	-6.669
1.0	-0.693	-3.833	1.0	-0.693	-6.742
1.0	-0.695	-3.848	1.0	-0.695	-6.809
1.0	-0.698	-3.870	1.0	-0.698	-6.898
1.0	-0.700	-3.877	1.0	-0.700	-6.964
1.0	-0.698	-3.737	1.0	-0.698	-6.838
1.0	-0.695	-3.633	1.0	-0.695	-6.720
1.0	-0.693	-3.508	1.0	-0.693	-6.595
1.0	-0.690	-3.412	1.0	-0.690	-6.477
1.0	-0.688	-3.323	1.0	-0.688	-6.351

Table 7.2: Cyclic voltammetry results for millerite electrode in pH 12 buffer solution in the presence and absence of 0.01M KEX

Collectorless			**KEX 0.01M**		
Scan	Potential (V)	Current Density (mA/cm^2)	Scan	Potential (V)	Current Density (mA/cm^2)
1.0	-0.698	-9.511	1.0	-0.698	-10.992
1.0	-0.695	-6.561	1.0	-0.695	-7.359
1.0	-0.693	-5.069	1.0	-0.693	-5.500
1.0	-0.690	-4.171	1.0	-0.690	-4.372
1.0	-0.688	-3.546	1.0	-0.688	-3.612
1.0	-0.685	-3.105	1.0	-0.685	-3.078
1.0	-0.683	-2.765	1.0	-0.683	-2.668
1.0	-0.680	-2.498	1.0	-0.680	-2.353
1.0	-0.678	-2.276	1.0	-0.678	-2.096
1.0	-0.676	-2.096	1.0	-0.676	-1.895
1.0	-0.673	-1.936	1.0	-0.673	-1.724
1.0	-0.671	-1.804	1.0	-0.671	-1.572
1.0	-0.668	-1.693	1.0	-0.668	-1.450
1.0	-0.666	-1.589	1.0	-0.666	-1.343
1.0	-0.663	-1.502	1.0	-0.663	-1.249
1.0	-0.661	-1.423	1.0	-0.661	-1.166
1.0	-0.658	-1.346	1.0	-0.658	-1.090
1.0	-0.656	-1.277	1.0	-0.656	-1.031
1.0	-0.654	-1.221	1.0	-0.654	-0.972
1.0	-0.651	-1.169	1.0	-0.651	-0.919
1.0	-0.649	-1.121	1.0	-0.649	-0.881
1.0	-0.646	-1.079	1.0	-0.646	-0.836
1.0	-0.644	-1.034	1.0	-0.644	-0.798
1.0	-0.641	-0.996	1.0	-0.641	-0.763
1.0	-0.639	-0.961	1.0	-0.639	-0.732
1.0	-0.636	-0.933	1.0	-0.636	-0.697
1.0	-0.634	-0.909	1.0	-0.634	-0.673
1.0	-0.632	-0.878	1.0	-0.632	-0.652
1.0	-0.629	-0.854	1.0	-0.629	-0.632

1.0	-0.627	-0.829	1.0	-0.627	-0.614
1.0	-0.624	-0.802	1.0	-0.624	-0.586
1.0	-0.622	-0.784	1.0	-0.622	-0.562
1.0	-0.619	-0.767	1.0	-0.619	-0.545
1.0	-0.617	-0.749	1.0	-0.617	-0.527
1.0	-0.615	-0.732	1.0	-0.615	-0.520
1.0	-0.612	-0.708	1.0	-0.612	-0.507
1.0	-0.610	-0.694	1.0	-0.610	-0.496
1.0	-0.607	-0.670	1.0	-0.607	-0.486
1.0	-0.605	-0.663	1.0	-0.605	-0.468
1.0	-0.602	-0.649	1.0	-0.602	-0.458
1.0	-0.600	-0.635	1.0	-0.600	-0.448
1.0	-0.597	-0.621	1.0	-0.597	-0.441
1.0	-0.595	-0.607	1.0	-0.595	-0.434
1.0	-0.593	-0.597	1.0	-0.593	-0.423
1.0	-0.590	-0.586	1.0	-0.590	-0.413
1.0	-0.588	-0.573	1.0	-0.588	-0.402
1.0	-0.585	-0.566	1.0	-0.585	-0.396
1.0	-0.583	-0.552	1.0	-0.583	-0.392
1.0	-0.580	-0.541	1.0	-0.580	-0.382
1.0	-0.578	-0.531	1.0	-0.578	-0.371
1.0	-0.575	-0.520	1.0	-0.575	-0.368
1.0	-0.573	-0.510	1.0	-0.573	-0.361
1.0	-0.571	-0.510	1.0	-0.571	-0.361
1.0	-0.568	-0.500	1.0	-0.568	-0.354
1.0	-0.566	-0.493	1.0	-0.566	-0.354
1.0	-0.563	-0.482	1.0	-0.563	-0.350
1.0	-0.561	-0.479	1.0	-0.561	-0.344
1.0	-0.558	-0.465	1.0	-0.558	-0.337
1.0	-0.556	-0.461	1.0	-0.556	-0.330
1.0	-0.553	-0.448	1.0	-0.553	-0.330
1.0	-0.551	-0.441	1.0	-0.551	-0.319
1.0	-0.549	-0.437	1.0	-0.549	-0.319
1.0	-0.546	-0.430	1.0	-0.546	-0.319
1.0	-0.544	-0.423	1.0	-0.544	-0.312
1.0	-0.541	-0.416	1.0	-0.541	-0.312
1.0	-0.539	-0.413	1.0	-0.539	-0.309
1.0	-0.536	-0.402	1.0	-0.536	-0.298
1.0	-0.534	-0.396	1.0	-0.534	-0.298
1.0	-0.532	-0.392	1.0	-0.532	-0.291
1.0	-0.529	-0.389	1.0	-0.529	-0.288
1.0	-0.527	-0.385	1.0	-0.527	-0.285
1.0	-0.524	-0.375	1.0	-0.524	-0.281
1.0	-0.522	-0.371	1.0	-0.522	-0.278
1.0	-0.519	-0.364	1.0	-0.519	-0.281
1.0	-0.517	-0.364	1.0	-0.517	-0.278
1.0	-0.514	-0.361	1.0	-0.514	-0.274
1.0	-0.512	-0.357	1.0	-0.512	-0.267
1.0	-0.510	-0.354	1.0	-0.510	-0.267
1.0	-0.507	-0.347	1.0	-0.507	-0.264
1.0	-0.505	-0.344	1.0	-0.505	-0.257
1.0	-0.502	-0.333	1.0	-0.502	-0.257
1.0	-0.500	-0.340	1.0	-0.500	-0.253
1.0	-0.497	-0.337	1.0	-0.497	-0.260
1.0	-0.495	-0.326	1.0	-0.495	-0.250
1.0	-0.492	-0.319	1.0	-0.492	-0.250

1.0	-0.490	-0.319	1.0	-0.490	-0.243
1.0	-0.488	-0.319	1.0	-0.488	-0.253
1.0	-0.485	-0.316	1.0	-0.485	-0.246
1.0	-0.483	-0.316	1.0	-0.483	-0.243
1.0	-0.480	-0.305	1.0	-0.480	-0.239
1.0	-0.478	-0.305	1.0	-0.478	-0.243
1.0	-0.475	-0.302	1.0	-0.475	-0.243
1.0	-0.473	-0.298	1.0	-0.473	-0.236
1.0	-0.470	-0.295	1.0	-0.470	-0.236
1.0	-0.468	-0.288	1.0	-0.468	-0.236
1.0	-0.466	-0.288	1.0	-0.466	-0.229
1.0	-0.463	-0.285	1.0	-0.463	-0.226
1.0	-0.461	-0.281	1.0	-0.461	-0.226
1.0	-0.458	-0.281	1.0	-0.458	-0.222
1.0	-0.456	-0.274	1.0	-0.456	-0.226
1.0	-0.453	-0.271	1.0	-0.453	-0.219
1.0	-0.451	-0.271	1.0	-0.451	-0.226
1.0	-0.448	-0.267	1.0	-0.448	-0.212
1.0	-0.446	-0.260	1.0	-0.446	-0.208
1.0	-0.444	-0.260	1.0	-0.444	-0.208
1.0	-0.441	-0.260	1.0	-0.441	-0.212
1.0	-0.439	-0.257	1.0	-0.439	-0.208
1.0	-0.436	-0.253	1.0	-0.436	-0.212
1.0	-0.434	-0.243	1.0	-0.434	-0.205
1.0	-0.431	-0.253	1.0	-0.431	-0.198
1.0	-0.429	-0.250	1.0	-0.429	-0.198
1.0	-0.427	-0.243	1.0	-0.427	-0.201
1.0	-0.424	-0.239	1.0	-0.424	-0.198
1.0	-0.422	-0.239	1.0	-0.422	-0.198
1.0	-0.419	-0.236	1.0	-0.419	-0.201
1.0	-0.417	-0.232	1.0	-0.417	-0.198
1.0	-0.414	-0.226	1.0	-0.414	-0.198
1.0	-0.412	-0.222	1.0	-0.412	-0.194
1.0	-0.409	-0.222	1.0	-0.409	-0.194
1.0	-0.407	-0.219	1.0	-0.407	-0.194
1.0	-0.405	-0.215	1.0	-0.405	-0.187
1.0	-0.402	-0.212	1.0	-0.402	-0.187
1.0	-0.400	-0.212	1.0	-0.400	-0.187
1.0	-0.397	-0.208	1.0	-0.397	-0.187
1.0	-0.395	-0.208	1.0	-0.395	-0.184
1.0	-0.392	-0.205	1.0	-0.392	-0.187
1.0	-0.390	-0.201	1.0	-0.390	-0.180
1.0	-0.387	-0.198	1.0	-0.387	-0.184
1.0	-0.385	-0.198	1.0	-0.385	-0.177
1.0	-0.383	-0.198	1.0	-0.383	-0.177
1.0	-0.380	-0.194	1.0	-0.380	-0.173
1.0	-0.378	-0.194	1.0	-0.378	-0.170
1.0	-0.375	-0.194	1.0	-0.375	-0.173
1.0	-0.373	-0.191	1.0	-0.373	-0.167
1.0	-0.370	-0.191	1.0	-0.370	-0.170
1.0	-0.368	-0.191	1.0	-0.368	-0.167
1.0	-0.365	-0.187	1.0	-0.365	-0.167
1.0	-0.363	-0.191	1.0	-0.363	-0.163
1.0	-0.361	-0.184	1.0	-0.361	-0.167
1.0	-0.358	-0.184	1.0	-0.358	-0.163
1.0	-0.356	-0.180	1.0	-0.356	-0.160

1.0	-0.353	-0.180	1.0	-0.353	-0.160
1.0	-0.351	-0.177	1.0	-0.351	-0.160
1.0	-0.348	-0.177	1.0	-0.348	-0.156
1.0	-0.346	-0.170	1.0	-0.346	-0.156
1.0	-0.344	-0.173	1.0	-0.344	-0.149
1.0	-0.341	-0.177	1.0	-0.341	-0.149
1.0	-0.339	-0.170	1.0	-0.339	-0.149
1.0	-0.336	-0.170	1.0	-0.336	-0.153
1.0	-0.334	-0.170	1.0	-0.334	-0.146
1.0	-0.331	-0.163	1.0	-0.331	-0.146
1.0	-0.329	-0.163	1.0	-0.329	-0.146
1.0	-0.326	-0.163	1.0	-0.326	-0.142
1.0	-0.324	-0.167	1.0	-0.324	-0.142
1.0	-0.322	-0.160	1.0	-0.322	-0.139
1.0	-0.319	-0.160	1.0	-0.319	-0.139
1.0	-0.317	-0.156	1.0	-0.317	-0.139
1.0	-0.314	-0.153	1.0	-0.314	-0.142
1.0	-0.312	-0.160	1.0	-0.312	-0.135
1.0	-0.309	-0.153	1.0	-0.309	-0.135
1.0	-0.307	-0.149	1.0	-0.307	-0.132
1.0	-0.304	-0.146	1.0	-0.304	-0.135
1.0	-0.302	-0.153	1.0	-0.302	-0.128
1.0	-0.300	-0.149	1.0	-0.300	-0.132
1.0	-0.297	-0.146	1.0	-0.297	-0.128
1.0	-0.295	-0.146	1.0	-0.295	-0.132
1.0	-0.292	-0.142	1.0	-0.292	-0.128
1.0	-0.290	-0.142	1.0	-0.290	-0.128
1.0	-0.287	-0.139	1.0	-0.287	-0.121
1.0	-0.285	-0.142	1.0	-0.285	-0.121
1.0	-0.282	-0.139	1.0	-0.282	-0.125
1.0	-0.280	-0.139	1.0	-0.280	-0.118
1.0	-0.278	-0.139	1.0	-0.278	-0.118
1.0	-0.275	-0.132	1.0	-0.275	-0.118
1.0	-0.273	-0.135	1.0	-0.273	-0.111
1.0	-0.270	-0.132	1.0	-0.270	-0.115
1.0	-0.268	-0.128	1.0	-0.268	-0.108
1.0	-0.265	-0.128	1.0	-0.265	-0.111
1.0	-0.263	-0.125	1.0	-0.263	-0.111
1.0	-0.261	-0.125	1.0	-0.261	-0.111
1.0	-0.258	-0.128	1.0	-0.258	-0.108
1.0	-0.256	-0.125	1.0	-0.256	-0.111
1.0	-0.253	-0.121	1.0	-0.253	-0.111
1.0	-0.251	-0.121	1.0	-0.251	-0.115
1.0	-0.248	-0.118	1.0	-0.248	-0.108
1.0	-0.246	-0.118	1.0	-0.246	-0.108
1.0	-0.243	-0.118	1.0	-0.243	-0.104
1.0	-0.241	-0.115	1.0	-0.241	-0.101
1.0	-0.239	-0.115	1.0	-0.239	-0.101
1.0	-0.236	-0.115	1.0	-0.236	-0.104
1.0	-0.234	-0.111	1.0	-0.234	-0.104
1.0	-0.231	-0.111	1.0	-0.231	-0.104
1.0	-0.229	-0.111	1.0	-0.229	-0.104
1.0	-0.226	-0.108	1.0	-0.226	-0.097
1.0	-0.224	-0.108	1.0	-0.224	-0.097
1.0	-0.221	-0.104	1.0	-0.221	-0.097
1.0	-0.219	-0.108	1.0	-0.219	-0.097

1.0	-0.217	-0.104	1.0	-0.217	-0.094
1.0	-0.214	-0.104	1.0	-0.214	-0.097
1.0	-0.212	-0.101	1.0	-0.212	-0.097
1.0	-0.209	-0.101	1.0	-0.209	-0.090
1.0	-0.207	-0.104	1.0	-0.207	-0.094
1.0	-0.204	-0.104	1.0	-0.204	-0.094
1.0	-0.202	-0.097	1.0	-0.202	-0.087
1.0	-0.199	-0.097	1.0	-0.199	-0.097
1.0	-0.197	-0.094	1.0	-0.197	-0.094
1.0	-0.195	-0.097	1.0	-0.195	-0.090
1.0	-0.192	-0.097	1.0	-0.192	-0.090
1.0	-0.190	-0.094	1.0	-0.190	-0.087
1.0	-0.187	-0.094	1.0	-0.187	-0.083
1.0	-0.185	-0.094	1.0	-0.185	-0.087
1.0	-0.182	-0.090	1.0	-0.182	-0.087
1.0	-0.180	-0.090	1.0	-0.180	-0.080
1.0	-0.178	-0.094	1.0	-0.178	-0.083
1.0	-0.175	-0.090	1.0	-0.175	-0.087
1.0	-0.173	-0.090	1.0	-0.173	-0.083
1.0	-0.170	-0.094	1.0	-0.170	-0.076
1.0	-0.168	-0.083	1.0	-0.168	-0.083
1.0	-0.165	-0.087	1.0	-0.165	-0.083
1.0	-0.163	-0.087	1.0	-0.163	-0.080
1.0	-0.160	-0.080	1.0	-0.160	-0.080
1.0	-0.158	-0.083	1.0	-0.158	-0.083
1.0	-0.156	-0.083	1.0	-0.156	-0.087
1.0	-0.153	-0.083	1.0	-0.153	-0.083
1.0	-0.151	-0.083	1.0	-0.151	-0.076
1.0	-0.148	-0.083	1.0	-0.148	-0.073
1.0	-0.146	-0.080	1.0	-0.146	-0.073
1.0	-0.143	-0.080	1.0	-0.143	-0.076
1.0	-0.141	-0.076	1.0	-0.141	-0.076
1.0	-0.138	-0.076	1.0	-0.138	-0.073
1.0	-0.136	-0.069	1.0	-0.136	-0.076
1.0	-0.134	-0.073	1.0	-0.134	-0.080
1.0	-0.131	-0.073	1.0	-0.131	-0.076
1.0	-0.129	-0.076	1.0	-0.129	-0.073
1.0	-0.126	-0.076	1.0	-0.126	-0.069
1.0	-0.124	-0.073	1.0	-0.124	-0.069
1.0	-0.121	-0.069	1.0	-0.121	-0.066
1.0	-0.119	-0.073	1.0	-0.119	-0.069
1.0	-0.116	-0.069	1.0	-0.116	-0.066
1.0	-0.114	-0.066	1.0	-0.114	-0.066
1.0	-0.112	-0.066	1.0	-0.112	-0.069
1.0	-0.109	-0.066	1.0	-0.109	-0.062
1.0	-0.107	-0.066	1.0	-0.107	-0.066
1.0	-0.104	-0.062	1.0	-0.104	-0.066
1.0	-0.102	-0.059	1.0	-0.102	-0.062
1.0	-0.099	-0.056	1.0	-0.099	-0.066
1.0	-0.097	-0.059	1.0	-0.097	-0.069
1.0	-0.094	-0.062	1.0	-0.094	-0.059
1.0	-0.092	-0.059	1.0	-0.092	-0.056
1.0	-0.090	-0.056	1.0	-0.090	-0.052
1.0	-0.087	-0.059	1.0	-0.087	-0.049
1.0	-0.085	-0.059	1.0	-0.085	-0.056
1.0	-0.082	-0.056	1.0	-0.082	-0.052

1.0	-0.080	-0.056	1.0	-0.080	-0.049
1.0	-0.077	-0.052	1.0	-0.077	-0.045
1.0	-0.075	-0.049	1.0	-0.075	-0.045
1.0	-0.073	-0.045	1.0	-0.073	-0.049
1.0	-0.070	-0.049	1.0	-0.070	-0.045
1.0	-0.068	-0.049	1.0	-0.068	-0.042
1.0	-0.065	-0.042	1.0	-0.065	-0.042
1.0	-0.063	-0.045	1.0	-0.063	-0.042
1.0	-0.060	-0.035	1.0	-0.060	-0.042
1.0	-0.058	-0.035	1.0	-0.058	-0.035
1.0	-0.055	-0.035	1.0	-0.055	-0.035
1.0	-0.053	-0.031	1.0	-0.053	-0.035
1.0	-0.051	-0.028	1.0	-0.051	-0.031
1.0	-0.048	-0.028	1.0	-0.048	-0.031
1.0	-0.046	-0.024	1.0	-0.046	-0.028
1.0	-0.043	-0.024	1.0	-0.043	-0.028
1.0	-0.041	-0.024	1.0	-0.041	-0.021
1.0	-0.038	-0.021	1.0	-0.038	-0.024
1.0	-0.036	-0.024	1.0	-0.036	-0.024
1.0	-0.033	-0.017	1.0	-0.033	-0.024
1.0	-0.031	-0.021	1.0	-0.031	-0.017
1.0	-0.029	-0.017	1.0	-0.029	-0.017
1.0	-0.026	-0.014	1.0	-0.026	-0.017
1.0	-0.024	-0.014	1.0	-0.024	-0.021
1.0	-0.021	-0.014	1.0	-0.021	-0.014
1.0	-0.019	-0.010	1.0	-0.019	-0.014
1.0	-0.016	0.000	1.0	-0.016	-0.014
1.0	-0.014	-0.007	1.0	-0.014	-0.007
1.0	-0.011	0.000	1.0	-0.011	-0.007
1.0	-0.009	0.000	1.0	-0.009	-0.003
1.0	-0.007	0.003	1.0	-0.007	-0.003
1.0	-0.004	0.000	1.0	-0.004	0.000
1.0	-0.002	0.007	1.0	-0.002	0.000
1.0	0.001	0.010	1.0	0.001	0.007
1.0	0.003	0.007	1.0	0.003	0.003
1.0	0.006	0.010	1.0	0.006	0.003
1.0	0.008	0.014	1.0	0.008	0.003
1.0	0.010	0.021	1.0	0.010	0.007
1.0	0.013	0.024	1.0	0.013	0.007
1.0	0.015	0.024	1.0	0.015	0.007
1.0	0.018	0.031	1.0	0.018	0.014
1.0	0.020	0.028	1.0	0.020	0.014
1.0	0.023	0.035	1.0	0.023	0.017
1.0	0.025	0.038	1.0	0.025	0.017
1.0	0.028	0.035	1.0	0.028	0.021
1.0	0.030	0.042	1.0	0.030	0.021
1.0	0.032	0.045	1.0	0.032	0.021
1.0	0.035	0.045	1.0	0.035	0.028
1.0	0.037	0.049	1.0	0.037	0.031
1.0	0.040	0.049	1.0	0.040	0.031
1.0	0.042	0.049	1.0	0.042	0.038
1.0	0.045	0.052	1.0	0.045	0.038
1.0	0.047	0.056	1.0	0.047	0.038
1.0	0.050	0.052	1.0	0.050	0.045
1.0	0.052	0.062	1.0	0.052	0.042
1.0	0.054	0.059	1.0	0.054	0.056

1.0	0.057	0.062	1.0	0.057	0.049
1.0	0.059	0.069	1.0	0.059	0.059
1.0	0.062	0.073	1.0	0.062	0.059
1.0	0.064	0.080	1.0	0.064	0.066
1.0	0.067	0.080	1.0	0.067	0.066
1.0	0.069	0.080	1.0	0.069	0.076
1.0	0.072	0.080	1.0	0.072	0.076
1.0	0.074	0.083	1.0	0.074	0.083
1.0	0.076	0.090	1.0	0.076	0.083
1.0	0.079	0.094	1.0	0.079	0.090
1.0	0.081	0.097	1.0	0.081	0.090
1.0	0.084	0.101	1.0	0.084	0.101
1.0	0.086	0.101	1.0	0.086	0.108
1.0	0.089	0.104	1.0	0.089	0.108
1.0	0.091	0.108	1.0	0.091	0.118
1.0	0.093	0.111	1.0	0.093	0.128
1.0	0.096	0.121	1.0	0.096	0.139
1.0	0.098	0.121	1.0	0.098	0.142
1.0	0.101	0.125	1.0	0.101	0.153
1.0	0.103	0.128	1.0	0.103	0.160
1.0	0.106	0.135	1.0	0.106	0.170
1.0	0.108	0.142	1.0	0.108	0.180
1.0	0.111	0.139	1.0	0.111	0.191
1.0	0.113	0.149	1.0	0.113	0.201
1.0	0.115	0.153	1.0	0.115	0.212
1.0	0.118	0.160	1.0	0.118	0.226
1.0	0.120	0.167	1.0	0.120	0.236
1.0	0.123	0.170	1.0	0.123	0.243
1.0	0.125	0.177	1.0	0.125	0.253
1.0	0.128	0.184	1.0	0.128	0.257
1.0	0.130	0.187	1.0	0.130	0.271
1.0	0.133	0.198	1.0	0.133	0.281
1.0	0.135	0.201	1.0	0.135	0.302
1.0	0.137	0.208	1.0	0.137	0.309
1.0	0.140	0.212	1.0	0.140	0.319
1.0	0.142	0.226	1.0	0.142	0.330
1.0	0.145	0.232	1.0	0.145	0.347
1.0	0.147	0.229	1.0	0.147	0.361
1.0	0.150	0.236	1.0	0.150	0.375
1.0	0.152	0.243	1.0	0.152	0.382
1.0	0.155	0.257	1.0	0.155	0.396
1.0	0.157	0.267	1.0	0.157	0.413
1.0	0.159	0.274	1.0	0.159	0.423
1.0	0.162	0.278	1.0	0.162	0.437
1.0	0.164	0.288	1.0	0.164	0.451
1.0	0.167	0.295	1.0	0.167	0.461
1.0	0.169	0.305	1.0	0.169	0.482
1.0	0.172	0.309	1.0	0.172	0.493
1.0	0.174	0.316	1.0	0.174	0.503
1.0	0.177	0.333	1.0	0.177	0.524
1.0	0.179	0.340	1.0	0.179	0.538
1.0	0.181	0.344	1.0	0.181	0.559
1.0	0.184	0.354	1.0	0.184	0.573
1.0	0.186	0.368	1.0	0.186	0.586
1.0	0.189	0.382	1.0	0.189	0.604
1.0	0.191	0.392	1.0	0.191	0.625

1.0	0.194	0.406	1.0	0.194	0.645
1.0	0.196	0.413	1.0	0.196	0.663
1.0	0.198	0.423	1.0	0.198	0.677
1.0	0.201	0.434	1.0	0.201	0.701
1.0	0.203	0.451	1.0	0.203	0.722
1.0	0.206	0.461	1.0	0.206	0.739
1.0	0.208	0.475	1.0	0.208	0.756
1.0	0.211	0.486	1.0	0.211	0.770
1.0	0.213	0.503	1.0	0.213	0.795
1.0	0.216	0.514	1.0	0.216	0.812
1.0	0.218	0.527	1.0	0.218	0.829
1.0	0.220	0.545	1.0	0.220	0.854
1.0	0.223	0.555	1.0	0.223	0.871
1.0	0.225	0.566	1.0	0.225	0.895
1.0	0.228	0.586	1.0	0.228	0.916
1.0	0.230	0.600	1.0	0.230	0.940
1.0	0.233	0.621	1.0	0.233	0.965
1.0	0.235	0.628	1.0	0.235	0.982
1.0	0.238	0.652	1.0	0.238	1.010
1.0	0.240	0.670	1.0	0.240	1.031
1.0	0.242	0.687	1.0	0.242	1.055
1.0	0.245	0.704	1.0	0.245	1.083
1.0	0.247	0.718	1.0	0.247	1.100
1.0	0.250	0.736	1.0	0.250	1.128
1.0	0.252	0.753	1.0	0.252	1.145
1.0	0.255	0.770	1.0	0.255	1.173
1.0	0.257	0.791	1.0	0.257	1.201
1.0	0.260	0.808	1.0	0.260	1.225
1.0	0.262	0.833	1.0	0.262	1.253
1.0	0.264	0.847	1.0	0.264	1.277
1.0	0.267	0.867	1.0	0.267	1.305
1.0	0.269	0.888	1.0	0.269	1.332
1.0	0.272	0.909	1.0	0.272	1.360
1.0	0.274	0.937	1.0	0.274	1.384
1.0	0.277	0.951	1.0	0.277	1.419
1.0	0.279	0.978	1.0	0.279	1.450
1.0	0.281	1.006	1.0	0.281	1.475
1.0	0.284	1.027	1.0	0.284	1.495
1.0	0.286	1.048	1.0	0.286	1.534
1.0	0.289	1.069	1.0	0.289	1.561
1.0	0.291	1.090	1.0	0.291	1.593
1.0	0.294	1.121	1.0	0.294	1.627
1.0	0.296	1.149	1.0	0.296	1.662
1.0	0.299	1.169	1.0	0.299	1.693
1.0	0.301	1.204	1.0	0.301	1.728
1.0	0.303	1.228	1.0	0.303	1.763
1.0	0.306	1.260	1.0	0.306	1.794
1.0	0.308	1.280	1.0	0.308	1.832
1.0	0.311	1.315	1.0	0.311	1.874
1.0	0.313	1.350	1.0	0.313	1.905
1.0	0.316	1.378	1.0	0.316	1.943
1.0	0.318	1.409	1.0	0.318	1.981
1.0	0.321	1.440	1.0	0.321	2.019
1.0	0.323	1.478	1.0	0.323	2.061
1.0	0.325	1.513	1.0	0.325	2.103
1.0	0.328	1.544	1.0	0.328	2.148

1.0	0.330	1.579	1.0	0.330	2.189
1.0	0.333	1.613	1.0	0.333	2.224
1.0	0.335	1.655	1.0	0.335	2.269
1.0	0.338	1.686	1.0	0.338	2.314
1.0	0.340	1.728	1.0	0.340	2.359
1.0	0.343	1.766	1.0	0.343	2.408
1.0	0.345	1.811	1.0	0.345	2.450
1.0	0.347	1.849	1.0	0.347	2.502
1.0	0.350	1.895	1.0	0.350	2.547
1.0	0.352	1.936	1.0	0.352	2.592
1.0	0.355	1.985	1.0	0.355	2.644
1.0	0.357	2.026	1.0	0.357	2.693
1.0	0.360	2.071	1.0	0.360	2.748
1.0	0.362	2.124	1.0	0.362	2.790
1.0	0.364	2.172	1.0	0.364	2.845
1.0	0.367	2.228	1.0	0.367	2.894
1.0	0.369	2.269	1.0	0.369	2.946
1.0	0.372	2.321	1.0	0.372	2.998
1.0	0.374	2.380	1.0	0.374	3.050
1.0	0.377	2.425	1.0	0.377	3.109
1.0	0.379	2.474	1.0	0.379	3.158
1.0	0.382	2.529	1.0	0.382	3.210
1.0	0.384	2.578	1.0	0.384	3.265
1.0	0.386	2.634	1.0	0.386	3.321
1.0	0.389	2.682	1.0	0.389	3.380
1.0	0.391	2.745	1.0	0.391	3.428
1.0	0.394	2.797	1.0	0.394	3.487
1.0	0.396	2.852	1.0	0.396	3.539
1.0	0.399	2.904	1.0	0.399	3.598
1.0	0.401	2.956	1.0	0.401	3.647
1.0	0.404	3.012	1.0	0.404	3.706
1.0	0.406	3.064	1.0	0.406	3.768
1.0	0.408	3.112	1.0	0.408	3.827
1.0	0.411	3.158	1.0	0.411	3.876
1.0	0.413	3.210	1.0	0.413	3.942
1.0	0.416	3.258	1.0	0.416	4.001
1.0	0.418	3.307	1.0	0.418	4.056
1.0	0.421	3.348	1.0	0.421	4.112
1.0	0.423	3.387	1.0	0.423	4.167
1.0	0.426	3.428	1.0	0.426	4.230
1.0	0.428	3.470	1.0	0.428	4.285
1.0	0.430	3.501	1.0	0.430	4.344
1.0	0.433	3.536	1.0	0.433	4.400
1.0	0.435	3.577	1.0	0.435	4.462
1.0	0.438	3.605	1.0	0.438	4.518
1.0	0.440	3.626	1.0	0.440	4.580
1.0	0.443	3.661	1.0	0.443	4.639
1.0	0.445	3.685	1.0	0.445	4.695
1.0	0.447	3.706	1.0	0.447	4.761
1.0	0.450	3.727	1.0	0.450	4.820
1.0	0.452	3.744	1.0	0.452	4.875
1.0	0.455	3.758	1.0	0.455	4.941
1.0	0.457	3.768	1.0	0.457	5.000
1.0	0.460	3.782	1.0	0.460	5.062
1.0	0.462	3.786	1.0	0.462	5.125
1.0	0.465	3.792	1.0	0.465	5.180

1.0	0.467	3.796	1.0	0.467	5.243
1.0	0.469	3.803	1.0	0.469	5.295
1.0	0.472	3.803	1.0	0.472	5.357
1.0	0.474	3.803	1.0	0.474	5.413
1.0	0.477	3.799	1.0	0.477	5.475
1.0	0.479	3.796	1.0	0.479	5.541
1.0	0.482	3.789	1.0	0.482	5.597
1.0	0.484	3.782	1.0	0.484	5.659
1.0	0.487	3.782	1.0	0.487	5.715
1.0	0.489	3.772	1.0	0.489	5.774
1.0	0.491	3.758	1.0	0.491	5.829
1.0	0.494	3.744	1.0	0.494	5.888
1.0	0.496	3.737	1.0	0.496	5.940
1.0	0.499	3.720	1.0	0.499	6.003
1.0	0.501	3.709	1.0	0.501	6.048
1.0	0.504	3.699	1.0	0.504	6.107
1.0	0.506	3.678	1.0	0.506	6.162
1.0	0.509	3.664	1.0	0.509	6.207
1.0	0.511	3.650	1.0	0.511	6.270
1.0	0.513	3.636	1.0	0.513	6.312
1.0	0.516	3.622	1.0	0.516	6.357
1.0	0.518	3.609	1.0	0.518	6.402
1.0	0.521	3.591	1.0	0.521	6.447
1.0	0.523	3.567	1.0	0.523	6.485
1.0	0.526	3.563	1.0	0.526	6.527
1.0	0.528	3.553	1.0	0.528	6.565
1.0	0.531	3.539	1.0	0.531	6.603
1.0	0.533	3.529	1.0	0.533	6.627
1.0	0.535	3.525	1.0	0.535	6.655
1.0	0.538	3.515	1.0	0.538	6.676
1.0	0.540	3.508	1.0	0.540	6.697
1.0	0.543	3.498	1.0	0.543	6.724
1.0	0.545	3.508	1.0	0.545	6.735
1.0	0.548	3.515	1.0	0.548	6.749
1.0	0.550	3.525	1.0	0.550	6.752
1.0	0.552	3.539	1.0	0.552	6.749
1.0	0.555	3.560	1.0	0.555	6.752
1.0	0.557	3.577	1.0	0.557	6.752
1.0	0.560	3.609	1.0	0.560	6.745
1.0	0.562	3.647	1.0	0.562	6.731
1.0	0.565	3.692	1.0	0.565	6.714
1.0	0.567	3.754	1.0	0.567	6.690
1.0	0.570	3.827	1.0	0.570	6.669
1.0	0.572	3.904	1.0	0.572	6.641
1.0	0.574	3.990	1.0	0.574	6.610
1.0	0.577	4.108	1.0	0.577	6.575
1.0	0.579	4.244	1.0	0.579	6.541
1.0	0.582	4.389	1.0	0.582	6.506
1.0	0.584	4.570	1.0	0.584	6.464
1.0	0.587	4.768	1.0	0.587	6.430
1.0	0.589	4.986	1.0	0.589	6.384
1.0	0.592	5.243	1.0	0.592	6.350
1.0	0.594	5.524	1.0	0.594	6.315
1.0	0.596	5.840	1.0	0.596	6.284
1.0	0.599	6.173	1.0	0.599	6.256
1.0	0.601	6.534	1.0	0.601	6.232

1.0	0.604	6.922	1.0	0.604	6.214
1.0	0.606	7.328	1.0	0.606	6.204
1.0	0.609	7.758	1.0	0.609	6.207
1.0	0.611	8.203	1.0	0.611	6.225
1.0	0.614	8.650	1.0	0.614	6.249
1.0	0.616	9.105	1.0	0.616	6.291
1.0	0.618	9.570	1.0	0.618	6.357
1.0	0.621	10.021	1.0	0.621	6.436
1.0	0.623	10.486	1.0	0.623	6.541
1.0	0.626	10.933	1.0	0.626	6.669
1.0	0.628	11.381	1.0	0.628	6.829
1.0	0.631	11.815	1.0	0.631	7.006
1.0	0.633	12.241	1.0	0.633	7.210
1.0	0.635	12.651	1.0	0.635	7.450
1.0	0.638	13.046	1.0	0.638	7.713
1.0	0.640	13.428	1.0	0.640	7.991
1.0	0.643	13.796	1.0	0.643	8.289
1.0	0.645	14.139	1.0	0.645	8.605
1.0	0.648	14.479	1.0	0.648	8.931
1.0	0.650	14.788	1.0	0.650	9.254
1.0	0.653	15.080	1.0	0.653	9.580
1.0	0.655	15.343	1.0	0.655	9.903
1.0	0.657	15.590	1.0	0.657	10.212
1.0	0.660	15.808	1.0	0.660	10.517
1.0	0.662	16.006	1.0	0.662	10.808
1.0	0.665	16.183	1.0	0.665	11.083
1.0	0.667	16.329	1.0	0.667	11.343
1.0	0.670	16.454	1.0	0.670	11.586
1.0	0.672	16.551	1.0	0.672	11.808
1.0	0.675	16.620	1.0	0.675	11.988
1.0	0.677	16.665	1.0	0.677	12.162
1.0	0.679	16.669	1.0	0.679	12.314
1.0	0.682	16.655	1.0	0.682	12.436
1.0	0.684	16.606	1.0	0.684	12.540
1.0	0.687	16.544	1.0	0.687	12.616
1.0	0.689	16.443	1.0	0.689	12.665
1.0	0.692	16.329	1.0	0.692	12.689
1.0	0.694	16.187	1.0	0.694	12.689
1.0	0.697	16.030	1.0	0.697	12.672
1.0	0.699	15.857	1.0	0.699	12.630
1.0	0.701	15.666	1.0	0.701	12.575
1.0	0.704	15.468	1.0	0.704	12.505
1.0	0.706	15.267	1.0	0.706	12.418
1.0	0.709	15.059	1.0	0.709	12.328
1.0	0.711	14.854	1.0	0.711	12.228
1.0	0.714	14.649	1.0	0.714	12.127
1.0	0.716	14.445	1.0	0.716	12.023
1.0	0.718	14.247	1.0	0.718	11.919
1.0	0.721	14.049	1.0	0.721	11.815
1.0	0.723	13.869	1.0	0.723	11.711
1.0	0.726	13.685	1.0	0.726	11.606
1.0	0.728	13.515	1.0	0.728	11.513
1.0	0.731	13.348	1.0	0.731	11.426
1.0	0.733	13.185	1.0	0.733	11.336
1.0	0.736	13.036	1.0	0.736	11.235
1.0	0.738	12.890	1.0	0.738	11.155

1.0	0.740	12.752	1.0	0.740	11.072
1.0	0.743	12.613	1.0	0.743	10.989
1.0	0.745	12.484	1.0	0.745	10.902
1.0	0.748	12.359	1.0	0.748	10.826
1.0	0.750	12.248	1.0	0.750	10.746
1.0	0.753	12.141	1.0	0.753	10.666
1.0	0.755	12.033	1.0	0.755	10.590
1.0	0.758	11.926	1.0	0.758	10.517
1.0	0.760	11.829	1.0	0.760	10.451
1.0	0.762	11.731	1.0	0.762	10.385
1.0	0.765	11.638	1.0	0.765	10.323
1.0	0.767	11.551	1.0	0.767	10.267
1.0	0.770	11.471	1.0	0.770	10.212
1.0	0.772	11.388	1.0	0.772	10.167
1.0	0.775	11.315	1.0	0.775	10.121
1.0	0.777	11.239	1.0	0.777	10.087
1.0	0.780	11.169	1.0	0.780	10.062
1.0	0.782	11.103	1.0	0.782	10.042
1.0	0.784	11.037	1.0	0.784	10.042
1.0	0.787	10.978	1.0	0.787	10.038
1.0	0.789	10.930	1.0	0.789	10.052
1.0	0.792	10.878	1.0	0.792	10.083
1.0	0.794	10.840	1.0	0.794	10.132
1.0	0.797	10.798	1.0	0.797	10.191
1.0	0.799	10.770	1.0	0.799	10.274
1.0	0.802	10.753	1.0	0.802	10.382
1.0	0.799	10.503	1.0	0.799	10.271
1.0	0.797	10.326	1.0	0.797	10.222
1.0	0.794	10.184	1.0	0.794	10.198
1.0	0.792	10.055	1.0	0.792	10.187
1.0	0.789	9.927	1.0	0.789	10.173
1.0	0.787	9.806	1.0	0.787	10.170
1.0	0.784	9.677	1.0	0.784	10.146
1.0	0.782	9.549	1.0	0.782	10.118
1.0	0.780	9.424	1.0	0.780	10.073
1.0	0.777	9.296	1.0	0.777	10.010
1.0	0.775	9.174	1.0	0.775	9.934
1.0	0.772	9.056	1.0	0.772	9.847
1.0	0.770	8.945	1.0	0.770	9.743
1.0	0.767	8.848	1.0	0.767	9.629
1.0	0.765	8.744	1.0	0.765	9.504
1.0	0.762	8.654	1.0	0.762	9.379
1.0	0.760	8.567	1.0	0.760	9.247
1.0	0.758	8.487	1.0	0.758	9.119
1.0	0.755	8.404	1.0	0.755	8.983
1.0	0.753	8.331	1.0	0.753	8.851
1.0	0.750	8.251	1.0	0.750	8.723
1.0	0.748	8.189	1.0	0.748	8.595
1.0	0.745	8.126	1.0	0.745	8.470
1.0	0.743	8.060	1.0	0.743	8.348
1.0	0.740	7.994	1.0	0.740	8.227
1.0	0.738	7.932	1.0	0.738	8.105
1.0	0.736	7.870	1.0	0.736	7.998
1.0	0.733	7.811	1.0	0.733	7.883
1.0	0.731	7.748	1.0	0.731	7.779
1.0	0.728	7.686	1.0	0.728	7.682

1.0	0.726	7.620	1.0	0.726	7.578
1.0	0.723	7.554	1.0	0.723	7.481
1.0	0.721	7.484	1.0	0.721	7.387
1.0	0.718	7.422	1.0	0.718	7.287
1.0	0.716	7.359	1.0	0.716	7.200
1.0	0.714	7.297	1.0	0.714	7.099
1.0	0.711	7.231	1.0	0.711	7.019
1.0	0.709	7.165	1.0	0.709	6.926
1.0	0.706	7.096	1.0	0.706	6.836
1.0	0.704	7.037	1.0	0.704	6.738
1.0	0.701	6.971	1.0	0.701	6.652
1.0	0.699	6.908	1.0	0.699	6.565
1.0	0.697	6.842	1.0	0.697	6.475
1.0	0.694	6.783	1.0	0.694	6.381
1.0	0.692	6.718	1.0	0.692	6.291
1.0	0.689	6.648	1.0	0.689	6.197
1.0	0.687	6.596	1.0	0.687	6.114
1.0	0.684	6.534	1.0	0.684	6.024
1.0	0.682	6.471	1.0	0.682	5.937
1.0	0.679	6.412	1.0	0.679	5.843
1.0	0.677	6.357	1.0	0.677	5.763
1.0	0.675	6.301	1.0	0.675	5.670
1.0	0.672	6.242	1.0	0.672	5.586
1.0	0.670	6.183	1.0	0.670	5.507
1.0	0.667	6.128	1.0	0.667	5.420
1.0	0.665	6.072	1.0	0.665	5.333
1.0	0.662	6.010	1.0	0.662	5.257
1.0	0.660	5.954	1.0	0.660	5.177
1.0	0.657	5.899	1.0	0.657	5.097
1.0	0.655	5.843	1.0	0.655	5.021
1.0	0.653	5.777	1.0	0.653	4.941
1.0	0.650	5.722	1.0	0.650	4.865
1.0	0.648	5.663	1.0	0.648	4.792
1.0	0.645	5.604	1.0	0.645	4.722
1.0	0.643	5.541	1.0	0.643	4.643
1.0	0.640	5.482	1.0	0.640	4.570
1.0	0.638	5.420	1.0	0.638	4.507
1.0	0.635	5.350	1.0	0.635	4.434
1.0	0.633	5.291	1.0	0.633	4.362
1.0	0.631	5.222	1.0	0.631	4.292
1.0	0.628	5.156	1.0	0.628	4.226
1.0	0.626	5.087	1.0	0.626	4.157
1.0	0.623	5.024	1.0	0.623	4.094
1.0	0.621	4.951	1.0	0.621	4.028
1.0	0.618	4.882	1.0	0.618	3.966
1.0	0.616	4.813	1.0	0.616	3.897
1.0	0.614	4.743	1.0	0.614	3.838
1.0	0.611	4.670	1.0	0.611	3.779
1.0	0.609	4.601	1.0	0.609	3.709
1.0	0.606	4.525	1.0	0.606	3.647
1.0	0.604	4.448	1.0	0.604	3.588
1.0	0.601	4.379	1.0	0.601	3.522
1.0	0.599	4.303	1.0	0.599	3.466
1.0	0.596	4.230	1.0	0.596	3.414
1.0	0.594	4.150	1.0	0.594	3.348
1.0	0.592	4.077	1.0	0.592	3.289

1.0	0.589	4.001	1.0	0.589	3.234
1.0	0.587	3.917	1.0	0.587	3.178
1.0	0.584	3.848	1.0	0.584	3.123
1.0	0.582	3.765	1.0	0.582	3.071
1.0	0.579	3.692	1.0	0.579	3.012
1.0	0.577	3.616	1.0	0.577	2.956
1.0	0.574	3.529	1.0	0.574	2.901
1.0	0.572	3.459	1.0	0.572	2.849
1.0	0.570	3.376	1.0	0.570	2.797
1.0	0.567	3.300	1.0	0.567	2.748
1.0	0.565	3.227	1.0	0.565	2.700
1.0	0.562	3.144	1.0	0.562	2.651
1.0	0.560	3.074	1.0	0.560	2.599
1.0	0.557	3.001	1.0	0.557	2.557
1.0	0.555	2.925	1.0	0.555	2.502
1.0	0.552	2.849	1.0	0.552	2.446
1.0	0.550	2.779	1.0	0.550	2.412
1.0	0.548	2.710	1.0	0.548	2.366
1.0	0.545	2.641	1.0	0.545	2.321
1.0	0.543	2.564	1.0	0.543	2.280
1.0	0.540	2.495	1.0	0.540	2.238
1.0	0.538	2.425	1.0	0.538	2.193
1.0	0.535	2.363	1.0	0.535	2.148
1.0	0.533	2.297	1.0	0.533	2.106
1.0	0.531	2.231	1.0	0.531	2.068
1.0	0.528	2.162	1.0	0.528	2.030
1.0	0.526	2.106	1.0	0.526	1.995
1.0	0.523	2.044	1.0	0.523	1.957
1.0	0.521	1.981	1.0	0.521	1.919
1.0	0.518	1.922	1.0	0.518	1.884
1.0	0.516	1.863	1.0	0.516	1.846
1.0	0.513	1.808	1.0	0.513	1.815
1.0	0.511	1.756	1.0	0.511	1.777
1.0	0.509	1.700	1.0	0.509	1.745
1.0	0.506	1.648	1.0	0.506	1.707
1.0	0.504	1.596	1.0	0.504	1.672
1.0	0.501	1.544	1.0	0.501	1.648
1.0	0.499	1.499	1.0	0.499	1.617
1.0	0.496	1.443	1.0	0.496	1.586
1.0	0.494	1.398	1.0	0.494	1.551
1.0	0.491	1.353	1.0	0.491	1.520
1.0	0.489	1.308	1.0	0.489	1.492
1.0	0.487	1.270	1.0	0.487	1.468
1.0	0.484	1.221	1.0	0.484	1.443
1.0	0.482	1.180	1.0	0.482	1.412
1.0	0.479	1.142	1.0	0.479	1.388
1.0	0.477	1.100	1.0	0.477	1.364
1.0	0.474	1.065	1.0	0.474	1.336
1.0	0.472	1.027	1.0	0.472	1.312
1.0	0.469	0.996	1.0	0.469	1.291
1.0	0.467	0.958	1.0	0.467	1.263
1.0	0.465	0.923	1.0	0.465	1.239
1.0	0.462	0.892	1.0	0.462	1.221
1.0	0.460	0.861	1.0	0.460	1.197
1.0	0.457	0.826	1.0	0.457	1.176
1.0	0.455	0.802	1.0	0.455	1.155

1.0	0.452	0.770	1.0	0.452	1.138
1.0	0.450	0.743	1.0	0.450	1.110
1.0	0.447	0.718	1.0	0.447	1.096
1.0	0.445	0.684	1.0	0.445	1.072
1.0	0.443	0.656	1.0	0.443	1.055
1.0	0.440	0.632	1.0	0.440	1.034
1.0	0.438	0.607	1.0	0.438	1.013
1.0	0.435	0.586	1.0	0.435	0.996
1.0	0.433	0.562	1.0	0.433	0.978
1.0	0.430	0.538	1.0	0.430	0.965
1.0	0.428	0.520	1.0	0.428	0.947
1.0	0.426	0.500	1.0	0.426	0.926
1.0	0.423	0.475	1.0	0.423	0.909
1.0	0.421	0.458	1.0	0.421	0.895
1.0	0.418	0.441	1.0	0.418	0.878
1.0	0.416	0.423	1.0	0.416	0.867
1.0	0.413	0.406	1.0	0.413	0.850
1.0	0.411	0.385	1.0	0.411	0.833
1.0	0.408	0.368	1.0	0.408	0.822
1.0	0.406	0.354	1.0	0.406	0.808
1.0	0.404	0.333	1.0	0.404	0.791
1.0	0.401	0.323	1.0	0.401	0.781
1.0	0.399	0.312	1.0	0.399	0.767
1.0	0.396	0.295	1.0	0.396	0.753
1.0	0.394	0.274	1.0	0.394	0.739
1.0	0.391	0.264	1.0	0.391	0.725
1.0	0.389	0.246	1.0	0.389	0.715
1.0	0.386	0.232	1.0	0.386	0.704
1.0	0.384	0.219	1.0	0.384	0.690
1.0	0.382	0.212	1.0	0.382	0.680
1.0	0.379	0.198	1.0	0.379	0.666
1.0	0.377	0.187	1.0	0.377	0.656
1.0	0.374	0.177	1.0	0.374	0.642
1.0	0.372	0.163	1.0	0.372	0.635
1.0	0.369	0.156	1.0	0.369	0.625
1.0	0.367	0.146	1.0	0.367	0.614
1.0	0.364	0.139	1.0	0.364	0.597
1.0	0.362	0.125	1.0	0.362	0.593
1.0	0.360	0.115	1.0	0.360	0.583
1.0	0.357	0.108	1.0	0.357	0.579
1.0	0.355	0.090	1.0	0.355	0.569
1.0	0.352	0.083	1.0	0.352	0.555
1.0	0.350	0.076	1.0	0.350	0.545
1.0	0.347	0.069	1.0	0.347	0.534
1.0	0.345	0.062	1.0	0.345	0.524
1.0	0.343	0.052	1.0	0.343	0.520
1.0	0.340	0.045	1.0	0.340	0.510
1.0	0.338	0.035	1.0	0.338	0.500
1.0	0.335	0.031	1.0	0.335	0.489
1.0	0.333	0.021	1.0	0.333	0.482
1.0	0.330	0.010	1.0	0.330	0.475
1.0	0.328	0.007	1.0	0.328	0.472
1.0	0.325	0.003	1.0	0.325	0.465
1.0	0.323	-0.007	1.0	0.323	0.451
1.0	0.321	-0.010	1.0	0.321	0.448
1.0	0.318	-0.024	1.0	0.318	0.437

1.0	0.316	-0.024	1.0	0.316	0.430
1.0	0.313	-0.028	1.0	0.313	0.423
1.0	0.311	-0.031	1.0	0.311	0.416
1.0	0.308	-0.042	1.0	0.308	0.406
1.0	0.306	-0.045	1.0	0.306	0.396
1.0	0.303	-0.056	1.0	0.303	0.392
1.0	0.301	-0.052	1.0	0.301	0.378
1.0	0.299	-0.059	1.0	0.299	0.371
1.0	0.296	-0.062	1.0	0.296	0.368
1.0	0.294	-0.069	1.0	0.294	0.357
1.0	0.291	-0.073	1.0	0.291	0.354
1.0	0.289	-0.076	1.0	0.289	0.347
1.0	0.286	-0.080	1.0	0.286	0.337
1.0	0.284	-0.083	1.0	0.284	0.326
1.0	0.281	-0.090	1.0	0.281	0.319
1.0	0.279	-0.090	1.0	0.279	0.316
1.0	0.277	-0.097	1.0	0.277	0.305
1.0	0.274	-0.097	1.0	0.274	0.295
1.0	0.272	-0.097	1.0	0.272	0.288
1.0	0.269	-0.108	1.0	0.269	0.288
1.0	0.267	-0.118	1.0	0.267	0.278
1.0	0.264	-0.118	1.0	0.264	0.271
1.0	0.262	-0.115	1.0	0.262	0.257
1.0	0.260	-0.118	1.0	0.260	0.253
1.0	0.257	-0.125	1.0	0.257	0.246
1.0	0.255	-0.125	1.0	0.255	0.239
1.0	0.252	-0.125	1.0	0.252	0.236
1.0	0.250	-0.128	1.0	0.250	0.222
1.0	0.247	-0.132	1.0	0.247	0.215
1.0	0.245	-0.135	1.0	0.245	0.208
1.0	0.242	-0.139	1.0	0.242	0.201
1.0	0.240	-0.149	1.0	0.240	0.191
1.0	0.238	-0.149	1.0	0.238	0.184
1.0	0.235	-0.153	1.0	0.235	0.173
1.0	0.233	-0.153	1.0	0.233	0.160
1.0	0.230	-0.156	1.0	0.230	0.156
1.0	0.228	-0.156	1.0	0.228	0.156
1.0	0.225	-0.160	1.0	0.225	0.142
1.0	0.223	-0.163	1.0	0.223	0.135
1.0	0.220	-0.160	1.0	0.220	0.128
1.0	0.218	-0.167	1.0	0.218	0.118
1.0	0.216	-0.167	1.0	0.216	0.111
1.0	0.213	-0.170	1.0	0.213	0.101
1.0	0.211	-0.170	1.0	0.211	0.097
1.0	0.208	-0.173	1.0	0.208	0.083
1.0	0.206	-0.177	1.0	0.206	0.076
1.0	0.203	-0.173	1.0	0.203	0.069
1.0	0.201	-0.184	1.0	0.201	0.056
1.0	0.198	-0.173	1.0	0.198	0.049
1.0	0.196	-0.180	1.0	0.196	0.038
1.0	0.194	-0.180	1.0	0.194	0.031
1.0	0.191	-0.191	1.0	0.191	0.017
1.0	0.189	-0.187	1.0	0.189	0.017
1.0	0.186	-0.187	1.0	0.186	0.003
1.0	0.184	-0.201	1.0	0.184	-0.003
1.0	0.181	-0.198	1.0	0.181	-0.014

1.0	0.179	-0.201	1.0	0.179	-0.021
1.0	0.177	-0.205	1.0	0.177	-0.031
1.0	0.174	-0.205	1.0	0.174	-0.045
1.0	0.172	-0.201	1.0	0.172	-0.052
1.0	0.169	-0.208	1.0	0.169	-0.062
1.0	0.167	-0.205	1.0	0.167	-0.069
1.0	0.164	-0.205	1.0	0.164	-0.080
1.0	0.162	-0.208	1.0	0.162	-0.090
1.0	0.159	-0.212	1.0	0.159	-0.097
1.0	0.157	-0.212	1.0	0.157	-0.111
1.0	0.155	-0.215	1.0	0.155	-0.115
1.0	0.152	-0.215	1.0	0.152	-0.121
1.0	0.150	-0.212	1.0	0.150	-0.139
1.0	0.147	-0.215	1.0	0.147	-0.142
1.0	0.145	-0.215	1.0	0.145	-0.149
1.0	0.142	-0.226	1.0	0.142	-0.160
1.0	0.140	-0.222	1.0	0.140	-0.163
1.0	0.137	-0.222	1.0	0.137	-0.170
1.0	0.135	-0.226	1.0	0.135	-0.180
1.0	0.133	-0.226	1.0	0.133	-0.184
1.0	0.130	-0.229	1.0	0.130	-0.198
1.0	0.128	-0.229	1.0	0.128	-0.205
1.0	0.125	-0.236	1.0	0.125	-0.212
1.0	0.123	-0.236	1.0	0.123	-0.219
1.0	0.120	-0.232	1.0	0.120	-0.222
1.0	0.118	-0.226	1.0	0.118	-0.236
1.0	0.115	-0.232	1.0	0.115	-0.239
1.0	0.113	-0.229	1.0	0.113	-0.250
1.0	0.111	-0.236	1.0	0.111	-0.253
1.0	0.108	-0.236	1.0	0.108	-0.257
1.0	0.106	-0.236	1.0	0.106	-0.267
1.0	0.103	-0.239	1.0	0.103	-0.264
1.0	0.101	-0.239	1.0	0.101	-0.278
1.0	0.098	-0.236	1.0	0.098	-0.281
1.0	0.096	-0.243	1.0	0.096	-0.288
1.0	0.093	-0.243	1.0	0.093	-0.288
1.0	0.091	-0.246	1.0	0.091	-0.288
1.0	0.089	-0.243	1.0	0.089	-0.295
1.0	0.086	-0.250	1.0	0.086	-0.302
1.0	0.084	-0.250	1.0	0.084	-0.305
1.0	0.081	-0.253	1.0	0.081	-0.309
1.0	0.079	-0.250	1.0	0.079	-0.316
1.0	0.076	-0.257	1.0	0.076	-0.312
1.0	0.074	-0.253	1.0	0.074	-0.319
1.0	0.072	-0.257	1.0	0.072	-0.323
1.0	0.069	-0.260	1.0	0.069	-0.323
1.0	0.067	-0.260	1.0	0.067	-0.326
1.0	0.064	-0.257	1.0	0.064	-0.330
1.0	0.062	-0.257	1.0	0.062	-0.337
1.0	0.059	-0.264	1.0	0.059	-0.333
1.0	0.057	-0.264	1.0	0.057	-0.333
1.0	0.054	-0.264	1.0	0.054	-0.337
1.0	0.052	-0.264	1.0	0.052	-0.337
1.0	0.050	-0.264	1.0	0.050	-0.337
1.0	0.047	-0.271	1.0	0.047	-0.344
1.0	0.045	-0.260	1.0	0.045	-0.340

1.0	0.042	-0.264	1.0	0.042	-0.344
1.0	0.040	-0.271	1.0	0.040	-0.340
1.0	0.037	-0.267	1.0	0.037	-0.340
1.0	0.035	-0.267	1.0	0.035	-0.344
1.0	0.032	-0.267	1.0	0.032	-0.344
1.0	0.030	-0.271	1.0	0.030	-0.344
1.0	0.028	-0.271	1.0	0.028	-0.347
1.0	0.025	-0.278	1.0	0.025	-0.350
1.0	0.023	-0.274	1.0	0.023	-0.347
1.0	0.020	-0.278	1.0	0.020	-0.350
1.0	0.018	-0.281	1.0	0.018	-0.354
1.0	0.015	-0.278	1.0	0.015	-0.347
1.0	0.013	-0.281	1.0	0.013	-0.350
1.0	0.010	-0.281	1.0	0.010	-0.350
1.0	0.008	-0.281	1.0	0.008	-0.354
1.0	0.006	-0.288	1.0	0.006	-0.350
1.0	0.003	-0.285	1.0	0.003	-0.357
1.0	0.001	-0.281	1.0	0.001	-0.361
1.0	-0.002	-0.278	1.0	-0.002	-0.357
1.0	-0.004	-0.285	1.0	-0.004	-0.357
1.0	-0.007	-0.281	1.0	-0.007	-0.364
1.0	-0.009	-0.285	1.0	-0.009	-0.364
1.0	-0.011	-0.281	1.0	-0.011	-0.368
1.0	-0.014	-0.285	1.0	-0.014	-0.368
1.0	-0.016	-0.288	1.0	-0.016	-0.371
1.0	-0.019	-0.288	1.0	-0.019	-0.371
1.0	-0.021	-0.291	1.0	-0.021	-0.375
1.0	-0.024	-0.285	1.0	-0.024	-0.375
1.0	-0.026	-0.295	1.0	-0.026	-0.378
1.0	-0.029	-0.288	1.0	-0.029	-0.378
1.0	-0.031	-0.288	1.0	-0.031	-0.378
1.0	-0.033	-0.298	1.0	-0.033	-0.378
1.0	-0.036	-0.298	1.0	-0.036	-0.378
1.0	-0.038	-0.295	1.0	-0.038	-0.382
1.0	-0.041	-0.298	1.0	-0.041	-0.385
1.0	-0.043	-0.302	1.0	-0.043	-0.392
1.0	-0.046	-0.302	1.0	-0.046	-0.389
1.0	-0.048	-0.298	1.0	-0.048	-0.392
1.0	-0.051	-0.302	1.0	-0.051	-0.392
1.0	-0.053	-0.302	1.0	-0.053	-0.392
1.0	-0.055	-0.302	1.0	-0.055	-0.396
1.0	-0.058	-0.302	1.0	-0.058	-0.392
1.0	-0.060	-0.305	1.0	-0.060	-0.396
1.0	-0.063	-0.305	1.0	-0.063	-0.399
1.0	-0.065	-0.309	1.0	-0.065	-0.402
1.0	-0.068	-0.312	1.0	-0.068	-0.402
1.0	-0.070	-0.309	1.0	-0.070	-0.399
1.0	-0.073	-0.309	1.0	-0.073	-0.402
1.0	-0.075	-0.309	1.0	-0.075	-0.399
1.0	-0.077	-0.312	1.0	-0.077	-0.402
1.0	-0.080	-0.312	1.0	-0.080	-0.409
1.0	-0.082	-0.316	1.0	-0.082	-0.406
1.0	-0.085	-0.312	1.0	-0.085	-0.409
1.0	-0.087	-0.312	1.0	-0.087	-0.413
1.0	-0.090	-0.312	1.0	-0.090	-0.413
1.0	-0.092	-0.312	1.0	-0.092	-0.409

1.0	-0.094	-0.312	1.0	-0.094	-0.409
1.0	-0.097	-0.316	1.0	-0.097	-0.416
1.0	-0.099	-0.316	1.0	-0.099	-0.420
1.0	-0.102	-0.319	1.0	-0.102	-0.423
1.0	-0.104	-0.326	1.0	-0.104	-0.420
1.0	-0.107	-0.326	1.0	-0.107	-0.427
1.0	-0.109	-0.319	1.0	-0.109	-0.427
1.0	-0.112	-0.323	1.0	-0.112	-0.430
1.0	-0.114	-0.326	1.0	-0.114	-0.430
1.0	-0.116	-0.330	1.0	-0.116	-0.427
1.0	-0.119	-0.323	1.0	-0.119	-0.434
1.0	-0.121	-0.330	1.0	-0.121	-0.437
1.0	-0.124	-0.330	1.0	-0.124	-0.444
1.0	-0.126	-0.333	1.0	-0.126	-0.444
1.0	-0.129	-0.330	1.0	-0.129	-0.441
1.0	-0.131	-0.333	1.0	-0.131	-0.448
1.0	-0.134	-0.333	1.0	-0.134	-0.448
1.0	-0.136	-0.337	1.0	-0.136	-0.451
1.0	-0.138	-0.333	1.0	-0.138	-0.455
1.0	-0.141	-0.333	1.0	-0.141	-0.451
1.0	-0.143	-0.330	1.0	-0.143	-0.455
1.0	-0.146	-0.340	1.0	-0.146	-0.458
1.0	-0.148	-0.340	1.0	-0.148	-0.458
1.0	-0.151	-0.340	1.0	-0.151	-0.458
1.0	-0.153	-0.340	1.0	-0.153	-0.461
1.0	-0.156	-0.340	1.0	-0.156	-0.461
1.0	-0.158	-0.347	1.0	-0.158	-0.461
1.0	-0.160	-0.344	1.0	-0.160	-0.468
1.0	-0.163	-0.344	1.0	-0.163	-0.468
1.0	-0.165	-0.344	1.0	-0.165	-0.465
1.0	-0.168	-0.347	1.0	-0.168	-0.472
1.0	-0.170	-0.350	1.0	-0.170	-0.472
1.0	-0.173	-0.347	1.0	-0.173	-0.475
1.0	-0.175	-0.350	1.0	-0.175	-0.482
1.0	-0.178	-0.347	1.0	-0.178	-0.482
1.0	-0.180	-0.350	1.0	-0.180	-0.486
1.0	-0.182	-0.350	1.0	-0.182	-0.486
1.0	-0.185	-0.357	1.0	-0.185	-0.489
1.0	-0.187	-0.361	1.0	-0.187	-0.493
1.0	-0.190	-0.364	1.0	-0.190	-0.496
1.0	-0.192	-0.364	1.0	-0.192	-0.500
1.0	-0.195	-0.368	1.0	-0.195	-0.503
1.0	-0.197	-0.368	1.0	-0.197	-0.503
1.0	-0.199	-0.368	1.0	-0.199	-0.503
1.0	-0.202	-0.371	1.0	-0.202	-0.507
1.0	-0.204	-0.371	1.0	-0.204	-0.510
1.0	-0.207	-0.375	1.0	-0.207	-0.510
1.0	-0.209	-0.368	1.0	-0.209	-0.517
1.0	-0.212	-0.375	1.0	-0.212	-0.524
1.0	-0.214	-0.375	1.0	-0.214	-0.524
1.0	-0.217	-0.382	1.0	-0.217	-0.527
1.0	-0.219	-0.385	1.0	-0.219	-0.531
1.0	-0.221	-0.382	1.0	-0.221	-0.531
1.0	-0.224	-0.385	1.0	-0.224	-0.538
1.0	-0.226	-0.389	1.0	-0.226	-0.545
1.0	-0.229	-0.392	1.0	-0.229	-0.545

1.0	-0.231	-0.396	1.0	-0.231	-0.552
1.0	-0.234	-0.399	1.0	-0.234	-0.552
1.0	-0.236	-0.402	1.0	-0.236	-0.559
1.0	-0.239	-0.402	1.0	-0.239	-0.559
1.0	-0.241	-0.409	1.0	-0.241	-0.562
1.0	-0.243	-0.409	1.0	-0.243	-0.569
1.0	-0.246	-0.409	1.0	-0.246	-0.569
1.0	-0.248	-0.416	1.0	-0.248	-0.573
1.0	-0.251	-0.416	1.0	-0.251	-0.576
1.0	-0.253	-0.416	1.0	-0.253	-0.586
1.0	-0.256	-0.416	1.0	-0.256	-0.590
1.0	-0.258	-0.420	1.0	-0.258	-0.590
1.0	-0.261	-0.423	1.0	-0.261	-0.597
1.0	-0.263	-0.423	1.0	-0.263	-0.600
1.0	-0.265	-0.434	1.0	-0.265	-0.600
1.0	-0.268	-0.430	1.0	-0.268	-0.604
1.0	-0.270	-0.437	1.0	-0.270	-0.611
1.0	-0.273	-0.441	1.0	-0.273	-0.611
1.0	-0.275	-0.448	1.0	-0.275	-0.614
1.0	-0.278	-0.451	1.0	-0.278	-0.625
1.0	-0.280	-0.451	1.0	-0.280	-0.621
1.0	-0.282	-0.448	1.0	-0.282	-0.625
1.0	-0.285	-0.451	1.0	-0.285	-0.625
1.0	-0.287	-0.458	1.0	-0.287	-0.632
1.0	-0.290	-0.465	1.0	-0.290	-0.638
1.0	-0.292	-0.461	1.0	-0.292	-0.638
1.0	-0.295	-0.465	1.0	-0.295	-0.638
1.0	-0.297	-0.472	1.0	-0.297	-0.642
1.0	-0.300	-0.472	1.0	-0.300	-0.649
1.0	-0.302	-0.472	1.0	-0.302	-0.652
1.0	-0.304	-0.482	1.0	-0.304	-0.659
1.0	-0.307	-0.489	1.0	-0.307	-0.663
1.0	-0.309	-0.489	1.0	-0.309	-0.663
1.0	-0.312	-0.489	1.0	-0.312	-0.663
1.0	-0.314	-0.489	1.0	-0.314	-0.666
1.0	-0.317	-0.493	1.0	-0.317	-0.670
1.0	-0.319	-0.493	1.0	-0.319	-0.677
1.0	-0.322	-0.503	1.0	-0.322	-0.677
1.0	-0.324	-0.510	1.0	-0.324	-0.680
1.0	-0.326	-0.517	1.0	-0.326	-0.680
1.0	-0.329	-0.517	1.0	-0.329	-0.684
1.0	-0.331	-0.520	1.0	-0.331	-0.687
1.0	-0.334	-0.524	1.0	-0.334	-0.690
1.0	-0.336	-0.527	1.0	-0.336	-0.694
1.0	-0.339	-0.531	1.0	-0.339	-0.704
1.0	-0.341	-0.534	1.0	-0.341	-0.697
1.0	-0.344	-0.541	1.0	-0.344	-0.704
1.0	-0.346	-0.538	1.0	-0.346	-0.704
1.0	-0.348	-0.552	1.0	-0.348	-0.704
1.0	-0.351	-0.555	1.0	-0.351	-0.708
1.0	-0.353	-0.559	1.0	-0.353	-0.718
1.0	-0.356	-0.562	1.0	-0.356	-0.718
1.0	-0.358	-0.569	1.0	-0.358	-0.722
1.0	-0.361	-0.569	1.0	-0.361	-0.722
1.0	-0.363	-0.573	1.0	-0.363	-0.729
1.0	-0.365	-0.576	1.0	-0.365	-0.725

1.0	-0.368	-0.579	1.0	-0.368	-0.725
1.0	-0.370	-0.579	1.0	-0.370	-0.732
1.0	-0.373	-0.590	1.0	-0.373	-0.732
1.0	-0.375	-0.593	1.0	-0.375	-0.736
1.0	-0.378	-0.597	1.0	-0.378	-0.743
1.0	-0.380	-0.604	1.0	-0.380	-0.746
1.0	-0.383	-0.607	1.0	-0.383	-0.746
1.0	-0.385	-0.607	1.0	-0.385	-0.753
1.0	-0.387	-0.614	1.0	-0.387	-0.753
1.0	-0.390	-0.621	1.0	-0.390	-0.756
1.0	-0.392	-0.621	1.0	-0.392	-0.756
1.0	-0.395	-0.625	1.0	-0.395	-0.770
1.0	-0.397	-0.628	1.0	-0.397	-0.770
1.0	-0.400	-0.628	1.0	-0.400	-0.767
1.0	-0.402	-0.632	1.0	-0.402	-0.774
1.0	-0.405	-0.638	1.0	-0.405	-0.774
1.0	-0.407	-0.635	1.0	-0.407	-0.774
1.0	-0.409	-0.645	1.0	-0.409	-0.781
1.0	-0.412	-0.642	1.0	-0.412	-0.784
1.0	-0.414	-0.645	1.0	-0.414	-0.784
1.0	-0.417	-0.652	1.0	-0.417	-0.788
1.0	-0.419	-0.649	1.0	-0.419	-0.788
1.0	-0.422	-0.652	1.0	-0.422	-0.788
1.0	-0.424	-0.656	1.0	-0.424	-0.788
1.0	-0.427	-0.656	1.0	-0.427	-0.795
1.0	-0.429	-0.649	1.0	-0.429	-0.791
1.0	-0.431	-0.652	1.0	-0.431	-0.795
1.0	-0.434	-0.645	1.0	-0.434	-0.802
1.0	-0.436	-0.645	1.0	-0.436	-0.798
1.0	-0.439	-0.642	1.0	-0.439	-0.802
1.0	-0.441	-0.638	1.0	-0.441	-0.802
1.0	-0.444	-0.635	1.0	-0.444	-0.798
1.0	-0.446	-0.638	1.0	-0.446	-0.802
1.0	-0.448	-0.645	1.0	-0.448	-0.808
1.0	-0.451	-0.638	1.0	-0.451	-0.812
1.0	-0.453	-0.642	1.0	-0.453	-0.812
1.0	-0.456	-0.642	1.0	-0.456	-0.819
1.0	-0.458	-0.638	1.0	-0.458	-0.819
1.0	-0.461	-0.638	1.0	-0.461	-0.822
1.0	-0.463	-0.642	1.0	-0.463	-0.822
1.0	-0.466	-0.642	1.0	-0.466	-0.829
1.0	-0.468	-0.645	1.0	-0.468	-0.833
1.0	-0.470	-0.645	1.0	-0.470	-0.833
1.0	-0.473	-0.642	1.0	-0.473	-0.840
1.0	-0.475	-0.645	1.0	-0.475	-0.843
1.0	-0.478	-0.649	1.0	-0.478	-0.847
1.0	-0.480	-0.649	1.0	-0.480	-0.857
1.0	-0.483	-0.649	1.0	-0.483	-0.861
1.0	-0.485	-0.656	1.0	-0.485	-0.861
1.0	-0.488	-0.656	1.0	-0.488	-0.871
1.0	-0.490	-0.659	1.0	-0.490	-0.874
1.0	-0.492	-0.670	1.0	-0.492	-0.888
1.0	-0.495	-0.666	1.0	-0.495	-0.892
1.0	-0.497	-0.670	1.0	-0.497	-0.899
1.0	-0.500	-0.670	1.0	-0.500	-0.902
1.0	-0.502	-0.684	1.0	-0.502	-0.906

1.0	-0.505	-0.680	1.0	-0.505	-0.909
1.0	-0.507	-0.687	1.0	-0.507	-0.916
1.0	-0.510	-0.694	1.0	-0.510	-0.926
1.0	-0.512	-0.694	1.0	-0.512	-0.926
1.0	-0.514	-0.701	1.0	-0.514	-0.933
1.0	-0.517	-0.701	1.0	-0.517	-0.940
1.0	-0.519	-0.704	1.0	-0.519	-0.947
1.0	-0.522	-0.711	1.0	-0.522	-0.954
1.0	-0.524	-0.711	1.0	-0.524	-0.951
1.0	-0.527	-0.718	1.0	-0.527	-0.961
1.0	-0.529	-0.722	1.0	-0.529	-0.975
1.0	-0.532	-0.729	1.0	-0.532	-0.972
1.0	-0.534	-0.732	1.0	-0.534	-0.975
1.0	-0.536	-0.739	1.0	-0.536	-0.982
1.0	-0.539	-0.746	1.0	-0.539	-0.989
1.0	-0.541	-0.749	1.0	-0.541	-0.996
1.0	-0.544	-0.756	1.0	-0.544	-1.006
1.0	-0.546	-0.753	1.0	-0.546	-1.013
1.0	-0.549	-0.760	1.0	-0.549	-1.020
1.0	-0.551	-0.767	1.0	-0.551	-1.034
1.0	-0.553	-0.770	1.0	-0.553	-1.031
1.0	-0.556	-0.774	1.0	-0.556	-1.037
1.0	-0.558	-0.781	1.0	-0.558	-1.044
1.0	-0.561	-0.788	1.0	-0.561	-1.051
1.0	-0.563	-0.791	1.0	-0.563	-1.058
1.0	-0.566	-0.795	1.0	-0.566	-1.065
1.0	-0.568	-0.795	1.0	-0.568	-1.072
1.0	-0.571	-0.798	1.0	-0.571	-1.079
1.0	-0.573	-0.805	1.0	-0.573	-1.079
1.0	-0.575	-0.812	1.0	-0.575	-1.090
1.0	-0.578	-0.815	1.0	-0.578	-1.096
1.0	-0.580	-0.822	1.0	-0.580	-1.103
1.0	-0.583	-0.819	1.0	-0.583	-1.114
1.0	-0.585	-0.829	1.0	-0.585	-1.117
1.0	-0.588	-0.829	1.0	-0.588	-1.124
1.0	-0.590	-0.840	1.0	-0.590	-1.131
1.0	-0.593	-0.840	1.0	-0.593	-1.131
1.0	-0.595	-0.843	1.0	-0.595	-1.145
1.0	-0.597	-0.850	1.0	-0.597	-1.145
1.0	-0.600	-0.861	1.0	-0.600	-1.155
1.0	-0.602	-0.871	1.0	-0.602	-1.169
1.0	-0.605	-0.867	1.0	-0.605	-1.169
1.0	-0.607	-0.871	1.0	-0.607	-1.173
1.0	-0.610	-0.878	1.0	-0.610	-1.180
1.0	-0.612	-0.888	1.0	-0.612	-1.197
1.0	-0.615	-0.892	1.0	-0.615	-1.194
1.0	-0.617	-0.895	1.0	-0.617	-1.201
1.0	-0.619	-0.902	1.0	-0.619	-1.211
1.0	-0.622	-0.909	1.0	-0.622	-1.218
1.0	-0.624	-0.916	1.0	-0.624	-1.221
1.0	-0.627	-0.919	1.0	-0.627	-1.232
1.0	-0.629	-0.926	1.0	-0.629	-1.242
1.0	-0.632	-0.933	1.0	-0.632	-1.242
1.0	-0.634	-0.944	1.0	-0.634	-1.249
1.0	-0.636	-0.951	1.0	-0.636	-1.263
1.0	-0.639	-0.951	1.0	-0.639	-1.270

1.0	-0.641	-0.954	1.0	-0.641	-1.273
1.0	-0.644	-0.961	1.0	-0.644	-1.280
1.0	-0.646	-0.972	1.0	-0.646	-1.294
1.0	-0.649	-0.978	1.0	-0.649	-1.298
1.0	-0.651	-0.985	1.0	-0.651	-1.308
1.0	-0.654	-0.982	1.0	-0.654	-1.312
1.0	-0.656	-0.999	1.0	-0.656	-1.322
1.0	-0.658	-1.010	1.0	-0.658	-1.329
1.0	-0.661	-1.013	1.0	-0.661	-1.336
1.0	-0.663	-1.024	1.0	-0.663	-1.346
1.0	-0.666	-1.024	1.0	-0.666	-1.353
1.0	-0.668	-1.031	1.0	-0.668	-1.360
1.0	-0.671	-1.037	1.0	-0.671	-1.371
1.0	-0.673	-1.044	1.0	-0.673	-1.378
1.0	-0.676	-1.051	1.0	-0.676	-1.384
1.0	-0.678	-1.062	1.0	-0.678	-1.395
1.0	-0.680	-1.069	1.0	-0.680	-1.412
1.0	-0.683	-1.079	1.0	-0.683	-1.416
1.0	-0.685	-1.083	1.0	-0.685	-1.423
1.0	-0.688	-1.086	1.0	-0.688	-1.440
1.0	-0.690	-1.096	1.0	-0.690	-1.447
1.0	-0.693	-1.103	1.0	-0.693	-1.461
1.0	-0.695	-1.121	1.0	-0.695	-1.471
1.0	-0.698	-1.124	1.0	-0.698	-1.478
1.0	-0.700	-1.128	1.0	-0.700	-1.492
1.0	-0.698	-1.065	1.0	-0.698	-1.402
1.0	-0.695	-1.013	1.0	-0.695	-1.332
1.0	-0.693	-0.965	1.0	-0.693	-1.270
1.0	-0.690	-0.923	1.0	-0.690	-1.211
1.0	-0.688	-0.885	1.0	-0.688	-1.152

The selected original data for contact angle measurement of millerite electrode are summarized below:

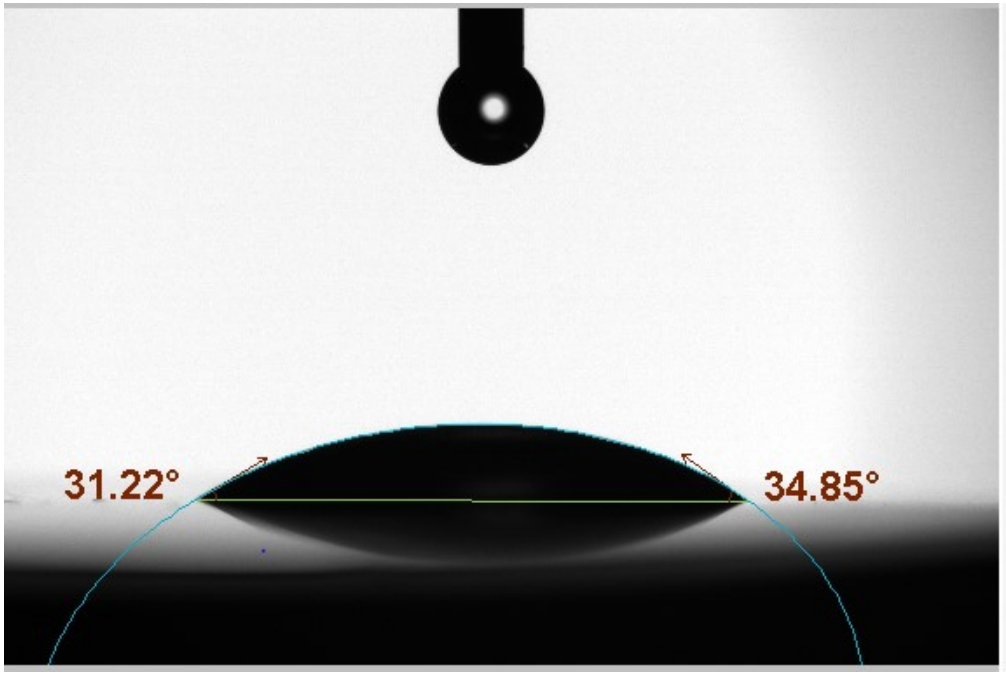

Figure 7.1: Contact angle measurement for bare millerite surface

Table 7.3: Contact angle measurement data for bare millerite electrode surface

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	37.00	39.24	38.12	0.00	33.19	36.77	34.98	0.00	34.71	32.95	33.83	0.00	41.71	40.50	41.10	0.00	45.62	44.75	45.19
0.12	36.71	39.13	37.92	0.12	33.05	36.58	34.81	0.12	35.05	33.13	34.09	0.12	41.67	40.69	41.18	0.12	45.29	44.5	44.9
0.24	36.81	39.06	37.94	0.24	33.11	36.88	34.99	0.24	35.26	33.17	34.22	0.24	41.59	40.57	41.08	0.24	45.75	44.8	45.27
0.36	36.91	39.27	38.09	0.36	33.29	36.78	35.04	0.36	34.91	32.9	33.9	0.36	41.79	41	41.4	0.36	46.02	44.72	45.37
0.48	37.46	39.56	38.51	0.48	33.12	36.99	35.06	0.48	35.09	32.9	34	0.48	41.5	40.56	41.03	0.48	45.52	44.62	45.07
0.6	36.3	38.88	37.59	0.6	33.05	36.8	34.92	0.6	34.59	33.07	33.83	0.6	41.72	40.28	41	0.6	45.35	44.29	44.82
0.72	36.48	38.76	37.62	0.72	33.13	36.8	34.96	0.72	34.59	33.23	33.91	0.72	41.83	40.84	41.34	0.72	45.28	44.09	44.69
0.84	36.7	39.15	37.93	0.84	33.06	36.95	35.01	0.84	34.92	33.24	34.08	0.84	41.75	40.84	41.3	0.84	45.38	44.39	44.89
0.96	36.94	39.22	38.08	0.96	33.07	36.73	34.9	0.96	34.82	32.75	33.78	0.96	41.82	40.69	41.25	0.96	44.84	44.75	44.79
1.09	36.93	39.36	38.15	1.09	33.08	36.81	34.95	1.09	34.17	32.69	33.43	1.09	41.9	41.01	41.45	1.09	46.07	44.89	45.48
1.21	36.36	38.8	37.58	1.21				1.21	34.85	32.99	33.92	1.21	41.67	40.63	41.15	1.21	44.86	44.1	44.48
1.33	36.47	38.92	37.69	1.33	32.82	36.36	34.59	1.33	34.89	32.84	33.87	1.33	41.73	40.72	41.22	1.33	45.04	44.28	44.66
1.45	36.15	38.53	37.34	1.45	32.88	36.36	34.62	1.45	34.63	32.81	33.72	1.45	41.79	40.63	41.21	1.45	45.68	44.7	45.19
1.57	36.63	38.9	37.76	1.57	33.01	36.52	34.77	1.57	34.84	33	33.92	1.57	41.56	40.66	41.11	1.57	45.81	44.83	45.32
1.69	36.24	38.92	37.58	1.69	33.06	36.73	34.9	1.69	34.41	32.48	33.45	1.69	41.72	40.64	41.18	1.69	45.45	44.36	44.9
1.81	37.07	39.4	38.23	1.81	32.98	36.5	34.74	1.81	34.98	33.08	34.03	1.81	41.89	40.96	41.42	1.81	45.65	44.63	45.14
1.93	36.28	38.65	37.46	1.93	33.01	36.76	34.89	1.93	35.39	33.26	34.32	1.93	41.27	40.25	40.76	1.93	45.53	44.41	44.97
2.05	36.52	38.69	37.61	2.05	33.16	36.96	35.06	2.05	34.55	32.75	33.65	2.05	41.6	40.54	41.07	2.05	45.34	44.3	44.82
2.17	36.65	39.01	37.83	2.17	32.81	36.55	34.68	2.17	34.51	32.55	33.53	2.17	41.53	40.2	40.86	2.17	45.5	44.55	45.03
2.29	36.29	38.79	37.54	2.29	32.95	36.35	34.65	2.29	34.55	33.16	33.86	2.29	41.52	40.51	41.02	2.29	45.45	44.69	45.07
2.41	36.64	38.82	37.73	2.41	33.05	36.79	34.92	2.41	34.7	32.93	33.82	2.41	41.74	40.65	41.19	2.41	45.62	44.65	45.14
2.53	36.46	38.88	37.67	2.53	32.92	36.5	34.71	2.53	35.01	33.05	34.03	2.53	41.51	40.34	40.93	2.53	44.84	44.14	44.49
2.65	36.68	39.23	37.95	2.65	33	36.65	34.83	2.65	35.29	33.19	34.24	2.65	41.42	40.45	40.93	2.65	45.29	44.31	44.8
2.77	36.62	38.68	37.65	2.77	32.79	36.35	34.57	2.77	34.62	32.97	33.79	2.77	41.39	40.55	40.97	2.77	45.59	44.44	45.02
2.89	36.91	39.15	38.03	2.89	32.86	36.5	34.68	2.89	34.62	32.98	33.8	2.89	41.87	40.94	41.4	2.89	45.61	44.69	45.15
3.01	36.73	38.98	37.85	3.01	33.02	36.69	34.86	3.01	35.15	32.89	34.02	3.01	41.43	40.53	40.98	3.01	45.78	44.43	45.11

3.14	36.74	38.82	37.78	3.14	33.1	36.49	34.8	3.14	34.55	32.71	33.63	3.14	41.57	40.53	41.05	3.14	45.37	44.36	44.87
3.26	36.61	38.84	37.73	3.26	32.86	36.5	34.68	3.26	34.61	32.98	33.79	3.26	41.62	40.43	41.03	3.26	45.85	44.49	45.17
3.38	36.97	39.04	38.01	3.38	33.01	36.53	34.77	3.38	35.04	32.98	34.01	3.38	41.43	40.29	40.86	3.38	45.8	44.64	45.22
3.5	36.9	38.93	37.92	3.5	32.77	36.33	34.55	3.5	34.32	32.8	33.56	3.5	41.69	40.62	41.16	3.5	45.73	44.78	45.26
3.62	36.44	38.99	37.72	3.62	33	36.55	34.78	3.62	34.85	32.97	33.91	3.62	41.39	40.43	40.91	3.62	45.21	44.27	44.74
3.74	36.5	38.9	37.7	3.74	33.02	36.68	34.85	3.74	34.11	32.69	33.4	3.74	41.71	40.42	41.07	3.74	45.52	44.61	45.06
3.86	36.48	39.02	37.75	3.86	33.04	36.67	34.85	3.86	34.73	32.78	33.75	3.86	41.42	40.42	40.92	3.86	45.49	44.45	44.97
3.98	36.32	38.82	37.57	3.98	32.83	36.31	34.57	3.98	34.15	32.58	33.36	3.98	41.32	40.67	41	3.98	45.23	44.34	44.79
4.1	36.21	38.73	37.47	4.1	32.92	36.73	34.82	4.1	34.54	32.97	33.76	4.1	41.59	40.64	41.12	4.1	45.72	44.47	45.09
4.22	36.71	39.06	37.88	4.22	33.07	36.5	34.78	4.22	34.58	32.96	33.77	4.22	41.37	40.28	40.83	4.22	45.62	44.44	45.03
4.34	36.31	38.64	37.47	4.34	32.84	36.74	34.79	4.34	35.12	33.13	34.13	4.34	41.75	40.57	41.16	4.34	45.23	44.37	44.8
4.46	36.6	38.97	37.78	4.46	32.84	36.37	34.6	4.46	34.93	33.02	33.98	4.46	41.59	40.36	40.98	4.46	45.79	44.75	45.27
4.58	36.86	38.84	37.85	4.58	33.07	36.56	34.81	4.58	35.03	33.13	34.08	4.58	41.61	40.41	41.01	4.58	45.43	44.22	44.83
4.7	36.92	38.88	37.9	4.7	32.69	36.36	34.53	4.7	34.85	32.97	33.91	4.7	41.78	40.66	41.22	4.7	45.5	44.39	44.94
4.82	36.42	38.67	37.55	4.82	32.81	36.09	34.45	4.82	34.44	32.98	33.71	4.82	41.45	40.48	40.96	4.82	45.26	44.35	44.8
4.94	36.78	38.96	37.87	4.94	32.7	36.34	34.52	4.94	35.16	32.92	34.04	4.94	41.64	40.64	41.14	4.94	45.85	44.59	45.22
5.06	36.91	38.91	37.91	5.06	32.78	36.31	34.55	5.06	34.47	32.75	33.61	5.06	41.59	40.75	41.17	5.06	44.96	44.08	44.52
5.19	36.87	38.89	37.88	5.19	32.77	36.24	34.51	5.19	34.4	32.63	33.51	5.19	41.39	40.58	40.99	5.19	45.67	44.39	45.03
5.31	36.21	38.71	37.46	5.31	32.66	36.45	34.55	5.31	34.32	32.74	33.53	5.31	41.68	40.64	41.16	5.31	45.4	44.58	44.99
5.43	36.29	38.76	37.53	5.43	32.84	36.32	34.58	5.43	34.66	32.9	33.78	5.43	41.64	40.33	40.98	5.43	45.48	44.43	44.96
5.55	36.7	38.84	37.77	5.55	32.98	36.59	34.79	5.55	34.83	32.97	33.9	5.55	41.83	40.55	41.19	5.55	45.59	44.47	45.03
5.67	36.64	39.07	37.85	5.67	32.94	36.55	34.74	5.67	34.71	32.77	33.74	5.67	41.62	40.39	41.01	5.67	45.61	44.52	45.07
5.79	36.72	38.81	37.77	5.79	32.8	36.39	34.59	5.79	34.64	32.76	33.7	5.79	41.47	40.67	41.07	5.79	45.01	44.31	44.66
5.91	36.96	39	37.98	5.91	32.74	36.39	34.56	5.91	34.5	32.73	33.61	5.91	41.4	39.98	40.69	5.91	45.4	44.39	44.9
6.03	36.53	39.03	37.78	6.03	32.72	36.28	34.5	6.03	35.14	33.04	34.09	6.03	41.49	40.36	40.92	6.03	45.5	44.4	44.95
6.15	36.51	38.77	37.64	6.15	32.82	36.41	34.62	6.15	34.67	32.85	33.76	6.15	41.61	40.63	41.12	6.15	45.49	44.48	44.98
6.27	36.56	39.24	37.9	6.27	32.71	36.32	34.51	6.27	34.69	33.02	33.85	6.27	41.46	40.53	41	6.27	45.43	44.4	44.91
6.39	36.59	39.05	37.82	6.39	32.7	36.24	34.47	6.39	34.79	32.92	33.86	6.39	41.6	40.72	41.16	6.39	45.14	44.26	44.7
6.51	36.48	38.76	37.62	6.51	32.76	36.24	34.5	6.51	34.43	32.52	33.48	6.51	41.78	40.59	41.18	6.51	45.43	44.41	44.92
6.63	36.77	38.91	37.84	6.63	32.71	36.21	34.46	6.63	34.77	32.74	33.76	6.63	41.63	40.99	41.31	6.63	45.41	44.39	44.9
6.75	36.37	38.81	37.59	6.75	32.7	36.22	34.46	6.75	34.74	33	33.87	6.75	41.48	40.66	41.07	6.75	45.15	44.16	44.66

6.87	36.31	38.53	37.42	6.87	32.73	36.16	34.44	6.87	35	32.88	33.94	6.87	41.51	40.68	41.09	6.87	45.4	44.24	44.82
6.99	36.27	38.66	37.47	6.99	32.91	36.53	34.72	6.99	35.05	33.09	34.07	6.99	41.47	40.23	40.85	6.99	45.04	44.23	44.64
7.11	36.59	38.82	37.71	7.11	32.73	36.32	34.52	7.11	34.82	33.04	33.93	7.11	41.87	40.64	41.26	7.11	45.55	44.3	44.93
7.23	36.38	38.41	37.4	7.23	32.97	36.46	34.72	7.24	34.63	32.85	33.74	7.23	41.33	40.26	40.79	7.23	45.31	44.57	44.94
7.36	36.1	38.55	37.33	7.36	32.82	36.5	34.66	7.36	34.5	32.94	33.72	7.36	41.48	40.44	40.96	7.36	45.09	44.13	44.61
7.48	36.32	38.63	37.47	7.48	32.81	36.08	34.44	7.48	33.99	32.66	33.32	7.48	41.61	40.53	41.07	7.48	45.61	44.45	45.03
7.6	36.56	38.43	37.5	7.6	32.62	36.28	34.45	7.6	34.93	32.93	33.93	7.6	41.19	40.21	40.7	7.6	44.99	44.3	44.64
7.72	36.65	38.91	37.78	7.72	33.23	34.88	34.05	7.72	34.58	33.01	33.79	7.72	41.45	40.73	41.09	7.72	45.5	44.46	44.98
7.84	36.12	39.01	37.57	7.84	32.68	36.17	34.43	7.84	34.56	32.88	33.72	7.84	41.64	40.36	41	7.84	44.9	44.23	44.56
7.96	36.84	38.7	37.77	7.96	32.66	36.19	34.42	7.96	34.6	32.59	33.6	7.96	41.58	40.73	41.15	7.96	44.86	44.19	44.52
8.08	36.63	39.25	37.94	8.08	32.97	36.59	34.78	8.08	34.5	32.66	33.58	8.08	41.4	40.39	40.89	8.08	45.2	44.15	44.67
8.2	36.31	39.03	37.67	8.2	32.78	36.47	34.62	8.2	34.88	32.69	33.78	8.2	41.5	40.44	40.97	8.2	45.16	44.17	44.67
8.32	36.18	39.07	37.62	8.32	32.74	36.16	34.45	8.32	34.68	32.74	33.71	8.32	41.53	40.68	41.11	8.32	44.97	43.91	44.44
8.44	36.46	38.75	37.61	8.44	32.63	36.28	34.46	8.44	34.66	32.87	33.76	8.44	41.57	40.34	40.95	8.44	45.63	44.46	45.05
8.56	36.67	38.93	37.8	8.56	32.94	36.46	34.7	8.56	34.46	32.44	33.45	8.56	41.57	40.5	41.03	8.56	45.01	44.18	44.6
8.68	36.04	38.71	37.38	8.68	32.68	36.23	34.45	8.68	34.79	32.76	33.78	8.68	41.45	40.39	40.92	8.68	45.41	44.64	45.03
8.8	36.46	38.63	37.55	8.8	32.8	36.23	34.52	8.8	34.04	32.5	33.27	8.8	41.38	40.39	40.89	8.8	45.32	44.31	44.81
8.92	36.56	38.64	37.6	8.92	32.72	36.24	34.48	8.92	34.75	32.8	33.78	8.92	41.43	40.52	40.98	8.92	45.1	44.1	44.6
9.04	36.37	38.74	37.56	9.04	32.83	36.46	34.64	9.04	34.46	32.81	33.64	9.04	41.79	40.7	41.24	9.04	45.32	44.55	44.94
9.16	36.41	38.46	37.43	9.16	32.8	36.14	34.47	9.16	34.3	32.45	33.37	9.16	41.68	40.59	41.13	9.16	45.55	44.65	45.1
9.28	36.11	38.64	37.37	9.28	32.57	36.3	34.44	9.28	34.59	32.75	33.67	9.28	41.23	40.14	40.68	9.28	45.01	44.15	44.58
9.41	36.04	38.47	37.26	9.41	32.71	36.15	34.43	9.41	34.65	32.95	33.8	9.41	41.34	40.2	40.77	9.41	45.21	44.02	44.61
9.53	36.56	38.62	37.59	9.53	32.76	36.37	34.56	9.53	34.24	32.62	33.43	9.53	41.6	40.6	41.1	9.53	45.45	44.37	44.91
9.65	36.54	38.73	37.64	9.65	32.74	36.18	34.46	9.65	34.18	32.66	33.42	9.65	41.55	40.56	41.06	9.65	44.94	43.97	44.45
9.77	36.22	38.71	37.47	9.77	32.67	36.09	34.38	9.77	34.44	32.54	33.49	9.77	41.42	40.66	41.04	9.77	44.73	43.96	44.35
9.89	36.17	38.35	37.26	9.89	32.63	36.19	34.41	9.89	34.7	32.75	33.73	9.89	41.53	40.21	40.87	9.89	45.18	44.15	44.66
				10.01	32.59	36.34	34.46					10.01	41.45	40.4	40.92				
			37.71				34.653				33.775				41.053				44.893
		STDEV:	0.2319			STDEV:	0.1976			STDEV:	0.2238			STDEV:	0.164			STDEV:	0.2408

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	31.41	34.99	33.20	0.00	30.27	30.09	30.18	0.00	30.94	27.56	29.25	0.00	31.13	29.92	30.53	0.00	33.69	26.72	30.21
0.12	31.2	34.82	33.01	0.12	30.27	30.18	30.22	0.12	30.76	27.47	29.11	0.12	31.06	29.92	30.49	0.12	31.69	28.99	30.34
0.24	31.22	34.74	32.98	0.24	30.26	30.05	30.15	0.24	30.65	27.43	29.04	0.24	31.22	29.85	30.54	0.24	33.79	26.67	30.23
0.36	31.18	34.86	33.02	0.36	30.27	30.09	30.18	0.36	30.73	27.6	29.17	0.36	31.02	29.94	30.48	0.36	33.65	26.73	30.19
0.48	31.33	34.82	33.07	0.48	30.21	30.15	30.18	0.48	30.92	27.5	29.21	0.48	31.05	29.75	30.4	0.48	33.64	26.71	30.17
0.6	31.22	34.78	33	0.6	30.23	30.08	30.15	0.6	30.89	27.63	29.26	0.6	31.04	30.01	30.52	0.6	33.57	26.62	30.09
0.72	31.23	34.98	33.11	0.72	30.22	30.22	30.22	0.72	30.74	27.44	29.09	0.72	31.05	29.91	30.48	0.72	33.59	26.82	30.2
0.84	31.33	34.93	33.13	0.84	30.24	30.02	30.13	0.84	30.69	27.48	29.09	0.84	31.05	29.95	30.5	0.84	33.75	26.7	30.22
0.96	31.18	34.91	33.04	0.96	30.22	30.08	30.15	0.96	30.8	27.49	29.15	0.96	31.04	29.85	30.44	0.96	33.46	26.75	30.11
1.08	31.24	34.81	33.03	1.09	30.37	30.15	30.26	1.09	30.77	27.48	29.13	1.09	31.07	29.88	30.47	1.09	33.59	26.67	30.13
1.21	31.29	34.82	33.06	1.21	30.18	30.09	30.14	1.21	30.75	27.52	29.13	1.21	31.09	29.84	30.46	1.21	33.69	26.74	30.22
1.33	31.17	34.92	33.04	1.33	30.36	30.07	30.22	1.33	30.71	27.54	29.13	1.33	31.01	29.94	30.47	1.33	33.47	26.63	30.05
1.45	31.27	34.96	33.12	1.45	30.3	30.05	30.18	1.45	30.77	27.47	29.12	1.45	31.02	29.94	30.48	1.45	33.61	26.75	30.18
1.57	31.1	34.89	32.99	1.57	30.33	30.02	30.18	1.57	30.68	27.49	29.09	1.57	31.07	29.8	30.43	1.57	33.54	26.7	30.12
1.69	31.18	34.95	33.07	1.69	30.32	30.14	30.23	1.69	30.77	27.44	29.11	1.69	31.05	29.84	30.44	1.69	33.93	26.67	30.3
1.81	31.11	35.02	33.06	1.81	30.26	30.1	30.18	1.81	30.81	27.36	29.08	1.81	31.08	29.77	30.43	1.81	33.04	28.42	30.73
1.93	31.04	34.9	32.97	1.93	30.34	30.03	30.19	1.93	30.74	27.45	29.09	1.93	31	29.78	30.39	1.93	33.8	26.77	30.28
2.05	31.18	34.88	33.03	2.05	30.27	30.06	30.17	2.05	30.74	27.55	29.15	2.05	31	29.82	30.41	2.05	33.59	26.71	30.15
2.17	31.11	34.84	32.98	2.17	30.3	30.07	30.19	2.17	30.92	27.55	29.23	2.17	31.03	29.79	30.41	2.17	33.57	26.67	30.12
2.29	31.28	34.98	33.13	2.29	30.29	30.03	30.16	2.29	30.74	27.56	29.15	2.29	30.95	29.77	30.36	2.29	33.72	26.6	30.16
2.41	31.22	34.84	33.03	2.41	30.27	30.08	30.17	2.41	30.64	27.49	29.07	2.41	30.91	29.79	30.35	2.41	33.78	26.7	30.24
2.53	31.2	34.84	33.02	2.53	30.23	30.1	30.17	2.53	30.8	27.53	29.16	2.53	30.97	29.79	30.38	2.53	33.81	26.66	30.24
2.65	31.28	34.99	33.13	2.65	30.34	30.04	30.19	2.65	30.7	27.37	29.03	2.65	30.86	29.92	30.39	2.65	33.69	26.77	30.23
2.77	31.12	34.83	32.98	2.77	30.28	30.01	30.15	2.77	30.91	27.56	29.24	2.77	30.95	29.82	30.39	2.77	33.81	26.61	30.21
2.89	31.16	34.76	32.96	2.89	30.24	30.13	30.19	2.89	30.72	27.49	29.1	2.89	31.04	29.91	30.47	2.89	33.6	26.83	30.21
3.01	31.2	34.97	33.08	3.01	30.37	29.89	30.13	3.01	30.87	27.49	29.18	3.01	31.04	29.76	30.4	3.01	33.76	26.58	30.17

3.13	31.22	34.83	33.03	3.14	30.2	30.03	30.11	3.14	30.78	27.44	29.11	3.14	30.99	29.75	30.37	3.14	33.56	26.71	30.14
3.26	31.1	34.89	32.99	3.26	30.23	30.08	30.16	3.26	30.59	27.41	29	3.26	30.87	29.79	30.33	3.26	33.7	26.79	30.25
3.38	31.28	34.94	33.11	3.38	30.31	30.08	30.19	3.38	30.67	27.45	29.06	3.38	30.98	29.77	30.37	3.38	33.7	26.71	30.2
3.5	31.15	34.87	33.01	3.5	30.24	30	30.12	3.5	30.67	27.39	29.03	3.5	30.95	29.8	30.37	3.5	33.74	26.78	30.26
3.62	31.22	34.85	33.03	3.62	30.16	30	30.08	3.62	30.61	27.36	28.99	3.62	31.03	29.74	30.39	3.62	33.7	26.64	30.17
3.74	31.04	34.79	32.92	3.74	30.2	30.02	30.11	3.74	30.88	27.55	29.21	3.74	31	29.8	30.4	3.74	33.71	26.7	30.21
3.86	31.19	34.77	32.98	3.86	30.27	30	30.14	3.86	30.56	27.4	28.98	3.86	30.85	29.7	30.28	3.86	33.62	26.7	30.16
3.98	31.17	34.85	33.01	3.98	30.15	30.08	30.12	3.98	30.7	27.48	29.09	3.98	30.87	29.69	30.28	3.98	33.64	26.68	30.16
4.1	31.2	34.73	32.97	4.1	30.28	29.94	30.11	4.1	30.66	27.44	29.05	4.1	30.81	29.73	30.27	4.1	33.62	26.58	30.1
4.22	31.17	34.83	33	4.22	30.26	29.96	30.11	4.22	30.77	27.48	29.13	4.22	31.01	29.78	30.39	4.22	33.77	26.75	30.26
4.34	31.04	34.79	32.91	4.34	30.28	30.01	30.14	4.34	30.64	27.36	29	4.34	30.92	29.84	30.38	4.34	33.62	26.75	30.18
4.46	31.16	34.82	32.99	4.46	30.21	29.98	30.1	4.46	30.61	27.41	29.01	4.46	30.9	29.71	30.3	4.46	33.82	26.73	30.28
4.58	31.07	34.75	32.91	4.58	30.2	29.95	30.07	4.58	30.56	27.43	28.99	4.58	31.03	29.78	30.41	4.58	33.57	26.68	30.12
4.7	31.1	34.73	32.91	4.7	30.28	29.98	30.13	4.7	30.62	27.44	29.03	4.7	30.84	29.54	30.19	4.7	33.45	26.59	30.02
4.82	31.15	34.8	32.97	4.82	30.13	29.94	30.03	4.82	30.55	27.28	28.92	4.82	30.91	29.73	30.32	4.82	33.64	26.53	30.09
4.94	31.3	34.97	33.14	4.94	30.24	30.08	30.16	4.94	30.6	27.43	29.02	4.94	30.95	29.78	30.36	4.94	33.65	26.64	30.15
5.06	31.1	34.86	32.98	5.06	30.12	29.97	30.04	5.06	30.65	27.41	29.03	5.06	30.99	29.78	30.39	5.06	33.67	26.66	30.16
5.18	31.21	34.76	32.99	5.19	30.16	30.03	30.09	5.19	30.61	27.41	29.01	5.18	30.82	29.68	30.25	5.19	33.59	26.61	30.1
5.31	31.22	34.75	32.99	5.31	30.1	29.94	30.02	5.31	30.8	27.42	29.11	5.31	30.84	29.82	30.33	5.31	33.48	26.7	30.09
5.43	31.2	34.81	33	5.43	30.22	29.97	30.1	5.43	30.59	27.38	28.99	5.43	31.03	29.73	30.38	5.43	33.64	26.59	30.11
5.55	31.05	34.68	32.87	5.55	30.2	30.02	30.11	5.55	30.81	27.45	29.13	5.55	30.85	29.76	30.3	5.55	33.61	26.66	30.14
5.67	31.19	34.7	32.95	5.67	30.11	29.97	30.04	5.67	30.65	27.41	29.03	5.67	30.83	29.8	30.32	5.67	33.53	26.67	30.1
5.79	31.22	34.88	33.05	5.79	30.11	29.88	29.99	5.79	30.54	27.37	28.95	5.79	30.82	29.75	30.28	5.79	33.52	26.65	30.08
5.91	31.11	34.88	33	5.91	30.11	30.1	30.1	5.91	30.55	27.37	28.96	5.91	30.97	29.65	30.31	5.91	33.55	26.61	30.08
6.03	31.23	34.67	32.95	6.03	30.25	29.88	30.07	6.03	30.75	27.38	29.06	6.03	30.96	29.61	30.29	6.03	33.53	26.6	30.06
6.15	31.1	34.87	32.98	6.15	30.26	30	30.13	6.15	30.69	27.45	29.07	6.15	30.91	29.74	30.32	6.15	33.74	26.58	30.16
6.27	31.03	34.74	32.88	6.27	30.24	29.89	30.06	6.27	30.63	27.39	29.01	6.27	30.9	29.71	30.3	6.27	33.57	26.7	30.14
6.39	31.09	34.75	32.92	6.39	30.15	29.92	30.04	6.39	30.48	27.25	28.86	6.39	30.91	29.68	30.3	6.39	33.57	26.65	30.11
6.51	31.1	34.77	32.94	6.51	30.13	30	30.06	6.51	30.48	27.36	28.92	6.51	30.92	29.66	30.29	6.51	33.61	26.62	30.12
6.63	31.06	34.84	32.95	6.63	30.21	29.9	30.06	6.63	30.47	27.34	28.9	6.63	30.88	29.68	30.28	6.63	33.58	26.63	30.1

6.75	31.02	34.72	32.87	6.75	30.15	29.94	30.04	6.75	30.67	27.35	29.01	6.75	30.85	29.64	30.25	6.75	33.51	26.54	30.02
6.87	31.14	34.82	32.98	6.87	30.13	29.99	30.06	6.87	30.74	27.4	29.07	6.87	30.87	29.6	30.24	6.87	33.59	26.58	30.09
6.99	31.06	34.73	32.89	6.99	30.16	29.94	30.05	6.99	30.47	27.21	28.84	6.99	30.78	29.79	30.28	6.99	33.56	26.53	30.05
7.11	31.04	34.66	32.85	7.11	30.14	29.95	30.04	7.11	30.41	27.22	28.81	7.11	30.86	29.61	30.23	7.11	33.59	26.54	30.06
7.23	31.22	34.72	32.97	7.24	30.01	29.88	29.94	7.23	30.6	27.3	28.95	7.23	30.89	29.67	30.28	7.23	33.49	26.56	30.03
7.36	31.05	34.68	32.86	7.36	30.05	29.91	29.98	7.36	30.46	27.22	28.84	7.36	30.82	29.79	30.31	7.36	33.77	26.58	30.18
7.48	31.2	34.71	32.96	7.48	30.15	30	30.08	7.48	30.63	27.29	28.96	7.48	30.91	29.72	30.32	7.48	33.45	26.52	29.98
7.6	31.1	34.79	32.94	7.6	30.07	29.85	29.96	7.6	30.65	27.28	28.96	7.6	30.84	29.66	30.25	7.6	33.47	26.62	30.04
7.72	31.1	34.79	32.94	7.72	30.08	29.92	30	7.72	30.85	27.52	29.19	7.72	30.81	29.74	30.28	7.72	33.54	26.48	30.01
7.84	31.15	34.83	32.99	7.84	30.1	29.94	30.02	7.84	30.59	27.32	28.96	7.84	30.84	29.66	30.25	7.84	33.31	26.54	29.93
7.96	31.15	34.78	32.96	7.96	30.13	29.86	30	7.96	30.54	27.37	28.96	7.96	30.86	29.59	30.23	7.96	33.53	26.61	30.07
8.08	31.19	34.85	33.02	8.08	30.12	29.88	30	8.08	30.58	27.33	28.95	8.08	30.81	29.65	30.23	8.08	33.31	26.54	29.93
8.2	31.13	34.76	32.95	8.2	30.16	29.84	30	8.2	30.43	27.27	28.85	8.2	30.87	29.69	30.28	8.2	33.39	26.61	30
8.32	31.06	34.7	32.88	8.32	30.07	29.94	30	8.32	30.36	27.17	28.77	8.32	30.95	29.64	30.29	8.32	33.5	26.54	30.02
8.44	30.98	34.76	32.87	8.44	30.16	29.98	30.07	8.44	30.51	27.28	28.89	8.44	30.79	29.74	30.27	8.44	33.56	26.61	30.08
8.56	31.1	34.81	32.96	8.56	30.13	29.97	30.05	8.56	30.41	27.27	28.84	8.56	30.81	29.66	30.23	8.56	33.45	26.61	30.03
8.68	31.16	34.66	32.91	8.68	30.18	29.89	30.04	8.68	30.57	27.32	28.95	8.68	30.85	29.6	30.23	8.68	33.33	26.61	29.97
8.8	31.04	34.73	32.88	8.8	30.1	29.81	29.96	8.8	30.34	27.28	28.81	8.8	30.92	29.64	30.28	8.8	33.49	26.54	30.02
8.92	31.12	34.75	32.93	8.92	30.06	29.93	30	8.92	30.63	27.33	28.98	8.92	30.79	29.66	30.22	8.92	33.46	26.57	30.02
9.04	30.96	34.68	32.82	9.04	30.02	29.8	29.91	9.04	30.44	27.27	28.86	9.04	30.79	29.69	30.24	9.04	33.41	26.55	29.98
9.16	31.07	34.59	32.83	9.16	30.16	29.87	30.02	9.16	30.64	27.35	29	9.16	30.77	29.58	30.17	9.16	33.34	26.58	29.96
9.28	30.92	34.67	32.8	9.28	29.91	29.89	29.9	9.28	30.45	27.16	28.81	9.28	30.77	29.58	30.17	9.28	33.55	26.5	30.03
9.41	31.09	34.66	32.88	9.41	30.14	29.86	30	9.41	30.57	27.36	28.96	9.41	30.7	29.69	30.2	9.41	33.35	26.55	29.95
9.53	31.04	34.7	32.87	9.53	30.14	29.92	30.03	9.53	30.41	27.22	28.81	9.53	30.8	29.56	30.18	9.53	33.34	26.49	29.92
9.65	31.03	34.65	32.84	9.65	30.12	29.93	30.02	9.65	30.46	27.17	28.82	9.65	30.88	29.66	30.27	9.65	33.31	26.49	29.9
9.77	30.96	34.75	32.85	9.77	30.1	29.81	29.96	9.77	30.35	27.24	28.8	9.77	30.75	29.6	30.18	9.77	33.31	26.52	29.91
9.89	31.02	34.64	32.83	9.89	29.97	29.84	29.91	9.89	30.51	27.16	28.84	9.89	30.74	29.57	30.15	9.89	33.67	26.64	30.15
				10.01	30.09	29.92	30.01					10.01	30.89	29.52	30.21				
			32.975				30.089				29.02				30.333				30.122
		STDEV:	0.0836			STDEV:	0.0831			STDEV:	0.1214			STDEV:	0.0955			STDEV:	0.1195

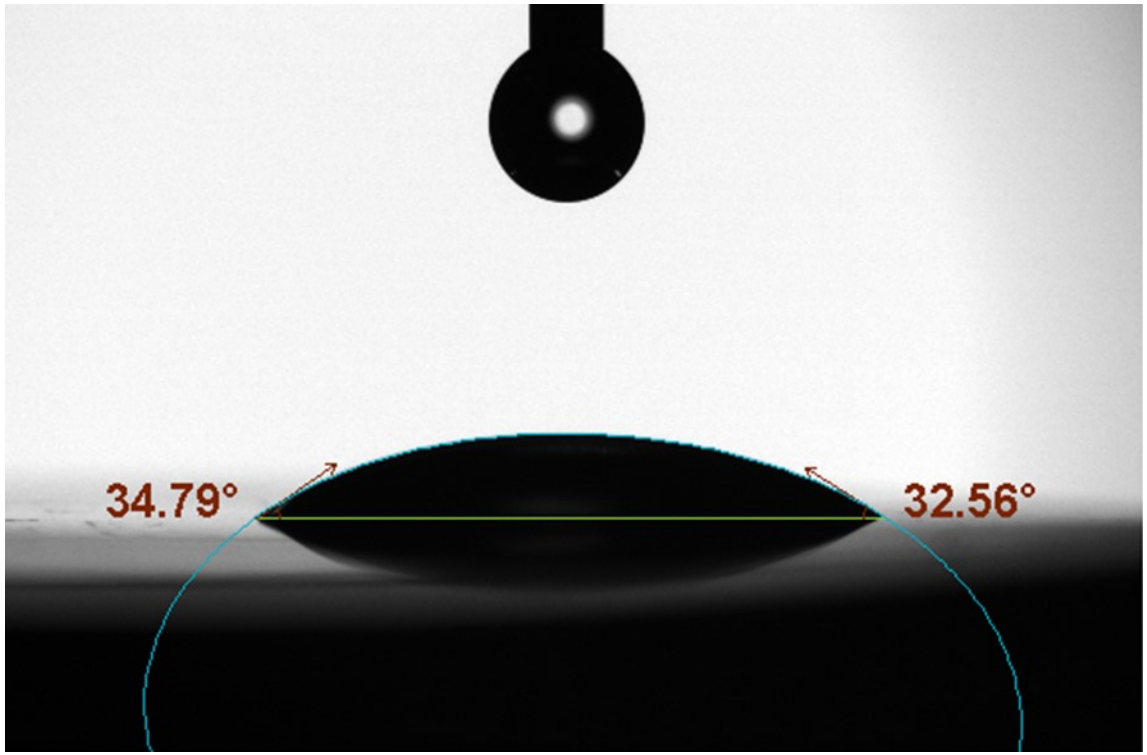

Figure 7.2: Contact angle measurement for millerite electrode at pH 12 conditioned at 0V potential under collectorless condition

Table 7.4: Contact angle measurement for millerite electrode at pH 12 conditioned at 0V potential under collectorless condition

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5					
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Volume [µl]	Baseline [mm]
0.00	34.99	32.76	33.88	0.00	37.53	36.50	37.01	0.00	33.66	35.23	34.45	0.00	29.64	31.15	30.40	0.00	27.73	28.23	27.98	15.63	6.32
0.12	35.19	32.65	33.92	0.12	37.55	36.51	37.03	0.12	33.33	35.13	34.23	0.12	30.42	31.9	31.16	0.12	27.53	28.19	27.86	16.31	6.31
0.24	35.05	32.74	33.89	0.24	37.44	36.55	36.99	0.24	33.46	35.27	34.37	0.24	30.2	31.93	31.06	0.24	27.61	28.17	27.89	15.75	6.31
0.36	34.99	32.73	33.86	0.36	37.64	36.58	37.11	0.36	33.42	35.18	34.3	0.36	30.46	31.93	31.2	0.36	27.62	28.13	27.87	15.35	6.31

0.48	35.2	32.54	33.87	0.48	37.53	36.39	36.96	0.48	33.66	35.31	34.48	0.48	30.32	32.09	31.2	0.48	27.58	28.17	27.87	16.31	6.31
0.6	34.96	32.66	33.81	0.6	37.33	36.49	36.91	0.6	33.66	35.43	34.54	0.6	29.71	31.19	30.45	0.6	27.6	28.33	27.97	16.47	6.32
0.72	34.98	32.65	33.82	0.72	37.71	36.54	37.12	0.72	33.68	35.13	34.4	0.72	44.75	31.87	38.31	0.72	27.64	28.11	27.88	15.53	6.32
0.84	35.1	32.55	33.83	0.84	37.45	36.51	36.98	0.84	33.45	35.16	34.3	0.84	30.32	32.03	31.17	0.84	27.64	28.39	28.01	16.21	6.32
0.96	35.09	32.53	33.81	0.96	37.31	36.44	36.88	0.96	33.44	35.17	34.31	0.96	30.42	31.96	31.19	0.96	27.63	28.29	27.96	16.68	6.33
1.09	34.93	32.82	33.88	1.09	37.43	36.55	36.99	1.09	33.72	35.49	34.61	1.09	30.31	31.88	31.1	1.09	27.62	28.05	27.84	16.26	6.34
1.21	35.21	32.57	33.89	1.21	37.37	36.48	36.92	1.21	33.51	35.46	34.49	1.21	30.3	31.93	31.12	1.21	27.5	28.03	27.77	15.46	6.29
1.33	35.17	32.77	33.97	1.33	37.33	36.51	36.92	1.33	33.69	35.01	34.35	1.33	30.39	31.93	31.16	1.33	27.52	28.2	27.86	16.51	6.33
1.45	35	32.61	33.81	1.45	37.39	36.32	36.86	1.45	33.64	35.24	34.44	1.45	30.24	31.81	31.03	1.45	27.56	28.26	27.91	16.28	6.32
1.57	35.17	32.68	33.93	1.57	37.56	36.61	37.09	1.57	33.53	35.25	34.39	1.57	30.38	31.95	31.16	1.57	27.7	28.07	27.89	14.67	6.32
1.69	35.25	32.57	33.91	1.69	37.44	36.62	37.03	1.69	33.66	35.34	34.5	1.69	30.5	31.92	31.21	1.69	27.63	28.26	27.95	15.94	6.33
1.81	34.97	32.54	33.76	1.81	37.19	36.75	36.97	1.81	33.35	35.09	34.22	1.81	30.23	31.96	31.1	1.81	27.5	28.08	27.79	16.29	6.33
1.93	35.07	32.59	33.83	1.93	37.62	36.31	36.97	1.93	33.45	35.07	34.26	1.93	30.48	31.7	31.09	1.93	27.64	28.13	27.89	16.11	6.32
2.05	35.12	32.63	33.88	2.05	37.51	36.56	37.03	2.05	33.35	35.05	34.2	2.05	30.41	31.92	31.16	2.05	27.52	28.1	27.81	16.25	6.33
2.17	34.97	32.59	33.78	2.17	37.27	36.35	36.81	2.17	33.44	35.08	34.26	2.17	30.39	31.8	31.09	2.17	27.54	28.26	27.9	16.5	6.32
2.29	34.84	32.71	33.78	2.29	37.49	36.36	36.92	2.29	33.46	35.11	34.28	2.29	30.34	31.79	31.06	2.29	27.59	28.06	27.83	14.75	6.29
2.41	34.9	32.45	33.67	2.41	37.2	36.6	36.9	2.41	33.22	35.05	34.13	2.41	30.28	31.87	31.08	2.41	27.51	28.07	27.79	17.12	6.34
2.53	35	32.44	33.72	2.53	37.37	36.4	36.89	2.53	33.56	35	34.28	2.53	30.45	31.86	31.15	2.53	27.5	28.17	27.83	16.24	6.32
2.65	34.93	32.63	33.78	2.65	37.35	36.53	36.94	2.65	33.41	35.1	34.25	2.65	30.5	31.8	31.15	2.65	27.61	28.15	27.88	15.43	6.33
2.77	35.1	32.46	33.78	2.77	37.39	36.2	36.79	2.77	33.53	35.13	34.33	2.77	30.4	31.81	31.11	2.77	27.6	28.13	27.86	15.87	6.33
2.89	34.98	32.57	33.77	2.89	37.45	36.53	36.99	2.89	33.24	35.21	34.23	2.89	30.23	31.87	31.05	2.89	27.57	28.04	27.8	16.2	6.33
3.01	35.01	32.48	33.74	3.01	37.28	36.24	36.76	3.01	33.52	35.05	34.29	3.01	30.27	31.72	31	3.01	27.46	28.14	27.8	16.63	6.33
3.14	34.9	32.59	33.75	3.14	37.37	36.38	36.87	3.14	33.31	35.14	34.22	3.14	30.27	31.7	30.98	3.14	27.48	28.13	27.8	15.75	6.32
3.26	34.94	32.47	33.71	3.26	37.37	36.54	36.95	3.26	33.58	35.12	34.35	3.26	30.31	31.92	31.12	3.26	27.52	28.02	27.77	16.03	6.32
3.38	34.89	32.49	33.69	3.38	37.31	36.35	36.83	3.38	33.5	34.95	34.22	3.38	30.29	31.74	31.01	3.38	27.56	28.1	27.83	15.32	6.32
3.5	35.06	32.6	33.83	3.5	37.28	36.49	36.89	3.5	33.48	35.1	34.29	3.5	33.6	31.78	32.69	3.5	27.61	28.24	27.93	16.23	6.33
3.62	34.78	32.49	33.64	3.62	37.37	36.3	36.83	3.62	33.46	35.06	34.26	3.62	30.33	31.7	31.01	3.62	27.61	28.32	27.97	16.61	6.33
3.74	34.87	32.61	33.74	3.74	37.37	36.56	36.96	3.74	33.45	35.02	34.24	3.74	30.24	31.72	30.98	3.74	27.52	28.04	27.78	15.66	6.34
3.86	34.95	32.57	33.76	3.86	37.34	36.44	36.89	3.86	33.4	34.91	34.16	3.86	30.34	31.83	31.08	3.86	27.33	27.92	27.62	16.27	6.31
3.98	35.09	32.53	33.81	3.98	37.39	36.48	36.94	3.98	33.53	34.96	34.24	3.98	30.4	31.69	31.04	3.98	27.48	28.11	27.8	16.25	6.32
4.1	34.84	32.45	33.65	4.1	37.31	36.45	36.88	4.1	33.52	34.92	34.22	4.1	30.18	31.85	31.01	4.1	27.38	27.91	27.64	15.77	6.29

4.22	35.04	32.51	33.78	4.22	37.31	36.34	36.82	4.22	33.52	35.04	34.28	4.22	30.25	31.74	30.99	4.22	27.48	28.08	27.78	15.9	6.32
4.34	35.05	32.7	33.87	4.34	37.22	36.26	36.74	4.34	33.53	34.96	34.24	4.34	30.32	31.8	31.06	4.34	27.43	27.91	27.67	16.76	6.33
4.46	35.02	32.48	33.75	4.46	37.39	36.47	36.93	4.46	33.44	34.95	34.2	4.46	30.45	32	31.23	4.46	27.5	28.25	27.87	16.42	6.33
4.58	34.78	32.59	33.69	4.58	37.27	36.19	36.73	4.58	33.65	35.19	34.42	4.58	30.32	31.74	31.03	4.58	27.42	27.92	27.67	15.67	6.32
4.7	34.86	32.52	33.69	4.7	37.28	36.21	36.75	4.7	33.35	35.07	34.21	4.7	30.3	31.8	31.05	4.7	27.37	27.96	27.67	16.23	6.33
4.82	34.86	32.5	33.68	4.82	37.46	36.28	36.87	4.82	33.6	35.11	34.36	4.82	30.33	31.81	31.07	4.82	27.56	28.2	27.88	16.31	6.33
4.94	34.84	32.46	33.65	4.94	37.35	36.41	36.88	4.94	33.48	35.19	34.33	4.94	30.3	31.8	31.05	4.94	27.44	27.97	27.7	15.52	6.32
5.06	35	32.59	33.79	5.06	37.36	36.36	36.86	5.06	33.53	35.07	34.3	5.06	30.16	31.7	30.93	5.06	27.44	28.02	27.73	16	6.33
5.19	34.82	32.4	33.61	5.19	37.34	36.39	36.86	5.19	33.45	34.94	34.2	5.19	30.24	31.75	31	5.19	27.43	28.18	27.8	16.29	6.32
5.31	35.07	32.59	33.83	5.31	37.31	36.46	36.88	5.31	33.45	34.77	34.11	5.31	30.41	31.81	31.11	5.31	27.46	28.1	27.78	16.29	6.32
5.43	34.99	32.58	33.79	5.43	37.24	36.28	36.76	5.43	33.49	35.27	34.38	5.43	30.4	31.85	31.12	5.43	27.48	28.12	27.8	16.08	6.33
5.55	34.96	32.47	33.71	5.55	37.23	36.35	36.79	5.55	33.39	34.81	34.1	5.55	30.41	31.8	31.1	5.55	27.45	28.05	27.75	16.6	6.33
5.67	34.94	32.6	33.77	5.67	37.39	36.54	36.97	5.67	33.47	34.98	34.23	5.67	30.27	31.83	31.05	5.67	27.4	28.06	27.73	16.13	6.33
5.79	34.97	32.67	33.82	5.79	37.22	36.52	36.87	5.79	33.5	35.27	34.39	5.79	30.41	31.88	31.14	5.79	27.28	27.83	27.55	15.39	6.3
5.91	34.82	32.39	33.61	5.91	37.17	36.18	36.68	5.91	33.27	34.82	34.05	5.91	30.31	31.76	31.04	5.91	27.22	27.93	27.58	16.14	6.28
6.03	34.91	32.53	33.72	6.03	37.22	36.21	36.71	6.03	33.39	34.95	34.17	6.03	30.16	31.59	30.87	6.03	27.44	27.95	27.69	15.97	6.32
6.15	34.76	32.42	33.59	6.15	37.16	36.14	36.65	6.15	33.34	34.93	34.14	6.15	30.17	31.68	30.92	6.15	27.33	27.97	27.65	16.42	6.33
6.27	34.89	32.51	33.7	6.27	37.28	36.31	36.79	6.27	33.4	34.97	34.18	6.27	30.31	31.74	31.02	6.27	27.41	27.94	27.67	15.66	6.32
6.39	34.82	32.46	33.64	6.39	37.27	36.41	36.84	6.39	33.3	34.82	34.06	6.39	30.29	31.76	31.03	6.39	27.38	27.92	27.65	15.59	6.33
6.51	34.84	32.53	33.69	6.51	37.27	36.41	36.84	6.51	33.27	34.88	34.07	6.51	30.33	31.82	31.07	6.51	27.39	28.03	27.71	16.51	6.32
6.63	34.99	32.57	33.78	6.63	37.25	36.24	36.75	6.63	33.42	34.89	34.16	6.63	30.24	31.68	30.96	6.63	27.41	28.06	27.73	15.97	6.33
6.75	34.69	32.49	33.59	6.75	37.21	36.42	36.82	6.75	33.42	34.98	34.2	6.75	30.3	31.82	31.06	6.75	27.32	27.98	27.65	16.81	6.34
6.87	34.89	32.35	33.62	6.87	37.21	36.29	36.75	6.87	33.51	34.92	34.22	6.87	30.23	31.65	30.94	6.87	27.5	28.17	27.83	15.63	6.32
6.99	34.85	32.3	33.57	6.99	37.26	36.37	36.81	6.99	33.45	34.98	34.22	6.99	30.24	31.64	30.94	6.99	27.44	28.03	27.74	16.54	6.32
7.11	34.73	32.44	33.58	7.11	37.38	36.28	36.83	7.11	33.28	34.88	34.08	7.11	30.23	31.69	30.96	7.11	27.36	27.94	27.65	15.65	6.3
7.23	34.68	32.3	33.49	7.23	37.19	36.21	36.7	7.23	33.43	35.01	34.22	7.23	30.18	31.59	30.89	7.24	27.43	28.11	27.77	16.84	6.34
7.36	34.88	32.45	33.66	7.36	37.33	36.32	36.82	7.36	33.31	34.95	34.13	7.36	30.11	31.79	30.95	7.36	27.4	27.96	27.68	14.93	6.32
7.48	34.68	32.4	33.54	7.48	37.26	36.33	36.79	7.48	33.49	35	34.25	7.48	30.22	31.7	30.96	7.48	27.43	28.08	27.76	16.7	6.32
7.6	34.65	32.44	33.54	7.6	37.25	36.29	36.77	7.6	33.49	34.98	34.23	7.6	30.2	31.67	30.93	7.6	27.5	27.97	27.74	15.2	6.33
7.72	34.63	32.41	33.52	7.72	37.2	36.18	36.69	7.72	33.49	35.05	34.27	7.72	30.25	31.66	30.96	7.72	27.42	28.03	27.73	16.2	6.32
7.84	34.81	32.41	33.61	7.84	37.17	36.47	36.82	7.84	33.3	34.85	34.07	7.84	30.29	31.69	30.99	7.84	27.39	28.01	27.7	15.97	6.34

7.96	34.89	32.41	33.65	7.96	37.04	36.25	36.65	7.96	33.23	34.71	33.97	7.96	30.27	31.69	30.98	7.96	27.42	28.13	27.77	16.99	6.33
8.08	34.8	32.44	33.62	8.08	37.42	36.39	36.9	8.08	33.4	35.11	34.25	8.08	30.2	31.49	30.84	8.08	27.43	27.92	27.68	15.37	6.33
8.2	34.63	32.43	33.53	8.2	37.24	36.33	36.79	8.2	33.24	34.88	34.06	8.2	30.17	31.61	30.89	8.2	27.43	28.15	27.79	16.16	6.34
8.32	34.79	32.56	33.67	8.32	37.22	36.16	36.69	8.32	33.21	34.62	33.92	8.32	30.26	31.7	30.98	8.32	27.25	27.89	27.57	16	6.3
8.44	34.71	32.37	33.54	8.44	37.22	36.25	36.73	8.44	33.31	34.91	34.11	8.44	30.24	31.82	31.03	8.44	27.37	27.88	27.63	15.93	6.32
8.56	34.6	32.33	33.46	8.56	37.19	36.14	36.67	8.56	33.33	34.93	34.13	8.56	30.25	31.54	30.9	8.56	27.32	27.98	27.65	15.77	6.3
8.68	34.79	32.33	33.56	8.68	37.09	36.12	36.61	8.68	33.36	34.89	34.12	8.68	30.15	31.71	30.93	8.68	27.37	27.98	27.68	16.19	6.33
8.8	34.72	32.48	33.6	8.8	37.2	36.18	36.69	8.8	33.32	34.81	34.07	8.8	30.3	31.64	30.97	8.8	27.36	28.06	27.71	16.48	6.33
8.92	34.75	32.45	33.6	8.92	37.1	36.1	36.6	8.92	33.27	34.98	34.12	8.92	30.28	31.75	31.02	8.92	27.43	28.02	27.73	15.76	6.32
9.04	34.55	32.37	33.46	9.04	37.32	36.5	36.91	9.04	33.43	35.11	34.27	9.04	30.18	31.77	30.97	9.04	27.48	27.98	27.73	16.11	6.34
9.16	34.68	32.41	33.55	9.16	37.24	36.18	36.71	9.16	33.39	34.7	34.04	9.16	30.09	31.56	30.83	9.16	27.46	28.08	27.77	15.5	6.33
9.28	34.86	32.41	33.63	9.28	37.18	36.33	36.76	9.28	33.21	34.76	33.99	9.28	30.16	31.59	30.87	9.28	27.28	27.93	27.61	15.87	6.3
9.41	34.77	32.37	33.57	9.41	37.05	36.23	36.64	9.41	33.44	35.16	34.3	9.41	37.25	31.53	34.39	9.41	27.3	27.87	27.58	15.92	6.33
9.53	34.84	32.33	33.58	9.53	37.4	36.34	36.87	9.53	33.47	34.85	34.16	9.53	30.4	31.49	30.95	9.53	27.33	27.83	27.58	16	6.32
9.65	34.77	32.38	33.57	9.65	37.15	36.24	36.69	9.65	33.12	34.7	33.91	9.65	30.09	31.61	30.85	9.65	27.42	27.92	27.67	16.24	6.34
9.77	34.61	32.31	33.46	9.77	37.1	36.09	36.59	9.77	33.45	34.8	34.13	9.77	30.23	31.59	30.91	9.77	27.38	28.04	27.71	15.87	6.32
9.89	34.71	32.31	33.51	9.89	37.1	36.18	36.64	9.89	33.33	34.86	34.09	9.89	30.22	31.45	30.83	9.89	27.28	27.98	27.63	15.79	6.32
				10.01	37.17	36.14	36.65	10.01	33.44	34.98	34.21		33.44	34.98	34.21	10.01	27.39	27.92	27.65	15.59	6.32
			33.704				36.836				34.228				31.208				27.765		
		STDEV:	0.1258			STDEV:	0.123			STDEV:	0.134			STDEV:	0.9602			STDEV:	0.1082		

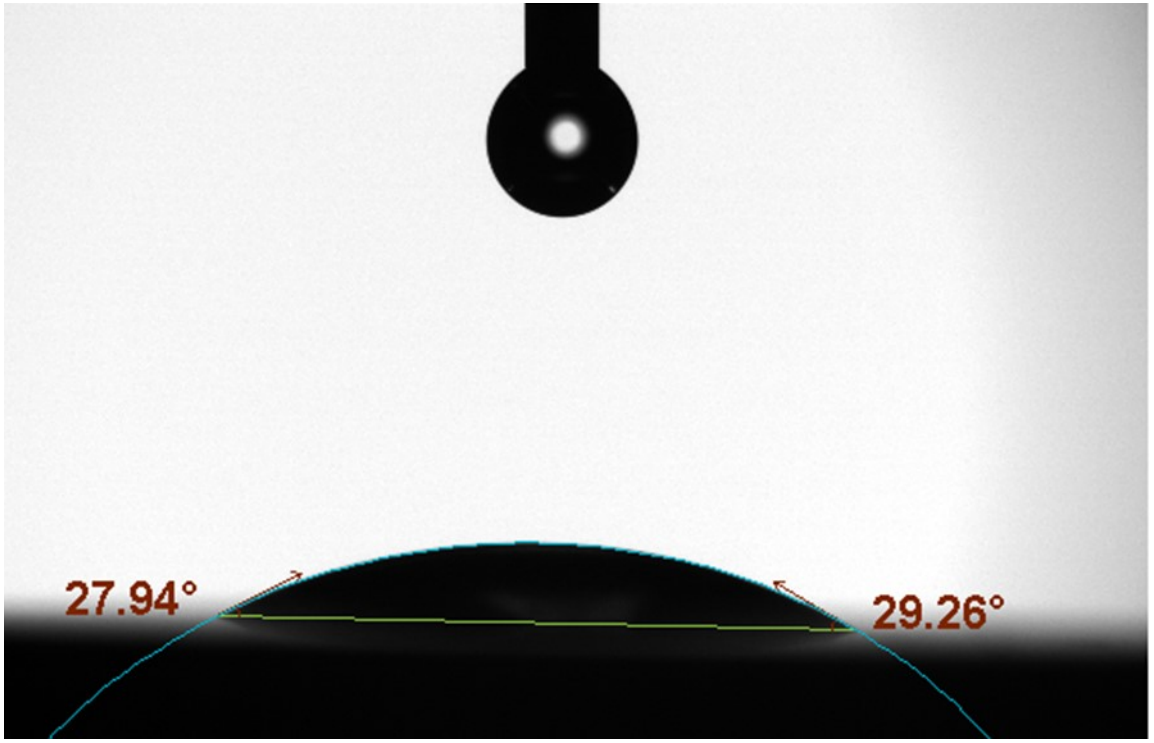

Figure 7.3: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.1V potential under collectorless condition

Table 7.5: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.1V potential under collectorless condition

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	20.03	21.86	20.95	0.00	31.96	31.82	31.89	0.00				0.00	27.21	25.16	26.19	0.00	30.22	29.60	29.91
0.12	20.07	21.83	20.95	0.12	31.81	31.92	31.86	0.12	25.15	26.79	25.97	0.12	27.23	25.07	26.15	0.12	30.01	29.74	29.88
0.24	25.77	28.43	27.1	0.24	31.91	31.94	31.92	0.24	27.98	29.34	28.66	0.24	27.27	25.03	26.15	0.24	30.28	29.66	29.97
0.36	25.8	28.45	27.13	0.36	31.87	31.77	31.82	0.36	27.99	29.33	28.66	0.36	27.12	25.08	26.1	0.36	29.96	29.64	29.8
0.48	25.82	28.52	27.17	0.48	31.8	31.88	31.84	0.48	28.05	29.3	28.68	0.48	27.21	25.04	26.13	0.48	29.96	29.7	29.83

0.6	25.7	28.48	27.09	0.6	31.9	31.79	31.85	0.6	23.92	24.39	24.16	0.6	27.2	25.11	26.15	0.6	30.08	29.74	29.91
0.72	25.68	28.32	27	0.72	31.88	31.93	31.91	0.72				0.72	27.16	25.04	26.1	0.72	30.27	29.73	30
0.84	21.4	23.52	22.46	0.84	31.77	31.92	31.85	0.84	28.02	29.31	28.67	0.84	27.23	25	26.12	0.84	30.06	29.7	29.88
0.96				0.96	31.91	31.85	31.88	0.96	27.98	29.34	28.66	0.96	27.19	25.08	26.13	0.96	30.07	29.73	29.9
1.09	21.47	23.53	22.5	1.09	31.79	31.81	31.8	1.09	28.13	29.4	28.76	1.09	27.16	25.04	26.1	1.09	30.17	29.73	29.95
1.21	25.72	28.44	27.08	1.21	31.89	31.76	31.83	1.21	27.99	29.28	28.64	1.21	27.21	25.08	26.14	1.21	30.07	29.68	29.88
1.33	25.77	28.39	27.08	1.33	31.9	31.81	31.85	1.33	27.95	29.38	28.66	1.33	27.24	24.84	26.04	1.33	29.96	29.55	29.76
1.45	25.63	28.39	27.01	1.45	31.78	31.85	31.82	1.45	28.06	29.25	28.65	1.45	27.18	25.02	26.1	1.45	30.04	29.53	29.78
1.57				1.57	31.88	31.95	31.91	1.57	28.02	29.31	28.67	1.57	27.16	25	26.08	1.57	30.13	29.53	29.83
1.69				1.69	31.87	31.78	31.83	1.69	27.91	29.38	28.65	1.69	26.99	25.09	26.04	1.69	30.24	29.92	30.08
1.81	23.4	25.92	24.66	1.81	31.78	31.83	31.81	1.81	27.97	29.31	28.64	1.81	27.2	24.81	26	1.81	33.29	30.88	32.08
1.93	25.67	28.52	27.1	1.93	31.81	31.85	31.83	1.93	27.98	29.41	28.69	1.93	27.12	24.73	25.92	1.93	29.86	29.55	29.71
2.05	25.79	28.51	27.15	2.05	31.77	31.83	31.8	2.05				2.05	27.14	24.95	26.05	2.05	30.37	29.44	29.9
2.17	25.82	28.43	27.13	2.17	31.77	31.76	31.76	2.17	27.94	29.31	28.63	2.17	27.15	24.75	25.95	2.17	29.79	29.6	29.7
2.29	25.71	28.43	27.07	2.29	31.87	31.91	31.89	2.29				2.29	27.17	24.73	25.95	2.29	29.99	29.47	29.73
2.41	26.75	28.14	27.44	2.41	31.75	31.78	31.76	2.41	27.9	29.25	28.57	2.41	27.11	25	26.05	2.41	29.94	29.47	29.71
2.53	25.6	28.31	26.95	2.53	31.88	31.85	31.87	2.53	27.91	29.36	28.64	2.53	27.21	25.03	26.12	2.53	29.95	29.46	29.7
2.65	21.37	23.43	22.4	2.65	31.86	31.85	31.85	2.65				2.65	27.12	25.03	26.08	2.65	30.2	29.75	29.98
2.77	25.8	28.5	27.15	2.77	31.8	31.85	31.82	2.77				2.77	27.16	24.85	26.01	2.77	30.06	29.64	29.85
2.89	25.69	28.42	27.05	2.89	31.9	31.79	31.85	2.89				2.89	27.1	25.04	26.07	2.89	30.05	29.74	29.9
3.01	25.72	28.41	27.07	3.01	31.77	31.82	31.8	3.01	27.94	29.26	28.6	3.01	27.14	25.02	26.08	3.01	30.23	29.76	30
3.14	25.76	28.41	27.09	3.14	31.72	31.91	31.82	3.14	24.41	25.07	24.74	3.14	27.15	25.03	26.09	3.14	29.87	29.55	29.71
3.26	25.77	28.4	27.08	3.26	31.78	31.81	31.79	3.26	28.07	29.25	28.66	3.26	27.09	24.98	26.03	3.26	30.15	29.6	29.88
3.38	25.71	28.46	27.09	3.38	31.9	31.78	31.84	3.38	27.93	29.28	28.6	3.38	27.14	24.96	26.05	3.38	28.9	28.9	28.9
3.5	25.77	28.43	27.1	3.5	31.82	31.82	31.82	3.5	28.07	29.23	28.65	3.5	27.06	25.03	26.04	3.5	30.04	29.59	29.81
3.62	25.66	28.47	27.07	3.62	31.8	31.74	31.77	3.62				3.62	27.09	24.96	26.03	3.62	30.02	29.53	29.78
3.74	25.66	28.34	27	3.74	31.8	31.81	31.8	3.74				3.74	27.13	24.96	26.04	3.74	29.93	29.76	29.84
3.86	25.7	28.49	27.1	3.86	31.78	31.81	31.79	3.86	27.92	29.18	28.55	3.86	27.09	24.98	26.04	3.86	30.04	29.83	29.93
3.98	25.6	28.3	26.95	3.98	31.75	31.73	31.74	3.98	27.89	29.26	28.58	3.98	27.12	25.03	26.07	3.98	29.9	29.52	29.71
4.1	25.74	28.27	27	4.1	31.78	31.67	31.72	4.1	27.85	29.18	28.52	4.1	27.16	24.98	26.07	4.1	30.15	29.59	29.87

4.22	25.67	28.32	26.99	4.22	31.82	31.77	31.79	4.22	21.58	22.15	21.87	4.22	27.04	25.05	26.05	4.22	29.95	29.65	29.8
4.34	25.78	28.38	27.08	4.34	31.84	31.77	31.81	4.34	27.96	29.22	28.59	4.34	27.07	24.98	26.03	4.34	29.87	29.44	29.65
4.46	25.71	28.43	27.07	4.46	31.72	31.77	31.74	4.46	27.96	29.21	28.59	4.46	27.07	24.9	25.99	4.46	33.29	30.85	32.07
4.58	25.7	28.39	27.04	4.58	31.67	31.83	31.75	4.58				4.58	27.07	24.93	26	4.58	30.17	29.81	29.99
4.7	25.68	28.41	27.05	4.7	31.76	31.76	31.76	4.7	23.06	24.44	23.75	4.7	27.06	24.97	26.02	4.7	29.95	29.64	29.8
4.82	25.74	28.33	27.03	4.82	31.76	31.75	31.75	4.82				4.82	27.08	24.94	26.01	4.82	30.11	29.84	29.98
4.94	25.69	28.43	27.06	4.94	31.66	31.71	31.69	4.94	24.51	25.4	24.96	4.94	27.1	24.96	26.03	4.94	30.03	29.58	29.8
5.06	25.73	28.29	27.01	5.06	31.82	31.73	31.77	5.06				5.06	27.06	24.98	26.02	5.06	30.04	29.63	29.83
5.19	25.66	28.47	27.06	5.19	31.79	31.75	31.77	5.18	26.48	28.06	27.27	5.19	27.06	24.66	25.86	5.19	29.96	29.42	29.69
5.31	25.68	28.47	27.08	5.31	31.81	31.69	31.75	5.31	27.9	29.24	28.57	5.31	27.04	24.97	26.01	5.31	30.18	29.6	29.89
5.43	25.57	28.24	26.91	5.43	31.71	31.75	31.73	5.43	27.84	29.28	28.56	5.43	27.14	24.92	26.03	5.43	30.09	29.59	29.84
5.55	25.65	28.4	27.02	5.55	31.78	31.79	31.79	5.55	27.91	29.18	28.54	5.55	27.01	24.91	25.96	5.55	33.2	30.65	31.92
5.67				5.67	31.71	31.79	31.75	5.67				5.67	27.12	24.82	25.97	5.67	30.03	29.71	29.87
5.79	25.64	28.3	26.97	5.79	31.65	31.75	31.7	5.79	27.94	29.21	28.57	5.79	27.11	24.95	26.03	5.79	28.32	28.38	28.35
5.91	25.67	28.38	27.02	5.91	31.76	31.67	31.71	5.91	27.82	29.25	28.54	5.91	27.05	24.95	26	5.91	30.02	29.75	29.88
6.03	21.29	23.53	22.41	6.03	31.64	31.75	31.7	6.03				6.03	27.03	24.94	25.99	6.03	29.93	29.43	29.68
6.15				6.15	31.69	31.69	31.69	6.15	27.86	29.21	28.53	6.15	27.03	24.99	26.01	6.15	29.89	29.4	29.65
6.27	25.65	28.45	27.05	6.27	31.65	31.74	31.69	6.27	27.89	29.2	28.54	6.27	27.08	24.73	25.9	6.27	30.02	29.59	29.81
6.39	25.67	28.16	26.92	6.39	31.69	31.61	31.65	6.39				6.39	27.07	24.71	25.89	6.39	29.96	29.87	29.92
6.51	25.66	28.41	27.04	6.51	31.76	31.75	31.76	6.51	27.83	29.28	28.55	6.51	27.04	24.93	25.99	6.51	30.1	29.43	29.76
6.63	25.65	28.32	26.98	6.63	31.63	31.7	31.67	6.63	25.04	26.64	25.84	6.63	27.03	24.92	25.97	6.63	29.77	29.74	29.76
6.75	23.19	25.71	24.45	6.75	31.73	31.73	31.73	6.75	27.82	29.27	28.55	6.75	27.12	24.81	25.97	6.75	29.98	29.7	29.84
6.87	25.61	28.3	26.95	6.87	31.62	31.71	31.67	6.87	23.63	24.09	23.86	6.87	27.11	24.71	25.91	6.87	29.99	29.43	29.71
6.99	25.65	28.32	26.99	6.99	31.72	31.66	31.69	6.99	27.93	29.22	28.57	6.99	27.03	24.82	25.92	6.99	30.02	29.44	29.73
7.11	25.62	28.28	26.95	7.11	31.61	31.76	31.68	7.11	27.86	29.17	28.51	7.11	27.08	24.93	26.01	7.11	30.06	29.61	29.84
7.23	25.71	28.37	27.04	7.23	31.75	31.69	31.72	7.23	27.86	29.29	28.58	7.23	27.04	24.9	25.97	7.24	30.22	29.6	29.91
7.36				7.36	31.69	31.67	31.68	7.36	27.96	29.13	28.55	7.36	26.91	24.93	25.92	7.36	29.7	29.46	29.58
7.48	25.68	28.35	27.02	7.48	31.73	31.64	31.69	7.48	23.98	24.76	24.37	7.48	27.01	24.96	25.98	7.48	30.03	29.75	29.89
7.6	25.66	28.21	26.93	7.6	31.65	31.67	31.66	7.6	24.04	24.68	24.36	7.6	27.02	24.94	25.98	7.6	30.03	29.6	29.81
7.72	25.63	28.27	26.95	7.72	31.63	31.7	31.66	7.72	27.8	29.16	28.48	7.72	27.02	24.93	25.97	7.72	29.87	29.63	29.75

7.84	25.64	28.38	27.01	7.84	31.7	31.71	31.71	7.84				7.84	26.96	24.88	25.92	7.84	30.29	29.65	29.97
7.96	25.58	28.35	26.96	7.96	31.75	31.63	31.69	7.96	27.84	29.06	28.45	7.96	27.02	24.64	25.83	7.96	29.79	29.44	29.62
8.08	25.59	28.33	26.96	8.08	31.67	31.72	31.7	8.08				8.08	27.02	24.9	25.96	8.08	30.05	29.3	29.67
8.2	22.02	24.36	23.19	8.2	31.68	31.68	31.68	8.2				8.2	26.99	24.63	25.81	8.2	30.16	29.8	29.98
8.32				8.32	31.68	31.59	31.63	8.32	27.77	29.22	28.5	8.32	26.95	24.97	25.96	8.32	30.19	29.64	29.91
8.44	25.57	28.39	26.98	8.44	31.65	31.67	31.66	8.44	25.24	26.34	25.79	8.44	27.03	24.94	25.98	8.44	29.94	29.56	29.75
8.56				8.56	31.66	31.56	31.61	8.56	24.17	24.88	24.52	8.56	27.07	24.82	25.94	8.56	26.22	27.14	26.68
8.68	25.53	28.42	26.97	8.68	31.73	31.51	31.62	8.68	27.82	29.14	28.48	8.68	27	24.9	25.95	8.68	29.92	29.49	29.7
8.8	21.15	22.97	22.06	8.8	31.58	31.71	31.64	8.8	27.75	29.21	28.48	8.8	26.96	24.95	25.95	8.8			
8.92	25.61	28.34	26.98	8.92	31.6	31.62	31.61	8.92	27.82	29.11	28.46	8.92	27.05	24.91	25.98	8.92	29.98	29.73	29.86
9.04	25.68	28.25	26.96	9.04	31.61	31.66	31.64	9.04	27.73	29.07	28.4	9.04	27.02	24.89	25.96	9.04	30.18	29.71	29.95
9.16	26.17	28.28	27.23	9.16	31.6	31.57	31.59	9.16	27.77	29.11	28.44	9.16	27.01	24.92	25.97	9.16	29.86	29.51	29.68
9.28	25.6	28.34	26.97	9.28	31.67	31.65	31.66	9.28	27.75	29.06	28.41	9.28	27	24.94	25.97	9.28	30.07	29.62	29.85
9.41	25.54	28.29	26.91	9.41	31.63	31.55	31.59	9.41	27.79	29.15	28.47	9.41	26.9	24.92	25.91	9.41	29.74	29.36	29.55
9.53	25.67	28.27	26.97	9.53	31.71	31.6	31.65	9.53				9.53	27.03	24.78	25.91	9.53	30	29.74	29.87
9.65	25.59	28.3	26.94	9.65	31.68	31.61	31.65	9.65				9.65	27.06	24.86	25.96	9.65	30.06	29.57	29.81
9.77	25.57	28.23	26.9	9.77	31.63	31.66	31.65	9.77				9.77	26.97	24.9	25.93	9.77	30	29.59	29.8
9.89	25.51	28.29	26.9	9.89	31.67	31.55	31.61	9.89	27.85	29.1	28.47	9.89	26.92	24.88	25.9	9.89	29.81	29.51	29.66
10.01	25.49	28.22	26.85					10.01	27.74	29.09	28.41								
			26.447				31.749				27.777				26.008				29.834
		STDEV:	1.5686			STDEV:	0.0854			STDEV:	1.6732			STDEV:	0.0772			STDEV:	0.5915

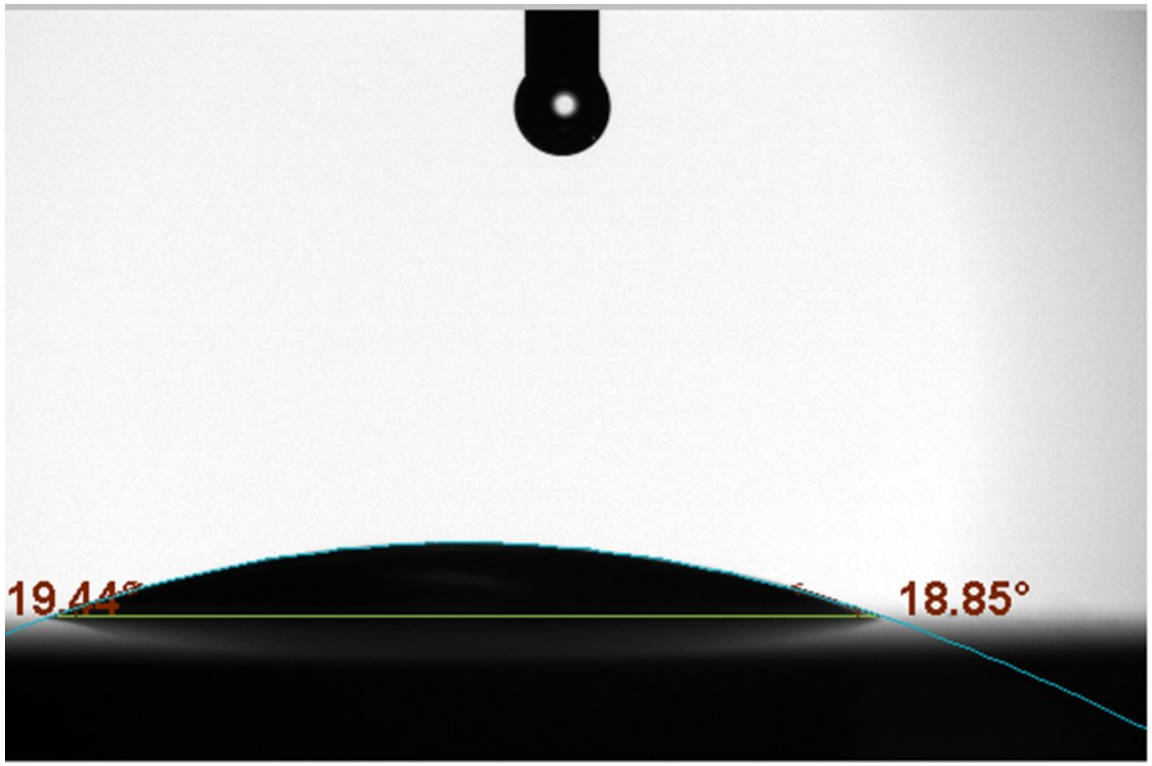

Figure 7.4: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.2V potential under collectorless condition

Table 7.6: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.2V potential under collectorless condition

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	17.52	16.85	17.18	0.00	19.69	18.43	19.06	0.00	21.14	21.04	21.09	0.00	26.04	15.02	20.53	0.00	19.58	19.07	19.33
0.12	17.49	16.73	17.11	0.12				0.12	21.28	21.1	21.19	0.12	24.31	14.83	19.57	0.12	19.72	19.06	19.39
0.24	17.51	16.76	17.13	0.24	19.68	19.35	19.52	0.24	21.07	21.17	21.12	0.24	24.25	14.67	19.46	0.24	19.52	18.89	19.2
0.36	17.51	16.72	17.12	0.36				0.36	21.16	21.11	21.14	0.36	24.36	15.12	19.74	0.36	19.57	19.03	19.3

0.48	17.48	16.73	17.1	0.48	20.16	18.24	19.2	0.48	21.01	21.03	21.02	0.48	26.3	15.17	20.73	0.48	19.63	19.04	19.34
0.6	17.53	16.73	17.13	0.6	19.51	19.5	19.51	0.6	21.05	21	21.03	0.6	26	14.86	20.43	0.6	19.54	19.02	19.28
0.72	17.54	16.7	17.12	0.72	20.2	18.28	19.24	0.72	21.1	21.03	21.07	0.72	24.33	14.83	19.58	0.72	19.6	19	19.3
0.84	17.51	16.81	17.16	0.84	19.91	18.35	19.13	0.84	21.03	21.03	21.03	0.84	26.17	14.79	20.48	0.84	19.74	19.22	19.48
0.96	17.49	16.74	17.11	0.96	19.38	19.45	19.41	0.96	21.16	21.17	21.16	0.96	24.26	14.93	19.6	0.97	19.65	19.07	19.36
1.09	17.49	16.69	17.09	1.09	19.45	18.06	18.75	1.09	21.09	20.92	21.01	1.09	24.27	14.73	19.5	1.09	18.36	17.65	18.01
1.21	17.49	16.74	17.11	1.21	20.15	18.22	19.19	1.21	21.13	20.93	21.03	1.21	24.25	14.48	19.36	1.21	19.65	19.09	19.37
1.33	17.5	16.77	17.13	1.33	19.51	19.3	19.4	1.33	21.1	21.08	21.09	1.33	24.25	14.75	19.5	1.33	19.59	18.97	19.28
1.45	17.52	16.71	17.12	1.45				1.45	21.07	20.95	21.01	1.45	24.31	15.05	19.68	1.45	19.58	19.01	19.29
1.57	17.42	16.72	17.07	1.57	20.29	18.2	19.25	1.57	21.18	20.95	21.07	1.57	24.33	14.79	19.56	1.57	19.57	18.94	19.26
1.69	17.47	16.72	17.09	1.69	19.61	19.5	19.56	1.69	21.12	21.16	21.14	1.69	24.34	14.89	19.62	1.69	19.52	19	19.26
1.81	17.45	16.7	17.08	1.81	19.5	18.18	18.84	1.81	21.26	21.14	21.2	1.81	24.35	14.91	19.63	1.81	19.54	18.92	19.23
1.93	17.48	16.74	17.11	1.93	19.58	19.51	19.54	1.93	21.12	21.05	21.09	1.93	24.27	14.8	19.54	1.93	19.62	19.06	19.34
2.05	17.47	16.73	17.1	2.05	20.13	18.3	19.22	2.05	21.16	20.9	21.03	2.05	24.09	14.82	19.46	2.05	19.62	19.01	19.32
2.17	17.43	16.71	17.07	2.17	19.5	18.27	18.89	2.17	21.09	21.1	21.09	2.17	24.27	14.72	19.5	2.17	19.59	18.93	19.26
2.29	17.48	16.76	17.12	2.29				2.29	21.11	21.09	21.1	2.29	24.21	14.75	19.48	2.29	19.68	19	19.34
2.41	17.48	16.71	17.1	2.41	20.13	18.3	19.22	2.41	21.05	21.09	21.07	2.41	24.15	14.43	19.29	2.41	19.67	19.13	19.4
2.53	17.5	16.76	17.13	2.53				2.53	21.07	20.93	21	2.53	24.32	15.05	19.69	2.53	19.56	18.98	19.27
2.65	17.5	16.75	17.12	2.65	19.22	17.92	18.57	2.65	20.95	20.91	20.93	2.65	24.29	14.76	19.52	2.65	19.55	19.06	19.3
2.77	17.37	16.71	17.04	2.77	19.27	17.82	18.55	2.77	21.03	20.99	21.01	2.77	24.17	14.84	19.5	2.77	19.53	18.88	19.21
2.89	17.46	16.72	17.09	2.89	19.46	19.3	19.38	2.89	21.17	21.1	21.13	2.89	24.3	14.89	19.59	2.89	19.62	19.08	19.35
3.01	17.46	16.66	17.06	3.01	19.58	18.23	18.9	3.01	21.02	20.93	20.97	3.01	25.91	14.82	20.36	3.01	19.57	18.88	19.23
3.14	17.48	16.73	17.1	3.14	19.39	19.41	19.4	3.14	21.05	21.16	21.1	3.14	24.33	14.69	19.51	3.14	19.56	19	19.28
3.26	17.49	16.72	17.1	3.26	17.99	16.27	17.13	3.26	21.04	20.98	21.01	3.26	24.22	14.63	19.42	3.26	19.62	19.07	19.35
3.38	17.42	16.7	17.06	3.38	19.4	19.46	19.43	3.38	21.02	20.92	20.97	3.38	24.26	14.88	19.57	3.38	19.59	18.97	19.28
3.5	17.45	16.69	17.07	3.5	19.53	19.41	19.47	3.5	21.05	20.99	21.02	3.5	26.03	15.07	20.55	3.5	19.56	18.97	19.27
3.62	17.42	16.71	17.07	3.62	19.46	19.49	19.48	3.62	21.07	20.92	21	3.62	24.26	14.86	19.56	3.62	19.61	18.97	19.29
3.74	17.42	16.71	17.06	3.74	19.57	19.43	19.5	3.74	21.15	21.01	21.08	3.74	24.2	14.79	19.5	3.74	19.51	18.91	19.21
3.86	17.4	16.68	17.04	3.86	20.13	18.22	19.17	3.86	20.99	20.97	20.98	3.86	24.18	14.7	19.44	3.86	19.63	18.96	19.29
3.98	17.44	16.69	17.06	3.98				3.98	21.05	21.01	21.03	3.98	24.19	14.84	19.51	3.98	19.5	18.89	19.2

4.1	17.43	16.69	17.06	4.1	19.43	18.04	18.73	4.1	20.91	21.02	20.97	4.1	24.09	14.44	19.27	4.1	19.5	18.89	19.2
4.22	17.5	16.7	17.1	4.22				4.22	21.12	21.05	21.09	4.22	24.17	14.8	19.49	4.22	19.51	18.92	19.21
4.34	17.52	16.68	17.1	4.34	19.47	19.5	19.48	4.34	20.97	21	20.99	4.34	24.26	15.06	19.66	4.34	19.58	19.01	19.29
4.46	17.47	16.68	17.07	4.46	19.55	19.43	19.49	4.46	21.09	21.06	21.07	4.46	24.17	14.93	19.55	4.46	19.46	18.96	19.21
4.58	17.42	16.67	17.04	4.58	19.44	18.09	18.76	4.58	21.02	20.89	20.95	4.58	24.18	14.96	19.57	4.58	19.6	18.93	19.27
4.7	17.41	16.66	17.04	4.7	19.46	18.94	19.2	4.7	20.98	20.91	20.95	4.7	26.71	17.64	22.17	4.7	19.55	18.99	19.27
4.82	17.45	16.7	17.08	4.82	19.54	19.55	19.54	4.82	21.06	20.85	20.95	4.82	24.21	14.88	19.55	4.82	19.48	18.91	19.2
4.94	17.46	16.7	17.08	4.94	20.17	18.14	19.15	4.94	20.92	20.88	20.9	4.94	24.19	15.01	19.6	4.94	19.5	18.83	19.16
5.06	17.46	16.7	17.08	5.06				5.06	21	20.87	20.93	5.06	26.32	14.65	20.49	5.06	19.5	18.95	19.23
5.18	17.44	16.71	17.07	5.19				5.19	21.03	20.92	20.98	5.18	25.83	14.82	20.32	5.19	19.55	18.95	19.25
5.31	17.45	16.7	17.07	5.31				5.31	20.98	20.86	20.92	5.31	24.22	14.72	19.47	5.31	19.53	18.93	19.23
5.43	17.45	16.69	17.07	5.43	19.52	19.36	19.44	5.43	20.93	20.87	20.9	5.43	24.1	14.72	19.41	5.43	19.57	18.97	19.27
5.55	17.39	16.67	17.03	5.55	19.46	18.04	18.75	5.55	20.99	21.07	21.03	5.55	24.14	14.67	19.4	5.55	19.51	18.97	19.24
5.67	17.44	16.67	17.06	5.67	19.62	19.49	19.55	5.67	20.99	20.84	20.91	5.67	24.13	14.61	19.37	5.67	19.51	18.91	19.21
5.79	17.39	16.65	17.02	5.79				5.79	21	20.89	20.94	5.79	26.03	14.83	20.43	5.79	19.58	18.89	19.23
5.91	17.45	16.7	17.07	5.91	19.54	19.14	19.34	5.91	20.94	20.92	20.93	5.91	24.27	14.68	19.48	5.91	19.52	18.94	19.23
6.03	17.47	16.66	17.06	6.03	19.48	18.16	18.82	6.03	21.1	21.05	21.07	6.03	26	14.77	20.39	6.03	19.5	18.96	19.23
6.15	17.41	16.76	17.08	6.15				6.15	21.05	20.96	21	6.15	24.11	14.68	19.39	6.15	19.49	18.92	19.2
6.27	17.45	16.63	17.04	6.27	19.13	17.73	18.43	6.27	20.95	20.91	20.93	6.27	24.13	14.7	19.41	6.27	19.6	19.02	19.31
6.39	17.37	16.68	17.03	6.39	19.61	19.3	19.45	6.39	21	20.96	20.98	6.39	26.23	14.91	20.57	6.39	19.61	19.06	19.33
6.51	17.41	16.64	17.02	6.51	19.28	19.3	19.29	6.51	20.93	20.97	20.95	6.51	24.19	14.94	19.56	6.51	19.46	18.81	19.14
6.63	17.43	16.7	17.06	6.63	19.66	19.33	19.49	6.63	21.01	20.89	20.95	6.63	24.18	14.62	19.4	6.63	19.55	18.97	19.26
6.75	17.42	16.68	17.05	6.75				6.75	20.9	21	20.95	6.75	24.15	14.76	19.46	6.75	19.47	18.91	19.19
6.87	17.45	16.65	17.05	6.87				6.87	20.92	20.99	20.95	6.87	24.1	14.83	19.47	6.87	19.5	18.91	19.21
6.99	17.43	16.68	17.06	6.99	19.44	18.17	18.8	6.99	21.01	20.83	20.92	6.99	24.2	14.65	19.42	6.99	19.52	18.91	19.22
7.11	17.42	16.65	17.03	7.11	20.09	18.17	19.13	7.11	21	20.89	20.95	7.11	24.06	14.41	19.23	7.11	19.52	19	19.26
7.23	17.39	16.64	17.02	7.23	18.16	16.54	17.35	7.23	20.86	20.76	20.81	7.23	23.98	14.22	19.1	7.23	19.5	18.82	19.16
7.36	17.43	16.68	17.05	7.36	20.11	18.16	19.14	7.36	20.89	20.87	20.88	7.36	24.11	14.68	19.4	7.36	19.51	19	19.25
7.48	17.37	16.62	16.99	7.48	20.08	18.18	19.13	7.48	21.07	21.03	21.05	7.48	24.18	14.76	19.47	7.48	19.48	18.9	19.19
7.6	17.4	16.68	17.04	7.6	19.32	17.99	18.65	7.6	20.92	21.01	20.97	7.6	24.07	14.3	19.18	7.6	19.44	18.85	19.15

7.72	17.39	16.64	17.01	7.72				7.72	21.07	21	21.03	7.72	24.08	14.59	19.33	7.72	19.57	18.98	19.28
7.84	17.4	16.66	17.03	7.84	20.06	18.13	19.1	7.84	21.01	20.9	20.96	7.84	24.15	14.55	19.35	7.84	19.46	18.89	19.18
7.96	17.35	16.61	16.98	7.96				7.96	20.86	20.87	20.87	7.96	24.13	14.75	19.44	7.96	19.45	18.86	19.16
8.08	17.42	16.64	17.03	8.08				8.08	21.09	20.95	21.02	8.08	26.05	15.01	20.53	8.08	19.54	18.96	19.25
8.2	17.33	16.71	17.02	8.2	19.5	19.3	19.4	8.2	20.89	20.89	20.89	8.2	24.1	14.74	19.42	8.2	19.48	18.86	19.17
8.32	17.41	16.61	17.01	8.32	19.5	19.4	19.45	8.32	20.98	21.04	21.01	8.32	24.33	14.72	19.52	8.32	19.45	18.77	19.11
8.44	17.31	16.59	16.95	8.44	19.55	19.32	19.43	8.44	20.95	20.98	20.96	8.44	24.1	14.61	19.36	8.44	19.53	18.96	19.25
8.56	17.39	16.66	17.02	8.56	19.41	19.25	19.33	8.56	20.89	21.04	20.97	8.56	24.11	14.78	19.44	8.56	19.45	18.94	19.2
8.68	17.39	16.63	17.01	8.68				8.68	20.91	20.92	20.91	8.68	24.21	14.93	19.57	8.68	19.46	18.94	19.2
8.8	17.39	16.63	17.01	8.8				8.8	21	20.93	20.96	8.8	24.14	14.48	19.31	8.8	19.48	18.87	19.17
8.92	17.39	16.61	17	8.92	19.66	19.48	19.57	8.92	20.85	20.84	20.85	8.92	25.98	14.63	20.31	8.92	19.54	18.97	19.25
9.04	17.39	16.64	17.01	9.04	19.54	19.22	19.38	9.04	20.86	20.81	20.84	9.04	25.91	14.72	20.31	9.04	19.47	18.84	19.15
9.16	17.38	16.63	17	9.16				9.16	20.97	20.75	20.86	9.16	25.82	14.98	20.4	9.16	19.48	18.92	19.2
9.28	17.38	16.64	17.01	9.28				9.28	20.86	20.78	20.82	9.28	24.09	14.81	19.45	9.28	19.45	18.9	19.17
9.41	17.35	16.65	17	9.41	20.01	18.13	19.07	9.41	20.9	20.89	20.89	9.41	25.99	14.82	20.4	9.41	19.44	18.85	19.14
9.53	17.37	16.62	16.99	9.53	19.33	19.08	19.2	9.53	21.04	20.89	20.96	9.53	24.01	14.42	19.22	9.53	19.44	18.87	19.16
9.65	17.38	16.59	16.99	9.65				9.65	20.91	20.94	20.93	9.65	24.05	14.56	19.31	9.65	19.49	18.95	19.22
9.77	17.36	16.6	16.98	9.77	18.47	13.33	15.9	9.77	20.77	20.68	20.73	9.77	24.14	14.58	19.36	9.77	19.53	19.03	19.28
9.89	17.36	16.59	16.98	9.89				9.89	20.95	20.91	20.93	9.89	25.81	14.82	20.32	9.89	19.46	18.86	19.16
10.01	17.37	16.6	16.99					10.01	20.89	20.94	20.91	10.01	24.08	14.7	19.39				
			17.059				19.081				20.989				19.695				19.233
		STDEV:	0.0467			STDEV:	0.6222			STDEV:	0.0886			STDEV:	0.4954			STDEV:	0.152

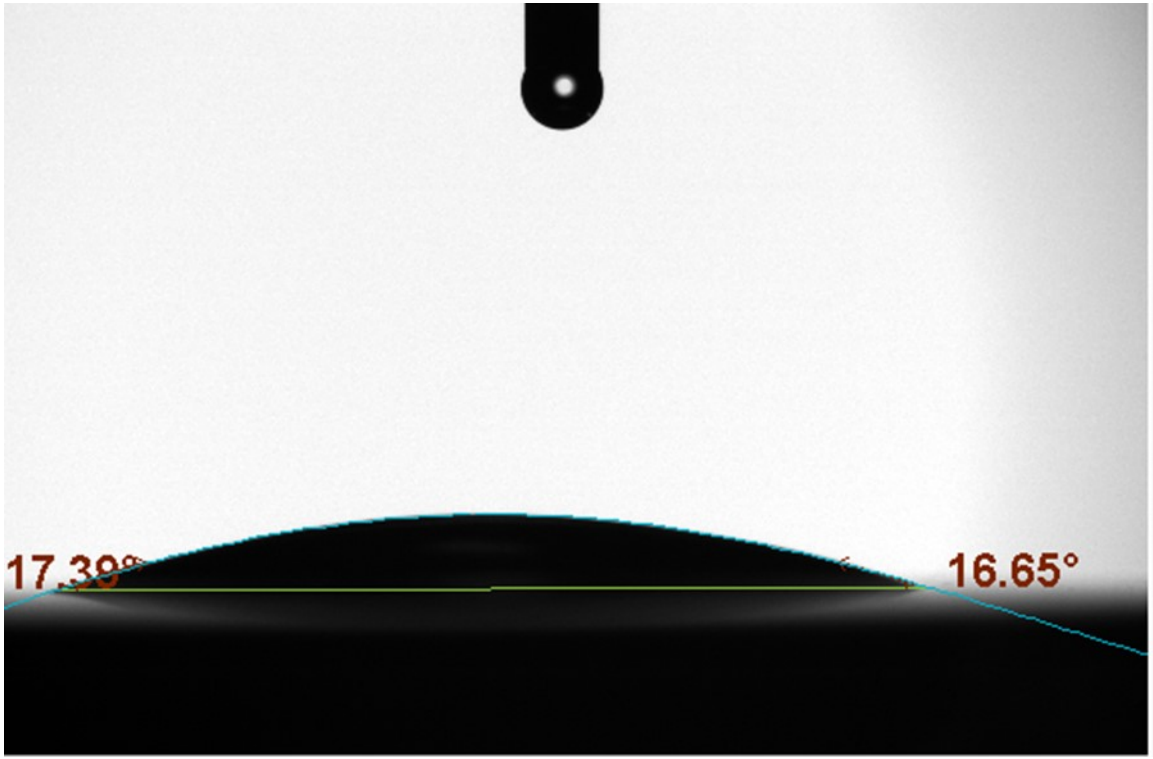

Figure 7.5: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.3V potential under collectorless condition

Table 7.7: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.3V potential under collectorless condition

Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	20.27	20.09	20.18	0.00	17.94	14.56	16.25	0.00	21.13	19.92	20.53	0.00	19.69	12.72	16.21
0.12	20.27	20.18	20.22	0.12	17.76	14.47	16.11	0.12	21.06	19.92	20.49	0.12	17.69	14.99	16.34
0.24	20.26	20.05	20.15	0.24	17.65	14.43	16.04	0.24	21.22	19.85	20.54	0.24	19.79	12.67	16.23
0.36	20.27	20.09	20.18	0.36	17.73	14.60	16.17	0.36	21.02	19.94	20.48	0.36	19.65	12.73	16.19

0.48	20.21	20.15	20.18	0.48	17.92	14.50	16.21	0.48	21.05	19.75	20.40	0.48	19.64	12.71	16.17
0.60	20.23	20.08	20.15	0.60	17.89	14.63	16.26	0.60	21.04	20.01	20.52	0.60	19.57	12.62	16.09
0.72	20.22	20.22	20.22	0.72	17.74	14.44	16.09	0.72	21.05	19.91	20.48	0.72	19.59	12.82	16.20
0.84	20.24	20.02	20.13	0.84	17.69	14.48	16.09	0.84	21.05	19.95	20.50	0.84	19.75	12.70	16.22
0.96	20.22	20.08	20.15	0.96	17.80	14.49	16.15	0.96	21.04	19.85	20.44	0.96	19.46	12.75	16.11
1.09	20.37	20.15	20.26	1.09	17.77	14.48	16.13	1.09	21.07	19.88	20.47	1.09	19.59	12.67	16.13
1.21	20.18	20.09	20.14	1.21	17.75	14.52	16.13	1.21	21.09	19.84	20.46	1.21	19.69	12.74	16.22
1.33	20.36	20.07	20.22	1.33	17.71	14.54	16.13	1.33	21.01	19.94	20.47	1.33	19.47	12.63	16.05
1.45	20.30	20.05	20.18	1.45	17.77	14.47	16.12	1.45	21.02	19.94	20.48	1.45	19.61	12.75	16.18
1.57	20.33	20.02	20.18	1.57	17.68	14.49	16.09	1.57	21.07	19.80	20.43	1.57	19.54	12.70	16.12
1.69	20.32	20.14	20.23	1.69	17.77	14.44	16.11	1.69	21.05	19.84	20.44	1.69	19.93	12.67	16.30
1.81	20.26	20.10	20.18	1.81	17.81	14.36	16.08	1.81	21.08	19.77	20.43	1.81	19.04	14.42	16.73
1.93	20.34	20.03	20.19	1.93	17.74	14.45	16.09	1.93	21.00	19.78	20.39	1.93	19.80	12.77	16.28
2.05	20.27	20.06	20.17	2.05	17.74	14.55	16.15	2.05	21.00	19.82	20.41	2.05	19.59	12.71	16.15
2.17	20.30	20.07	20.19	2.17	17.92	14.55	16.23	2.17	21.03	19.79	20.41	2.17	19.57	12.67	16.12
2.29	20.29	20.03	20.16	2.29	17.74	14.56	16.15	2.29	20.95	19.77	20.36	2.29	19.72	12.60	16.16
2.41	20.27	20.08	20.17	2.41	17.64	14.49	16.07	2.41	20.91	19.79	20.35	2.41	19.78	12.70	16.24
2.53	20.23	20.10	20.17	2.53	17.80	14.53	16.16	2.53	20.97	19.79	20.38	2.53	19.81	12.66	16.24
2.65	20.34	20.04	20.19	2.65	17.70	14.37	16.03	2.65	20.86	19.92	20.39	2.65	19.69	12.77	16.23
2.77	20.28	20.01	20.15	2.77	17.91	14.56	16.24	2.77	20.95	19.82	20.39	2.77	19.81	12.61	16.21
2.89	20.24	20.13	20.19	2.89	17.72	14.49	16.10	2.89	21.04	19.91	20.47	2.89	19.60	12.83	16.21
3.01	20.37	19.89	20.13	3.01	17.87	14.49	16.18	3.01	21.04	19.76	20.40	3.01	19.76	12.58	16.17
3.14	20.20	20.03	20.11	3.14	17.78	14.44	16.11	3.14	20.99	19.75	20.37	3.14	19.56	12.71	16.14
3.26	20.23	20.08	20.16	3.26	17.59	14.41	16.00	3.26	20.87	19.79	20.33	3.26	19.70	12.79	16.25
3.38	20.31	20.08	20.19	3.38	17.67	14.45	16.06	3.38	20.98	19.77	20.37	3.38	19.70	12.71	16.20
3.50	20.24	20.00	20.12	3.50	17.67	14.39	16.03	3.50	20.95	19.80	20.37	3.50	19.74	12.78	16.26
3.62	20.16	20.00	20.08	3.62	17.61	14.36	15.99	3.62	21.03	19.74	20.39	3.62	19.70	12.64	16.17
3.74	20.20	20.02	20.11	3.74	17.88	14.55	16.21	3.74	21.00	19.80	20.40	3.74	19.71	12.70	16.21
3.86	20.27	20.00	20.14	3.86	17.56	14.40	15.98	3.86	20.85	19.70	20.28	3.86	19.62	12.70	16.16
3.98	20.15	20.08	20.12	3.98	17.70	14.48	16.09	3.98	20.87	19.69	20.28	3.98	19.64	12.68	16.16

4.10	20.28	19.94	20.11	4.10	17.66	14.44	16.05	4.10	20.81	19.73	20.27	4.10	19.62	12.58	16.10
4.22	20.26	19.96	20.11	4.22	17.77	14.48	16.13	4.22	21.01	19.78	20.39	4.22	19.77	12.75	16.26
4.34	20.28	20.01	20.14	4.34	17.64	14.36	16.00	4.34	20.92	19.84	20.38	4.34	19.62	12.75	16.18
4.46	20.21	19.98	20.10	4.46	17.61	14.41	16.01	4.46	20.90	19.71	20.30	4.46	19.82	12.73	16.28
4.58	20.20	19.95	20.07	4.58	17.56	14.43	15.99	4.58	21.03	19.78	20.41	4.58	19.57	12.68	16.12
4.70	20.28	19.98	20.13	4.70	17.62	14.44	16.03	4.70	20.84	19.54	20.19	4.70	19.45	12.59	16.02
4.82	20.13	19.94	20.03	4.82	17.55	14.28	15.92	4.82	20.91	19.73	20.32	4.82	19.64	12.53	16.09
4.94	20.24	20.08	20.16	4.94	17.60	14.43	16.02	4.94	20.95	19.78	20.36	4.94	19.65	12.64	16.15
5.06	20.12	19.97	20.04	5.06	17.65	14.41	16.03	5.06	20.99	19.78	20.39	5.06	19.67	12.66	16.16
5.19	20.16	20.03	20.09	5.19	17.61	14.41	16.01	5.18	20.82	19.68	20.25	5.19	19.59	12.61	16.10
5.31	20.10	19.94	20.02	5.31	17.80	14.42	16.11	5.31	20.84	19.82	20.33	5.31	19.48	12.70	16.09
5.43	20.22	19.97	20.10	5.43	17.59	14.38	15.99	5.43	21.03	19.73	20.38	5.43	19.64	12.59	16.11
5.55	20.20	20.02	20.11	5.55	17.81	14.45	16.13	5.55	20.85	19.76	20.30	5.55	19.61	12.66	16.14
5.67	20.11	19.97	20.04	5.67	17.65	14.41	16.03	5.67	20.83	19.80	20.32	5.67	19.53	12.67	16.10
5.79	20.11	19.88	19.99	5.79	17.54	14.37	15.95	5.79	20.82	19.75	20.28	5.79	19.52	12.65	16.08
5.91	20.11	20.10	20.10	5.91	17.55	14.37	15.96	5.91	20.97	19.65	20.31	5.91	19.55	12.61	16.08
6.03	20.25	19.88	20.07	6.03	17.75	14.38	16.06	6.03	20.96	19.61	20.29	6.03	19.53	12.60	16.06
6.15	20.26	20.00	20.13	6.15	17.69	14.45	16.07	6.15	20.91	19.74	20.32	6.15	19.74	12.58	16.16
6.27	20.24	19.89	20.06	6.27	17.63	14.39	16.01	6.27	20.90	19.71	20.30	6.27	19.57	12.70	16.14
6.39	20.15	19.92	20.04	6.39	17.48	14.25	15.86	6.39	20.91	19.68	20.30	6.39	19.57	12.65	16.11
6.51	20.13	20.00	20.06	6.51	17.48	14.36	15.92	6.51	20.92	19.66	20.29	6.51	19.61	12.62	16.12
6.63	20.21	19.90	20.06	6.63	17.47	14.34	15.90	6.63	20.88	19.68	20.28	6.63	19.58	12.63	16.10
6.75	20.15	19.94	20.04	6.75	17.67	14.35	16.01	6.75	20.85	19.64	20.25	6.75	19.51	12.54	16.02
6.87	20.13	19.99	20.06	6.87	17.74	14.40	16.07	6.87	20.87	19.60	20.24	6.87	19.59	12.58	16.09
6.99	20.16	19.94	20.05	6.99	17.47	14.21	15.84	6.99	20.78	19.79	20.28	6.99	19.56	12.53	16.05
7.11	20.14	19.95	20.04	7.11	17.41	14.22	15.81	7.11	20.86	19.61	20.23	7.11	19.59	12.54	16.06
7.24	20.01	19.88	19.94	7.23	17.60	14.30	15.95	7.23	20.89	19.67	20.28	7.23	19.49	12.56	16.03
7.36	20.05	19.91	19.98	7.36	17.46	14.22	15.84	7.36	20.82	19.79	20.31	7.36	19.77	12.58	16.18
7.48	20.15	20.00	20.08	7.48	17.63	14.29	15.96	7.48	20.91	19.72	20.32	7.48	19.45	12.52	15.98
7.60	20.07	19.85	19.96	7.60	17.65	14.28	15.96	7.60	20.84	19.66	20.25	7.60	19.47	12.62	16.04

7.72	20.08	19.92	20.00	7.72	17.85	14.52	16.19	7.72	20.81	19.74	20.28	7.72	19.54	12.48	16.01
7.84	20.10	19.94	20.02	7.84	17.59	14.32	15.96	7.84	20.84	19.66	20.25	7.84	19.31	12.54	15.93
7.96	20.13	19.86	20.00	7.96	17.54	14.37	15.96	7.96	20.86	19.59	20.23	7.96	19.53	12.61	16.07
8.08	20.12	19.88	20.00	8.08	17.58	14.33	15.95	8.08	20.81	19.65	20.23	8.08	19.31	12.54	15.93
8.20	20.16	19.84	20.00	8.20	17.43	14.27	15.85	8.20	20.87	19.69	20.28	8.20	19.39	12.61	16.00
8.32	20.07	19.94	20.00	8.32	17.36	14.17	15.77	8.32	20.95	19.64	20.29	8.32	19.50	12.54	16.02
8.44	20.16	19.98	20.07	8.44	17.51	14.28	15.89	8.44	20.79	19.74	20.27	8.44	19.56	12.61	16.08
8.56	20.13	19.97	20.05	8.56	17.41	14.27	15.84	8.56	20.81	19.66	20.23	8.56	19.45	12.61	16.03
8.68	20.18	19.89	20.04	8.68	17.57	14.32	15.95	8.68	20.85	19.60	20.23	8.68	19.33	12.61	15.97
8.80	20.10	19.81	19.96	8.80	17.34	14.28	15.81	8.80	20.92	19.64	20.28	8.80	19.49	12.54	16.02
8.92	20.06	19.93	20.00	8.92	17.63	14.33	15.98	8.92	20.79	19.66	20.22	8.92	19.46	12.57	16.02
9.04	20.02	19.80	19.91	9.04	17.44	14.27	15.86	9.04	20.79	19.69	20.24	9.04	19.41	12.55	15.98
9.16	20.16	19.87	20.02	9.16	17.64	14.35	16.00	9.16	20.77	19.58	20.17	9.16	19.34	12.58	15.96
9.28	19.91	19.89	19.90	9.28	17.45	14.16	15.81	9.28	20.77	19.58	20.17	9.28	19.55	12.50	16.03
9.41	20.14	19.86	20.00	9.41	17.57	14.36	15.96	9.41	20.70	19.69	20.20	9.41	19.35	12.55	15.95
9.53	20.14	19.92	20.03	9.53	17.41	14.22	15.81	9.53	20.80	19.56	20.18	9.53	19.34	12.49	15.92
9.65	20.12	19.93	20.02	9.65	17.46	14.17	15.82	9.65	20.88	19.66	20.27	9.65	19.31	12.49	15.90
9.77	20.10	19.81	19.96	9.77	17.35	14.24	15.80	9.77	20.75	19.60	20.18	9.77	19.31	12.52	15.91
9.89	19.97	19.84	19.91	9.89	17.51	14.16	15.84	9.89	20.74	19.57	20.15	9.89	19.67	12.64	16.15
													16.89	15.52	16.21
			20.09				16.02				20.33				16.12
		STDEV:	0.08			STDEV:	0.12			STDEV:	0.10			STDEV:	0.12

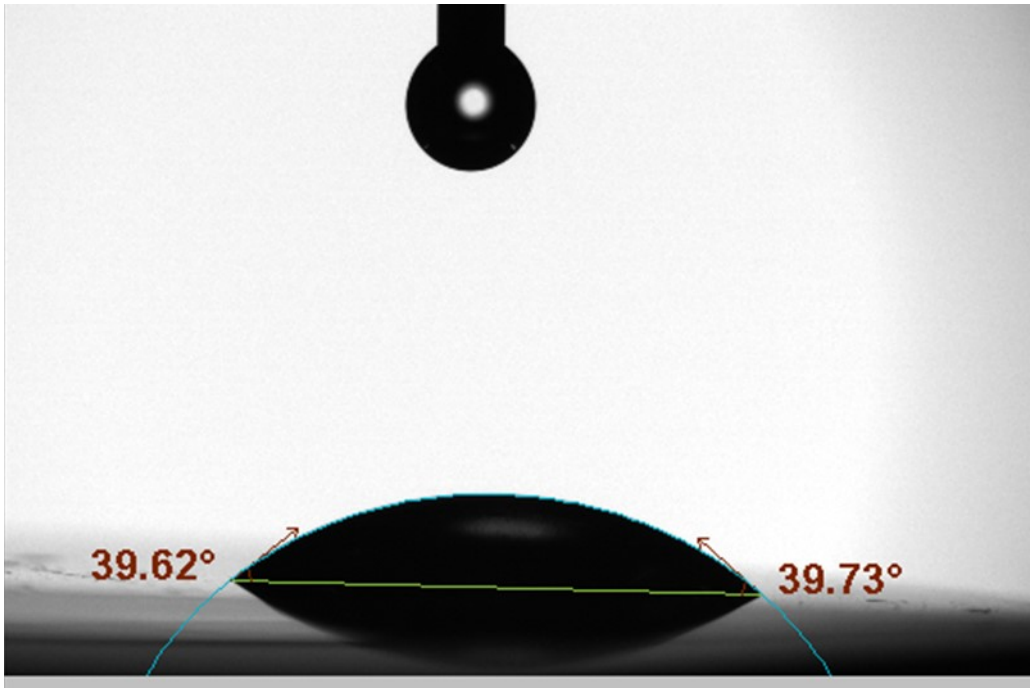

Figure 7.6: Contact angle measurement for millerite electrode at pH 12 conditioned at 0 V potential under 1.4 x 10^{-4}M KEX

Table 7.8: Contact angle measurement for millerite electrode at pH 12 conditioned at 0 V potential under 1.4 x 10^{-4}M KEX

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	33.34	39.70	36.52	0.00	42.21	50.13	46.17	0.00	39.62	39.73	39.68	0.00	40.79	47.97	44.38	0.00	42.81	43.67	43.24
0.12	33.24	39.54	36.39	0.12	42.11	50.25	46.18	0.12	39.67	39.63	39.65	0.12	40.78	47.97	44.38	0.12	42.86	43.7	43.28
0.24	33.29	39.68	36.48	0.24	42.18	50.22	46.2	0.24	39.6	39.78	39.69	0.24	40.78	48.13	44.45	0.24	42.85	43.66	43.25
0.36	33.3	39.6	36.45	0.36	42.19	50.24	46.21	0.36	39.59	39.6	39.59	0.36	40.89	47.95	44.42	0.36	42.83	43.73	43.28
0.48	33.25	39.57	36.41	0.48	42.17	50.12	46.14	0.48	39.61	39.82	39.71	0.48	40.78	47.99	44.38	0.48	42.8	43.63	43.21
0.6	33.32	39.46	36.39	0.6	42.18	50.25	46.21	0.6	39.66	39.71	39.68	0.6	40.82	47.97	44.4	0.6	42.8	43.61	43.2

0.72	33.21	39.66	36.44	0.72	42.08	50.27	46.18	0.72	39.65	39.81	39.73	0.72	40.8	47.97	44.38	0.72	42.81	43.63	43.22
0.84	33.12	39.5	36.31	0.84	42.18	50.18	46.18	0.84	39.55	39.71	39.63	0.84	40.77	47.99	44.38	0.84	42.79	43.63	43.21
0.96	33.27	39.61	36.44	0.96	42.19	50.19	46.19	0.96	39.66	39.66	39.66	0.96	40.79	47.93	44.36	0.96	42.82	43.66	43.24
1.09	33.19	39.6	36.4	1.09	42.13	50.2	46.17	1.09	39.49	39.64	39.57	1.08	40.71	47.93	44.32	1.09	42.89	43.59	43.24
1.21	35.95	37.5	36.73	1.21	42.12	50.22	46.17	1.21	39.57	39.6	39.59	1.21	40.77	47.99	44.38	1.21	42.91	43.62	43.27
1.33	33.17	39.55	36.36	1.33	42.14	50.13	46.14	1.33	39.54	39.68	39.61	1.33	40.85	47.92	44.38	1.33	42.9	43.61	43.25
1.45	33.21	39.49	36.35	1.45	42.13	50.08	46.11	1.45	39.55	39.63	39.59	1.45	40.77	47.97	44.37	1.45	42.8	43.52	43.16
1.57	33.2	39.67	36.44	1.57	42.14	50.29	46.22	1.57	39.6	39.61	39.6	1.57	40.72	47.98	44.35	1.57	42.87	43.6	43.23
1.69	33.18	39.6	36.39	1.69	42.1	50.13	46.12	1.69	39.68	39.61	39.64	1.69	40.76	48.01	44.39	1.69	42.87	43.51	43.19
1.81	33.24	39.63	36.43	1.81	42.05	50.17	46.11	1.81	39.56	39.62	39.59	1.81	40.87	47.89	44.38	1.81	42.76	43.58	43.17
1.93	33.18	39.58	36.38	1.93	42.11	50.19	46.15	1.93	39.59	39.71	39.65	1.93	40.74	47.9	44.32	1.93	42.77	43.53	43.15
2.05	33.26	39.47	36.36	2.05	42.08	50.1	46.09	2.05	39.61	39.64	39.62	2.05	40.68	47.93	44.3	2.05	42.84	43.61	43.22
2.17	33.23	39.55	36.39	2.17	42.05	50.12	46.09	2.17	39.67	39.67	39.67	2.17	40.67	48.01	44.34	2.17	42.79	43.6	43.19
2.29	33.24	39.54	36.39	2.29	42.14	50.19	46.17	2.29	39.59	39.61	39.6	2.29	40.85	47.9	44.37	2.29	42.78	43.49	43.13
2.41	33.15	39.56	36.36	2.41	42.06	50.16	46.11	2.41	39.63	39.68	39.65	2.41	40.78	48	44.39	2.41	42.8	43.62	43.21
2.53	33.19	39.43	36.31	2.53	42.13	50.15	46.14	2.53	39.57	39.6	39.58	2.53	40.73	47.98	44.36	2.53	42.97	42.99	42.98
2.65	33.18	39.52	36.35	2.65	42.05	50.11	46.08	2.65	39.54	39.7	39.62	2.65	40.76	47.99	44.38	2.65	42.75	43.54	43.15
2.77	33.12	39.59	36.35	2.77	42.12	50.15	46.14	2.77	39.6	39.63	39.62	2.77	40.78	47.95	44.37	2.77	42.74	43.56	43.15
2.89	33.1	39.59	36.35	2.89	41.98	50.24	46.11	2.89	39.59	39.66	39.63	2.89	40.67	48.07	44.37	2.89	42.76	43.51	43.14
3.01	33.18	39.41	36.29	3.01	42.1	50.07	46.09	3.01	39.61	39.57	39.59	3.01	40.7	47.93	44.32	3.01	42.8	43.47	43.14
3.14	33.2	39.55	36.37	3.14	42.15	50.23	46.19	3.14	39.6	39.6	39.6	3.13	40.74	47.76	44.25	3.14	42.8	43.61	43.2
3.26	33.07	39.48	36.27	3.26	42.18	50.07	46.13	3.26	39.54	39.68	39.61	3.26	40.88	47.91	44.39	3.26	42.8	43.53	43.17
3.38	33.16	39.51	36.34	3.38	42.14	50.11	46.12	3.38	39.58	39.62	39.6	3.38	40.69	47.91	44.3	3.38	42.8	43.56	43.18
3.5	33.17	39.56	36.36	3.5	42.09	50.28	46.19	3.5	39.53	39.59	39.56	3.5	40.76	47.89	44.32	3.5	42.76	43.55	43.15
3.62	33.12	39.48	36.3	3.62	42.06	50.1	46.08	3.62	39.49	39.45	39.47	3.62	40.68	47.94	44.31	3.62	42.76	43.51	43.14
3.74	33.04	39.41	36.23	3.74	42.1	50.12	46.11	3.74	39.54	39.7	39.62	3.74	40.67	47.92	44.3	3.74	42.73	43.5	43.11
3.86	33.26	39.52	36.39	3.86	42.06	50.14	46.1	3.86	39.6	39.62	39.61	3.86	40.66	47.91	44.29	3.86	42.72	43.58	43.15
3.98	33.09	39.4	36.24	3.98	42.07	50.26	46.16	3.98	39.52	39.71	39.61	3.98	40.76	47.87	44.32	3.98	42.84	43.55	43.19
4.1	33.22	39.6	36.41	4.1	42.04	50.08	46.06	4.1	39.58	39.61	39.59	4.1	40.68	47.9	44.29	4.1	42.73	43.62	43.18
4.22	33.16	39.4	36.28	4.22	42.05	50.21	46.13	4.22	39.63	39.62	39.62	4.22	40.72	47.87	44.3	4.22	42.94	43.4	43.17

4.34	33.14	39.47	36.31	4.34	42.03	50.2	46.12	4.34	39.55	39.7	39.63	4.34	40.73	47.89	44.31	4.34	42.74	43.54	43.14
4.46	33.14	39.5	36.32	4.46	42.09	50.06	46.07	4.46	39.57	39.68	39.62	4.46	40.74	47.85	44.3	4.46	42.72	43.56	43.14
4.58	33.08	39.54	36.31	4.58	42.03	50.13	46.08	4.58	39.49	39.68	39.58	4.58	40.72	47.88	44.3	4.58	42.72	43.52	43.12
4.7	33.1	39.46	36.28	4.7	41.99	50.09	46.04	4.7	39.51	39.59	39.55	4.7	40.68	47.99	44.34	4.7	42.7	43.52	43.11
4.82	33.14	39.51	36.33	4.82	42.01	50.12	46.07	4.82	39.48	39.65	39.56	4.82	40.68	47.84	44.26	4.82	42.78	42.68	42.73
4.94	33.12	39.36	36.24	4.94	41.93	50.04	45.99	4.94	39.47	39.66	39.56	4.94	40.67	47.87	44.27	4.94	42.67	43.46	43.06
5.06	33.09	39.46	36.28	5.06	42.02	50.08	46.05	5.06	39.54	39.64	39.59	5.06	40.6	47.88	44.24	5.06	42.79	43.47	43.13
5.18	33	39.58	36.29	5.19	42.06	50.2	46.13	5.19	39.48	39.61	39.55	5.18	40.65	47.9	44.28	5.19	42.74	43.54	43.14
5.31	33.14	39.42	36.28	5.31	41.97	50	45.98	5.31	39.63	39.55	39.59	5.31	40.72	47.8	44.26	5.31	42.74	43.5	43.12
5.43	33.08	39.4	36.24	5.43	42.09	50.1	46.09	5.43	39.53	39.63	39.58	5.43	40.65	47.99	44.32	5.43	42.68	43.43	43.06
5.55	33.16	39.51	36.34	5.55	42.05	50.13	46.09	5.55	39.47	39.56	39.52	5.55	40.73	47.79	44.26	5.55	42.64	43.47	43.06
5.67	33.12	39.5	36.31	5.67	41.99	50.15	46.07	5.67	39.54	39.62	39.58	5.67	40.71	47.84	44.27	5.67	42.69	43.46	43.08
5.79	33.04	39.55	36.3	5.79	42.05	50.12	46.09	5.79	39.56	39.55	39.55	5.79	40.7	47.83	44.26	5.79	42.79	43.5	43.14
5.91	33.02	39.53	36.27	5.91	42	50.13	46.06	5.91	39.5	39.55	39.53	5.91	40.71	47.93	44.32	5.91	42.71	43.39	43.05
6.03	33.03	39.33	36.18	6.03	42.05	49.95	46	6.03	39.44	39.61	39.53	6.03	40.63	47.82	44.23	6.03	42.66	43.42	43.04
6.15	33.18	39.48	36.33	6.15	42.09	49.99	46.04	6.15	39.48	39.57	39.52	6.15	40.69	47.85	44.27	6.15	42.68	43.46	43.07
6.27	33.5	39.07	36.29	6.27	42.03	50.14	46.08	6.27	39.54	39.6	39.57	6.27	40.67	47.99	44.33	6.27	42.66	43.52	43.09
6.39	33.58	38.98	36.28	6.39	41.98	50.05	46.02	6.39	39.53	39.5	39.52	6.39	40.58	47.88	44.23	6.39	42.66	43.43	43.05
6.51	33.22	39.39	36.3	6.51	41.95	50.13	46.04	6.51	39.45	39.67	39.56	6.51	40.64	47.88	44.26	6.51	42.67	43.46	43.07
6.63	33.08	39.48	36.28	6.63	42.08	49.97	46.03	6.63	39.57	39.46	39.51	6.63	40.58	47.9	44.24	6.63	42.64	43.39	43.01
6.75	33.12	39.42	36.27	6.75	42.06	50.04	46.05	6.75	39.41	39.58	39.5	6.75	40.74	47.9	44.32	6.75	42.65	43.42	43.04
6.87	33.2	39.27	36.24	6.87	42.03	50.03	46.03	6.87	39.53	39.57	39.55	6.87	40.63	47.94	44.29	6.87	42.65	43.42	43.03
6.99	33.16	39.4	36.28	6.99	42.08	50.09	46.09	6.99	39.56	39.58	39.57	6.99	40.65	47.96	44.3	6.99	42.67	43.45	43.06
7.11	33.2	39.45	36.33	7.11	42.04	49.94	45.99	7.11	39.53	39.59	39.56	7.11	40.58	47.9	44.24	7.11	42.64	43.39	43.01
7.23	33.25	39.26	36.26	7.23	42.05	50.06	46.06	7.23	39.51	39.63	39.57	7.23	40.67	47.77	44.22	7.23	42.7	43.5	43.1
7.36	33.16	39.52	36.34	7.36	42	50.15	46.08	7.36	39.51	39.56	39.53	7.36	40.65	47.78	44.22	7.36	42.67	43.49	43.08
7.48	33.14	39.27	36.2	7.48	42.02	50.12	46.07	7.48	39.54	39.51	39.52	7.48	40.63	47.85	44.24	7.48	42.67	43.35	43.01
7.6	33.25	39.32	36.28	7.6	41.92	50.12	46.02	7.6	39.45	39.63	39.54	7.6	40.64	47.76	44.2	7.6	42.71	43.48	43.09
7.72	33.3	39.29	36.29	7.72	42.05	50.05	46.05	7.72	39.49	39.55	39.52	7.72	40.67	47.88	44.27	7.72	42.7	43.43	43.07
7.84	33.08	39.38	36.23	7.84	41.93	50.07	46	7.84	39.38	39.64	39.51	7.84	40.64	47.87	44.25	7.84	42.69	43.49	43.09

7.96	33.15	39.41	36.28	7.96	41.96	49.96	45.96	7.96	39.48	39.57	39.53	7.96	40.63	47.9	44.26	7.96	42.7	43.47	43.09
8.08	33.28	39.38	36.33	8.08	41.93	50	45.96	8.08	39.53	39.59	39.56	8.08	40.67	47.89	44.28	8.08	42.63	43.46	43.04
8.2	33.23	39.22	36.22	8.2	42.02	49.95	45.99	8.2	39.4	39.57	39.49	8.2	40.65	47.82	44.23	8.2	42.63	43.37	43
8.32	33.25	39.25	36.25	8.32	41.96	49.91	45.93	8.32	39.43	39.55	39.49	8.32	40.61	47.78	44.2	8.32	42.65	43.32	42.99
8.44	33.26	39.27	36.26	8.44	42.02	49.98	46	8.44	39.37	39.6	39.49	8.44	40.68	47.9	44.29	8.44	42.71	43.4	43.05
8.56	33.11	39.34	36.23	8.56	41.94	49.93	45.93	8.56	39.52	39.46	39.49	8.56	40.58	47.72	44.15	8.56	42.64	43.36	43
8.68	33.25	39.25	36.25	8.68	41.89	49.98	45.94	8.68	39.55	39.44	39.49	8.68	40.67	47.77	44.22	8.68	42.66	43.41	43.03
8.8	33.21	39.52	36.36	8.8	41.91	50.07	45.99	8.8	39.43	39.57	39.5	8.8	40.67	47.74	44.2	8.8	42.68	43.4	43.04
8.92	33.08	39.55	36.31	8.92	41.95	49.93	45.94	8.92	39.54	39.42	39.48	8.92	40.54	47.82	44.18	8.92	42.62	43.38	43
9.04	33.29	39.3	36.29	9.04	41.86	50.11	45.98	9.04	39.45	39.48	39.47	9.04	40.51	47.8	44.15	9.04	42.57	43.42	43
9.16	33.15	39.21	36.18	9.16	42.02	50.07	46.04	9.16	39.42	39.51	39.46	9.16	40.53	47.92	44.22	9.16	42.66	43.41	43.04
9.28	33.2	39.15	36.17	9.28	41.91	50.04	45.97	9.29	39.39	39.55	39.47	9.28	40.6	47.89	44.24	9.28	42.66	43.45	43.06
9.41	33.23	39.12	36.17	9.41	41.95	49.91	45.93	9.41	39.41	39.55	39.48	9.41	40.59	47.89	44.24	9.41	42.65	43.36	43
9.53	33.15	39.21	36.18	9.53	42	50.07	46.03	9.53	39.44	39.56	39.5	9.53	40.62	47.73	44.18	9.53	42.59	43.39	42.99
9.65	33.26	39.29	36.28	9.65	41.94	49.93	45.93	9.65	39.54	39.4	39.47	9.65	40.63	47.77	44.2	9.65	42.62	43.35	42.98
9.77	33.08	39.34	36.21	9.77	41.94	49.92	45.93	9.77	39.41	39.51	39.46	9.77	40.65	47.82	44.23	9.77	42.64	43.35	42.99
9.89	33.2	39.33	36.27	9.89	41.91	50.02	45.97	9.89	39.39	39.53	39.46	9.89	40.56	47.88	44.22	9.89	42.67	43.39	43.03
				10.01	41.97	49.98	45.98	10.01	43.83	41.56	42.69	10.01	40.67	47.72	44.19	10.01	40.4	41.97	41.18
			36.318				46.073				39.606				44.294				43.086
		STDEV:	0.0867			STDEV:	0.079			STDEV:	0.3464			STDEV:	0.0677			STDEV:	0.2297

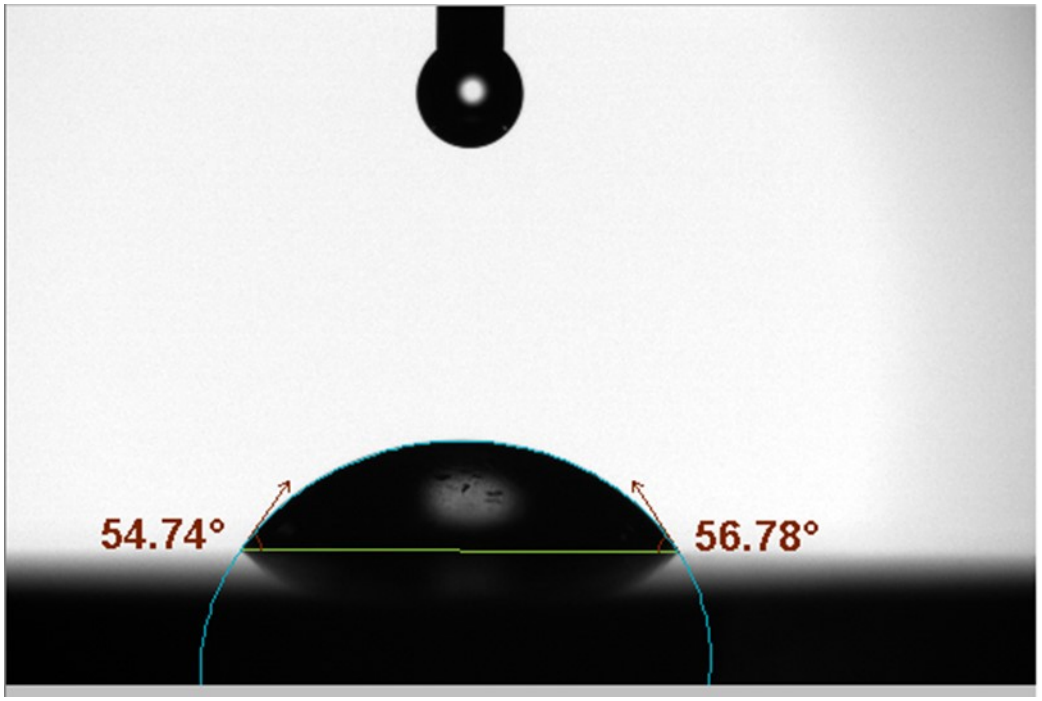

Figure 7.7: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.1 V potential under 1.4 x 10^{-4}M KEX

Table 7.9: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.1 V potential under 1.4 x 10^{-4}M KEX

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	54.74	56.78	55.76	0.00	53.13	57.13	55.13	0.00	47.36	53.31	50.33	0.00	43.67	49.24	46.46	0.00	45.75	49.78	47.77
0.12	54.78	56.79	55.78	0.12	53.16	57.16	55.16	0.12	47.34	53.39	50.36	0.12	43.75	49.46	46.61	0.12	45.69	49.83	47.76
0.24	54.83	56.86	55.84	0.24	53.27	57.04	55.16	0.24	47.11	53.54	50.32	0.24	43.76	49.26	46.51	0.24	45.71	49.79	47.75
0.36	54.83	56.88	55.85	0.36	53.22	57.13	55.17	0.36	47.33	53.34	50.34	0.36	43.62	49.39	46.5	0.36	45.62	49.81	47.72
0.48	54.85	56.85	55.85	0.48	53.16	57	55.08	0.48	47.23	53.35	50.29	0.48	43.69	49.26	46.48	0.48	45.68	49.83	47.76
0.6	54.77	56.82	55.79	0.6	53.18	57.08	55.13	0.6	47.31	53.15	50.23	0.6	43.59	49.25	46.42	0.6	45.71	49.8	47.75

0.72	54.88	56.81	55.84	0.72	53.14	57.01	55.08	0.72	47.1	53.23	50.17	0.72	43.6	49.29	46.45	0.72	45.72	49.8	47.76
0.84	54.8	56.84	55.82	0.84	53.18	57.08	55.13	0.84	47.09	53.34	50.22	0.84	43.68	49.31	46.5	0.84	45.7	49.72	47.71
0.96	54.76	56.93	55.85	0.96	53.09	56.98	55.03	0.96	47.13	53.26	50.2	0.96	43.64	49.38	46.51	0.96	45.72	49.75	47.73
1.09	54.9	56.95	55.93	1.09	53.05	56.97	55.01	1.09	47.03	53.43	50.23	1.09	43.68	49.27	46.47	1.09	45.76	49.84	47.8
1.21	54.89	56.87	55.88	1.21	53.16	56.97	55.06	1.21	47.11	53.18	50.15	1.21	43.66	49.22	46.44	1.21	45.72	49.78	47.75
1.33	54.91	56.92	55.92	1.33	53.15	57.06	55.1	1.33	47.22	53.22	50.22	1.33	43.7	49.23	46.46	1.33	45.75	49.77	47.76
1.45	54.86	56.84	55.85	1.45	53.16	56.98	55.07	1.45	47.23	53.16	50.2	1.45	43.62	49.27	46.45	1.45	45.73	49.82	47.77
1.57	54.85	56.87	55.86	1.57	53.07	57.03	55.05	1.57	47.07	53.39	50.23	1.57	43.62	49.24	46.43	1.57	45.68	49.83	47.75
1.69	54.69	56.77	55.73	1.69	53.08	56.89	54.99	1.69	47.19	53.27	50.23	1.69	43.69	49.16	46.43	1.69	45.62	49.77	47.7
1.81	54.69	56.89	55.79	1.81	53.05	57.03	55.04	1.81	47.19	53.26	50.23	1.81	43.66	49.36	46.51	1.81	45.69	49.67	47.68
1.93	54.81	56.93	55.87	1.93	53.13	56.95	55.04	1.93	47.21	53.2	50.21	1.93	43.66	49.3	46.48	1.93	45.74	49.7	47.72
2.05	54.78	56.89	55.84	2.05	53	56.96	54.98	2.05	47.16	53.14	50.15	2.05	43.59	49.31	46.45	2.05	45.55	49.66	47.61
2.17	54.78	56.92	55.85	2.17	53.14	56.91	55.02	2.17	47.09	53.32	50.2	2.17	43.63	49.09	46.36	2.17	45.72	49.76	47.74
2.29	54.67	56.74	55.71	2.29	53.06	56.91	54.99	2.29	47.2	53.21	50.2	2.29	43.59	49.3	46.44	2.29	45.7	49.72	47.71
2.41	54.85	56.72	55.79	2.41	53.08	57	55.04	2.41	47.11	53.39	50.25	2.41	43.65	49.17	46.41	2.41	45.62	49.71	47.67
2.53	54.78	56.88	55.83	2.53	53.11	56.96	55.03	2.53	47.14	53.29	50.21	2.53	43.51	49.1	46.31	2.53	45.63	49.62	47.63
2.65	54.82	56.82	55.82	2.65	53.02	56.83	54.93	2.65	47.14	53.18	50.16	2.65	43.63	49.24	46.43	2.65	45.68	49.73	47.71
2.77	54.72	56.81	55.77	2.77	52.99	56.84	54.91	2.77	47.18	53.17	50.17	2.77	43.61	49.15	46.38	2.77	45.55	49.72	47.64
2.89	54.78	56.82	55.8	2.89	52.97	56.81	54.89	2.89	47.18	53.22	50.2	2.89	43.59	49.21	46.4	2.89	45.67	49.72	47.7
3.01	54.76	56.78	55.77	3.01	53.06	56.85	54.96	3.01	47.04	53.18	50.11	3.01	43.64	49.28	46.46	3.01	45.68	49.79	47.74
3.14	54.79	56.78	55.79	3.14	52.99	56.98	54.99	3.14	47.16	53.11	50.14	3.14	43.58	49.27	46.42	3.14	45.66	49.72	47.69
3.26	54.76	56.8	55.78	3.26	53.08	56.83	54.96	3.26	47.01	53.29	50.15	3.26	43.55	49.16	46.35	3.26	45.59	49.72	47.65
3.38	54.67	56.73	55.7	3.38	53.07	56.87	54.97	3.38	47.02	53.31	50.17	3.38	43.59	49.24	46.42	3.38	45.66	49.75	47.71
3.5	54.77	56.73	55.75	3.5	52.99	56.94	54.97	3.5	47.09	53.28	50.18	3.5	43.58	49.2	46.39	3.5	45.69	49.67	47.68
3.62	54.71	56.73	55.72	3.62	53.03	56.9	54.97	3.62	47.22	53.08	50.15	3.62	43.72	49.21	46.46	3.62	45.72	49.62	47.67
3.74	54.67	56.8	55.74	3.74	52.97	56.85	54.91	3.74	47.09	53.25	50.17	3.74	43.55	49.27	46.41	3.74	45.62	49.68	47.65
3.86	54.67	56.81	55.74	3.86	53.04	56.84	54.94	3.86	46.98	53.27	50.13	3.86	43.55	49.21	46.38	3.86	45.56	49.66	47.61
3.98	54.73	56.73	55.73	3.98	52.42	52.46	52.44	3.98	47.08	53.29	50.18	3.98	43.66	49.19	46.43	3.98	45.61	49.57	47.59
4.1	54.78	56.77	55.78	4.1	53.07	56.8	54.93	4.1	47.08	53.14	50.11	4.1	43.58	49.21	46.4	4.1	45.55	49.71	47.63
4.22	54.73	56.86	55.79	4.22	53.02	56.83	54.93	4.22	47.24	53.12	50.18	4.22	43.5	49.14	46.32	4.22	45.63	49.76	47.69

4.34	54.7	56.74	55.72	4.34	52.93	56.84	54.89	4.34	46.94	53.17	50.05	4.34	43.6	49.19	46.4	4.34	45.52	49.59	47.56
4.46	54.65	56.73	55.69	4.46	53	56.78	54.89	4.46	47.18	53.08	50.13	4.46	43.54	49.13	46.33	4.46	45.53	49.65	47.59
4.58	54.66	56.75	55.7	4.58	52.94	56.89	54.92	4.58	47.23	53.17	50.2	4.58	43.58	49.14	46.36	4.58	45.55	49.52	47.53
4.7	54.7	56.78	55.74	4.7	52.94	56.81	54.88	4.7	47.06	53.07	50.06	4.7	43.5	49.05	46.28	4.7	45.57	49.63	47.6
4.82	54.74	56.67	55.71	4.82	52.99	56.79	54.89	4.82	47.03	53.2	50.12	4.82	43.51	49.21	46.36	4.82	45.56	49.57	47.56
4.94	54.74	56.76	55.75	4.94	53	56.87	54.93	4.94	47.15	53.09	50.12	4.94	43.6	49.02	46.31	4.94	45.51	49.53	47.52
5.06	54.61	56.68	55.64	5.06	52.93	56.79	54.86	5.06	47.2	53.18	50.19	5.06	43.49	49.1	46.3	5.06	45.54	49.72	47.63
5.19	54.68	56.74	55.71	5.18	53	56.81	54.9	5.18	47.06	53.2	50.13	5.19	43.58	49.13	46.36	5.19	45.63	49.57	47.6
5.31	54.74	56.82	55.78	5.31	52.92	56.76	54.84	5.31	47.04	53.08	50.06	5.31	43.61	49.13	46.37	5.31	45.5	49.53	47.51
5.43	54.68	56.75	55.71	5.43	52.88	56.76	54.82	5.43	47	53.14	50.07	5.43	43.47	49.13	46.3	5.43	45.49	49.6	47.54
5.55	54.68	56.8	55.74	5.55	52.95	56.72	54.83	5.55	47.1	53.02	50.06	5.55	43.48	49.1	46.29	5.55	45.53	49.56	47.55
5.67	54.7	56.79	55.75	5.67	52.91	56.85	54.88	5.67	47.16	53.04	50.1	5.67	43.43	49.17	46.3	5.67	45.59	49.59	47.59
5.79	54.67	56.69	55.68	5.79	52.95	56.73	54.84	5.79	47.04	53.03	50.03	5.79	43.55	48.98	46.26	5.79	45.55	49.49	47.52
5.91	54.71	56.65	55.68	5.91	52.87	56.7	54.79	5.91	47.06	53.14	50.1	5.91	43.54	49.15	46.34	5.91	45.54	49.59	47.57
6.03	54.63	56.78	55.7	6.03	52.97	56.81	54.89	6.03	46.98	53.18	50.08	6.03	43.51	49.16	46.33	6.03	45.51	49.49	47.5
6.15	54.65	56.79	55.72	6.15	52.94	56.84	54.89	6.15	47.2	53.15	50.17	6.15	43.55	49.07	46.31	6.15	45.54	49.53	47.53
6.27	54.69	56.63	55.66	6.27	52.91	56.8	54.86	6.27	47.1	53.25	50.18	6.27	43.45	49.07	46.26	6.27	45.55	49.51	47.53
6.39	54.66	56.75	55.71	6.39	52.88	56.67	54.77	6.39	46.99	53.14	50.06	6.39	43.46	48.98	46.22	6.39	45.52	49.61	47.57
6.51	54.71	56.68	55.7	6.51	52.88	56.79	54.84	6.51	46.92	53.21	50.06	6.51	43.74	49.07	46.4	6.51	45.46	49.52	47.49
6.63	54.63	56.7	55.66	6.63	52.92	56.83	54.88	6.63	47.23	53.07	50.15	6.63	43.43	49.12	46.28	6.63	45.45	49.53	47.49
6.75	54.72	56.7	55.71	6.75	52.94	56.64	54.79	6.75	46.98	53.17	50.08	6.75	43.47	49.03	46.25	6.75	45.47	49.58	47.53
6.87	54.6	56.71	55.65	6.87	52.85	56.77	54.81	6.87	47.09	53.02	50.06	6.87	43.61	49.12	46.37	6.87	45.5	49.58	47.54
6.99	54.6	56.66	55.63	6.99	52.95	56.66	54.81	6.99	47.04	53.16	50.1	6.99	43.46	49.14	46.3	6.99	45.43	49.51	47.47
7.11	54.62	56.71	55.67	7.11	52.86	56.68	54.77	7.11	47.01	53.16	50.08	7.11	43.47	49.18	46.32	7.11	45.4	49.49	47.45
7.23	54.66	56.61	55.64	7.23	52.92	56.65	54.79	7.23	47.16	52.99	50.08	7.23	43.44	49.1	46.27	7.23	45.44	49.48	47.46
7.36	54.55	56.67	55.61	7.36	52.9	56.65	54.78	7.36	47.03	53.17	50.1	7.36	43.47	49.07	46.27	7.36	45.42	49.54	47.48
7.48	54.62	56.73	55.67	7.48	52.81	56.69	54.75	7.48	46.97	53.01	49.99	7.48	43.46	49.18	46.32	7.48	45.49	49.39	47.44
7.6	54.75	56.74	55.75	7.6	52.86	56.78	54.82	7.6	47.02	53.2	50.11	7.6	43.42	49.11	46.26	7.6	45.38	49.47	47.43
7.72	54.61	56.7	55.65	7.72	52.88	56.68	54.78	7.72	47.16	53.05	50.11	7.72	43.54	49.1	46.32	7.72	45.37	49.56	47.46
7.84	54.6	56.61	55.6	7.84	52.79	56.68	54.73	7.84	46.96	53.18	50.07	7.84	43.42	49	46.21	7.84	45.5	49.34	47.42

7.96	54.65	56.72	55.68	7.96	52.79	56.67	54.73	7.96	46.98	53.19	50.08	7.96	43.43	49.06	46.25	7.96	45.43	49.54	47.49
8.08	54.64	56.65	55.65	8.08	52.84	56.7	54.77	8.08	47.08	52.96	50.02	8.08	43.4	48.94	46.17	8.08	45.4	49.39	47.4
8.2	54.66	56.54	55.6	8.2	52.8	56.74	54.77	8.2	46.98	53.03	50.01	8.2	43.47	48.98	46.23	8.2	45.39	49.55	47.47
8.32	54.56	56.6	55.58	8.32	52.85	56.65	54.75	8.32	47.12	53.02	50.07	8.32	43.34	48.97	46.16	8.32	45.46	49.42	47.44
8.44	54.56	56.65	55.61	8.44	52.82	56.65	54.74	8.44	46.85	53.08	49.97	8.44	43.56	49.02	46.29	8.44	45.32	49.51	47.41
8.56	54.64	56.68	55.66	8.56	52.87	56.54	54.71	8.56	47.14	53.04	50.09	8.56	43.45	49.08	46.27	8.56	45.39	49.5	47.44
8.68	54.56	56.68	55.62	8.68	52.78	56.68	54.73	8.68	47.04	53.09	50.07	8.68	43.39	49.07	46.23	8.68	45.5	49.47	47.48
8.8	54.6	56.65	55.62	8.8	52.8	56.63	54.71	8.8	47.02	53.05	50.03	8.8	43.52	48.93	46.22	8.8	45.36	49.5	47.43
8.92	54.61	56.64	55.62	8.92	52.82	56.68	54.75	8.92	47.01	53.14	50.07	8.92	43.41	48.92	46.16	8.92	45.41	49.49	47.45
9.04	54.54	56.7	55.62	9.04	52.69	56.67	54.68	9.04	47.04	52.97	50	9.04	43.38	48.93	46.16	9.04	45.38	49.47	47.42
9.16	54.57	56.59	55.58	9.16	52.79	56.58	54.69	9.16	47.01	53.07	50.04	9.16	43.41	49.12	46.26	9.16	45.42	49.42	47.42
9.28	54.52	56.67	55.6	9.28	52.83	56.56	54.69	9.28	46.88	53.2	50.04	9.28	43.36	49.05	46.21	9.28	45.43	49.54	47.48
9.41	54.55	56.58	55.57	9.41	52.77	56.56	54.66	9.41	47.02	53.07	50.04	9.41	43.45	48.99	46.22	9.41	45.42	49.51	47.46
9.53	54.56	56.68	55.62	9.53	52.69	56.46	54.58	9.53	47.04	53.15	50.09	9.53	43.51	48.95	46.23	9.53	45.37	49.47	47.42
9.65	54.6	56.66	55.63	9.65	52.79	56.56	54.68	9.65	46.89	53.11	50	9.65	43.52	49.14	46.33	9.65	45.41	49.47	47.44
9.77	54.51	56.55	55.53	9.77	52.72	56.53	54.62	9.77	46.92	53.08	50	9.77	43.51	49.04	46.28	9.77	45.49	49.41	47.45
9.89	54.51	56.65	55.58	9.89	52.77	56.61	54.69	9.89	46.98	53.08	50.03	9.89	43.38	48.96	46.17	9.89	45.35	49.41	47.38
10.01	54.47	56.55	55.51					10.01	46.95	52.98	49.97	10.01	43.3	49.07	46.19	10.01	65.16	66.26	65.71
			55.72				54.859				50.13				46.345				47.8
		STDEV:	0.0928			STDEV:	0.3032			STDEV:	0.0867			STDEV:	0.1005			STDEV:	1.9813

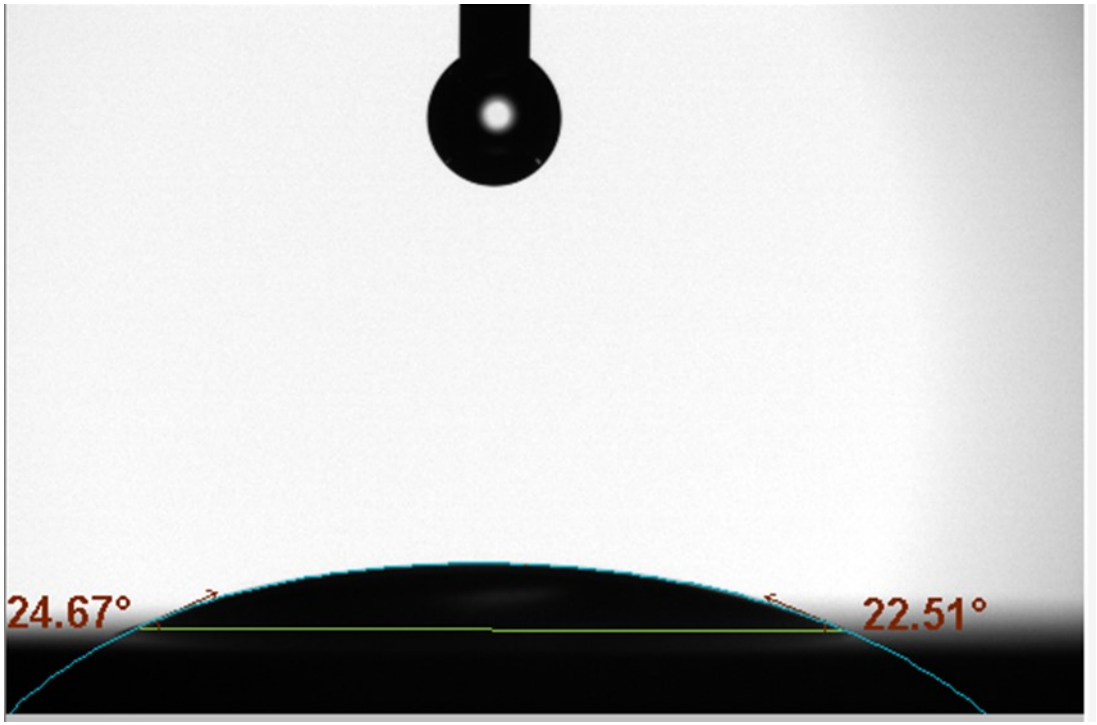

Figure 7.8: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.2 V potential under 1.4 x 10^{-4}M KEX

Table 7.10: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.2 V potential under 1.4 x 10^{-4}M KEX

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	16.84	22.17	19.51	0.00	30.33	27.13	28.73	0.00	29.38	23.53	26.46	0.00	25.93	20.64	23.29	0.00	24.67	22.51	23.59
0.12	16.76	22.03	19.39	0.12	30.38	26.94	28.66	0.12	29.46	23.52	26.49	0.12	27.02	21.56	24.29	0.12	24.7	22.53	23.62
0.24	16.64	22.01	19.32	0.24	30.39	27.03	28.71	0.24	29.51	23.5	26.51	0.24				0.24	24.58	22.44	23.51
0.36	16.82	22.08	19.45	0.36	30.39	26.86	28.62	0.36	29.51	23.48	26.5	0.36	25.97	20.62	23.3	0.36	24.52	22.53	23.53
0.48	16.75	22.05	19.4	0.48	30.34	26.76	28.55	0.48	29.39	23.42	26.41	0.48	25.92	20.48	23.2	0.48	24.7	22.44	23.57

0.6	16.84	22.16	19.5	0.6	30.35	27.09	28.72	0.6	29.37	23.55	26.46	0.6	26.01	20.62	23.31	0.6	24.77	22.41	23.59
0.72	16.77	22.07	19.42	0.72	30.37	27.14	28.75	0.72	29.32	23.54	26.43	0.72	26.75	21.51	24.13	0.72	24.73	22.45	23.59
0.84	16.75	22.09	19.42	0.84	30.49	27.06	28.77	0.84	29.5	23.52	26.51	0.84	25.89	20.55	23.22	0.84	24.52	22.42	23.47
0.96	16.86	22.13	19.5	0.96	30.26	26.9	28.58	0.96	29.48	23.37	26.42	0.96	27.12	22.5	24.81	0.96	24.49	22.44	23.46
1.09	16.74	22.1	19.42	1.09	30.48	27.2	28.84	1.09	29.53	23.44	26.49	1.09	25.87	20.49	23.18	1.09	24.62	22.6	23.61
1.21	16.77	21.99	19.38	1.21	30.24	27	28.62	1.21	29.42	23.37	26.4	1.21	25.84	20.52	23.18	1.21	24.71	22.42	23.57
1.33	16.77	22.02	19.39	1.33	30.36	27.08	28.72	1.33	29.59	23.54	26.56	1.33	25.83	20.55	23.19	1.33	24.61	22.49	23.55
1.45	16.73	22.11	19.42	1.45	30.42	26.97	28.69	1.45	29.48	23.53	26.51	1.45	25.91	20.59	23.25	1.45	24.79	22.56	23.68
1.57	16.74	22.06	19.4	1.57	30.33	27.05	28.69	1.57	29.58	23.55	26.56	1.57	25.9	20.53	23.22	1.57	24.5	22.43	23.47
1.69	16.74	22.15	19.45	1.69	20	23.14	21.57	1.69	29.24	23.5	26.37	1.69	26.58	22.04	24.31	1.69	24.74	22.58	23.66
1.81	16.75	22.12	19.43	1.81	30.36	26.98	28.67	1.81	29.19	23.47	26.33	1.81	25.93	20.51	23.22	1.81	24.62	22.44	23.53
1.93	16.67	22.09	19.38	1.93	30.32	26.99	28.66	1.93	29.51	23.52	26.52	1.93	25.95	20.57	23.26	1.93	24.66	22.46	23.56
2.05	16.87	22.25	19.56	2.05	30.38	27.09	28.74	2.05	29.42	23.41	26.41	2.05	25.77	20.58	23.17	2.05	24.68	22.53	23.6
2.17	16.76	22.06	19.41	2.17	30.37	26.9	28.64	2.17	29.44	23.46	26.45	2.17	26.78	21.46	24.12	2.17	24.57	22.44	23.5
2.29	16.68	22	19.34	2.29	30.21	26.7	28.45	2.29	29.28	23.38	26.33	2.29				2.29	24.59	22.47	23.53
2.41	16.74	22.05	19.4	2.41	30.24	26.9	28.57	2.41	29.47	23.49	26.48	2.41	27.08	21.87	24.47	2.41	24.52	22.45	23.48
2.53	16.71	22.02	19.36	2.53	30.27	26.93	28.6	2.53	29.64	23.37	26.51	2.53	25.14	125.68	75.41	2.53	24.46	22.33	23.39
2.65	16.7	22.01	19.36	2.65	30.35	26.98	28.67	2.65	29.44	23.37	26.4	2.65	26.86	21.45	24.16	2.65	24.43	22.33	23.38
2.77	16.71	22.14	19.43	2.77	30.24	26.98	28.61	2.77	29.46	23.44	26.45	2.77	26.72	21.88	24.3	2.77	24.64	22.43	23.54
2.89	16.73	21.99	19.36	2.89	29.72	28.04	28.88	2.89	29.34	23.49	26.42	2.89	25.86	20.49	23.18	2.89	24.78	22.58	23.68
3.01	16.85	22.22	19.53	3.01	29.61	27.75	28.68	3.01	29.32	23.46	26.39	3.01	25.85	20.41	23.13	3.01	24.61	22.5	23.56
3.14	16.73	22.09	19.41	3.14	30.28	26.84	28.56	3.14	29.4	23.61	26.5	3.13	26.88	21.52	24.2	3.14	24.44	22.29	23.36
3.26	16.73	22.03	19.38	3.26	29.97	28.46	29.22	3.26	29.33	23.42	26.37	3.26	22.81	18.33	20.57	3.26	24.72	22.35	23.54
3.38	16.65	21.96	19.31	3.38	30.3	27.05	28.67	3.38	29.39	23.43	26.41	3.38	25.83	20.47	23.15	3.38	24.65	22.6	23.63
3.5	16.69	22.04	19.36	3.5	30.24	27.05	28.65	3.5	29.27	23.49	26.38	3.5				3.5	24.73	22.57	23.65
3.62	16.64	22.02	19.33	3.62	30.19	26.99	28.59	3.62	29.15	23.46	26.31	3.62	25.86	20.51	23.18	3.62	24.51	22.49	23.5
3.74	16.71	22	19.35	3.74	30.32	26.97	28.65	3.74	29.22	23.36	26.29	3.74	26.9	21.41	24.15	3.74	24.63	22.45	23.54
3.86	16.74	22.11	19.42	3.86				3.86	29.48	23.47	26.47	3.86	25.82	20.52	23.17	3.86	24.62	22.46	23.54
3.98	16.69	22.01	19.35	3.98				3.98	29.54	23.52	26.53	3.98				3.98	18.5	19.05	18.78
4.1	16.67	21.98	19.33	4.1	30.34	27.03	28.68	4.1	29.36	23.48	26.42	4.1	25.79	20.53	23.16	4.1	24.49	22.45	23.47

4.22	16.77	22.1	19.43	4.22				4.22	29.34	23.38	26.36	4.22	24.37	19.57	21.97	4.22	24.59	22.31	23.45
4.34	16.69	22.09	19.39	4.34	30.48	26.93	28.71	4.34	29.57	23.37	26.47	4.34				4.34	24.68	22.33	23.51
4.46	16.68	21.98	19.33	4.46	30.21	26.91	28.56	4.46	29.52	23.51	26.52	4.46	25.83	20.47	23.15	4.46	24.57	22.45	23.51
4.58	16.74	21.96	19.35	4.58	30.28	26.87	28.58	4.58	29.36	23.38	26.37	4.58	26.79	21.53	24.16	4.58	24.46	22.48	23.47
4.7	16.74	22.04	19.39	4.7	30.41	26.92	28.67	4.7	29.43	23.51	26.47	4.7				4.7	24.6	22.3	23.45
4.82	16.7	22.06	19.38	4.82	30.38	26.87	28.63	4.82	29.24	23.54	26.39	4.82	25.1	19.32	22.21	4.82	24.63	22.46	23.55
4.94	16.66	21.96	19.31	4.94	30.13	27.13	28.63	4.94	29.26	23.5	26.38	4.94	26.55	21.92	24.23	4.94	24.59	22.43	23.51
5.06	16.71	21.95	19.33	5.06	30.36	26.93	28.65	5.06	29.41	23.24	26.32	5.06	26.8	21.35	24.08	5.06	24.41	22.3	23.35
5.19	16.7	22.05	19.38	5.19				5.18	29.41	23.48	26.44	5.18	25.83	20.49	23.16	5.19	24.5	22.43	23.46
5.31	16.63	22.08	19.35	5.31	30.24	26.93	28.59	5.31	29.37	23.35	26.36	5.31	25.87	20.54	23.2	5.31	24.55	22.29	23.42
5.43	16.65	21.97	19.31	5.43	30.19	26.8	28.5	5.43	29.18	23.34	26.26	5.43	25.81	20.42	23.11	5.43	24.41	22.3	23.35
5.55	16.71	22.05	19.38	5.55	29.41	27.74	28.58	5.55	29.16	23.34	26.25	5.55	25.85	20.54	23.19	5.55	24.48	22.4	23.44
5.67	16.74	22.03	19.38	5.67	30.13	26.98	28.56	5.67	29.24	23.48	26.36	5.67	25.77	20.46	23.12	5.67	24.44	22.3	23.37
5.79				5.79	30.24	26.91	28.58	5.79	29.47	23.21	26.34	5.79	26.76	21.5	24.13	5.79	24.62	22.38	23.5
5.91				5.91	30.29	26.67	28.48	5.91	29.21	23.5	26.35	5.91	26.81	21.5	24.16	5.91	24.5	22.47	23.48
6.03	16.7	21.92	19.31	6.03	30.25	26.92	28.58	6.03	29.21	23.51	26.36	6.03				6.03	24.49	22.32	23.4
6.15	16.68	22	19.34	6.15	30.36	26.91	28.63	6.15	29.41	23.49	26.45	6.15				6.15	24.59	22.33	23.46
6.27	16.68	21.98	19.33	6.27	30.3	26.99	28.64	6.27	29.46	23.53	26.5	6.27	25.65	20.55	23.1	6.27	24.59	22.31	23.45
6.39	18.26	22.27	20.26	6.39	29.79	27.4	28.59	6.39	29.41	23.53	26.47	6.39	25.86	20.38	23.12	6.39	24.34	22.39	23.37
6.51	16.76	22.01	19.38	6.51	29.46	27.64	28.55	6.51	29.26	23.52	26.39	6.51	26.64	21.44	24.04	6.51	24.5	22.41	23.45
6.63	16.66	21.95	19.31	6.63				6.63	29.39	23.37	26.38	6.63	25.74	20.48	23.11	6.63	24.47	22.34	23.4
6.75	16.71	21.93	19.32	6.75	30.18	26.82	28.5	6.75	29.39	23.34	26.36	6.75	25.77	20.49	23.13	6.75	24.44	22.31	23.37
6.87	16.63	21.89	19.26	6.87	30.2	26.86	28.53	6.87	29.26	23.35	26.3	6.87	25.75	20.45	23.1	6.87	24.49	22.37	23.43
6.99	16.68	21.96	19.32	6.99	30.2	26.9	28.55	6.99	29.25	23.49	26.37	6.99	25.77	20.4	23.09	6.99	24.67	22.46	23.57
7.11	16.67	21.94	19.31	7.11	30.13	26.71	28.42	7.11	29.26	23.37	26.32	7.11	23.72	18.51	21.11	7.11	24.59	22.38	23.48
7.23	16.72	21.99	19.35	7.24	30.32	26.86	28.59	7.23	29.32	23.36	26.34	7.23	27.22	21.04	24.13	7.23	24.51	22.4	23.46
7.36	16.71	21.97	19.34	7.36	30.15	26.71	28.43	7.36	29.3	23.33	26.32	7.36	27.02	20.94	23.98	7.36	24.53	22.44	23.48
7.48	16.7	22.04	19.37	7.48	30.25	26.9	28.58	7.48	29.44	23.37	26.41	7.48	25.71	20.52	23.11	7.48	24.6	22.33	23.46
7.6	16.68	21.92	19.3	7.6	30.15	26.93	28.54	7.6	29.23	23.48	26.35	7.6	25.83	20.5	23.16	7.6	24.63	22.47	23.55
7.72	16.76	22.09	19.43	7.72	30.32	26.77	28.54	7.72	29.28	23.31	26.3	7.72	25.87	20.56	23.22	7.72	24.4	22.27	23.33

7.84	16.74	21.95	19.35	7.84	30.08	26.71	28.39	7.84	29.31	23.33	26.32	7.84	26.54	21.38	23.96	7.84	24.59	22.28	23.43
7.96	16.66	21.89	19.28	7.96	30.16	26.98	28.57	7.96	29.42	23.31	26.36	7.96	25.71	20.43	23.07	7.96	24.46	22.47	23.47
8.08	16.68	21.97	19.32	8.08	30.27	26.98	28.62	8.08	29.28	23.34	26.31	8.08	26.63	21.33	23.98	8.08	24.32	22.09	23.21
8.2	16.63	21.82	19.23	8.2	24.02	22.21	23.12	8.2	29.49	23.37	26.43	8.2	26.41	21.94	24.18	8.2	24.47	22.45	23.46
8.32	16.71	21.92	19.31	8.32	30.23	26.93	28.58	8.32	29.36	23.31	26.34	8.32	26.68	21.29	23.98	8.32	24.47	22.43	23.45
8.44				8.44	30.35	27.03	28.69	8.44	29.35	23.4	26.37	8.44	25.88	20.46	23.17	8.44	24.65	22.46	23.56
8.56	16.73	21.99	19.36	8.56	30.29	26.87	28.58	8.56	29.25	23.3	26.27	8.56	26.65	21.35	24	8.56	24.49	22.28	23.38
8.68	16.59	21.85	19.22	8.68	30.28	26.91	28.6	8.68	29.31	23.47	26.39	8.68	26.62	21.39	24	8.68	24.51	22.47	23.49
8.8	16.72	21.98	19.35	8.8	30.23	26.85	28.54	8.8	29.34	23.31	26.32	8.8	26.65	21.46	24.06	8.8	24.55	22.31	23.43
8.92	16.65	21.85	19.25	8.92	30.2	26.79	28.5	8.92	29.24	23.35	26.3	8.92	25.75	20.42	23.08	8.92	24.4	22.46	23.43
9.04	16.65	21.96	19.31	9.04				9.04	29.45	23.32	26.38	9.04	26.65	21.45	24.05	9.04	24.4	22.3	23.35
9.16	16.59	21.89	19.24	9.16				9.16	29.23	23.33	26.28	9.16	26.71	21.3	24.01	9.16	24.52	22.46	23.49
9.28				9.28	30.26	26.9	28.58	9.28	29.22	23.38	26.3	9.28	26.67	21.41	24.04	9.28	24.46	22.35	23.4
9.41	16.53	21.82	19.18	9.41	30.21	26.88	28.55	9.41	29.49	23.32	26.41	9.41	25.45	20.13	22.79	9.41	24.4	22.26	23.33
9.53	16.64	21.9	19.27	9.53	30.26	26.89	28.58	9.53	29.44	23.3	26.37	9.53				9.53	24.66	22.24	23.45
9.65	16.63	21.83	19.23	9.65	28.24	25.37	26.81	9.65	29.27	23.47	26.37	9.65	26.73	21.33	24.03	9.65	24.46	22.43	23.45
9.77	16.63	21.86	19.24	9.77	30.07	26.82	28.44	9.77	29.2	23.35	26.27	9.77				9.77	24.38	22.35	23.36
9.89	16.61	21.87	19.24	9.89	30	26.72	28.36	9.89	29.22	23.49	26.35	9.89	25.77	20.32	23.05	9.89	24.66	22.23	23.44
10.01	64.36	66.6	65.48	10.01	30.31	26.85	28.58	10.01	64.59	65.96	65.27	10.01				10.01	64.94	64.45	64.69
			19.946				28.427				26.859				24.173				23.916
		STDEV:	5.1568			STDEV:	1.0348			STDEV:	4.2422			STDEV:	6.121			STDEV:	4.5323

Table 7.11: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.3 V potential under 1.4 x 10^{-4}M KEX

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0.00	21.32	23.89	22.61	0.00	26.45	20.24	23.35	0.00	26.15	32.40	29.27	0.00	26.70	19.94	23.32	0.00	22.33	18.73	20.53
0.12	21.27	23.79	22.53	0.12	26.24	20.15	23.2	0.12	26.15	32.34	29.24	0.12	26.72	20.15	23.43	0.12	22.32	18.75	20.53
0.24	21.15	23.68	22.41	0.24	26.4	20.21	23.3	0.24	26.22	32.52	29.37	0.24	26.82	20.08	23.45	0.24	22.34	18.85	20.6
0.36	21.21	23.79	22.5	0.36	26.47	20.21	23.34	0.36	26.16	32.21	29.18	0.36	26.75	20.03	23.39	0.36	22.37	18.74	20.55
0.48	21.29	23.81	22.55	0.48	26.34	20.17	23.25	0.48	26.32	32.24	29.28	0.48	26.79	20.04	23.41	0.48	22.39	18.83	20.61
0.6	21.31	23.9	22.6	0.6	26.35	20.22	23.28	0.6	26.16	32.33	29.25	0.6	26.8	20	23.4	0.6	22.22	18.57	20.39
0.72	21.31	23.8	22.55	0.72	26.43	20.2	23.31	0.72	26.27	32.42	29.34	0.72	26.79	20.27	23.53	0.72	22.4	18.71	20.55
0.84	21.25	23.77	22.51	0.84	26.29	20.18	23.24	0.84	26.19	32.24	29.21	0.84	26.65	20.02	23.33	0.84	22.27	18.6	20.44
0.96	21.13	23.65	22.39	0.96	26.24	20.15	23.2	0.96	26.2	32.39	29.3	0.96	26.75	20.06	23.41	0.96	22.3	18.61	20.46
1.09	21.24	23.71	22.47	1.09	26.32	20.16	23.24	1.09	26.34	32.24	29.29	1.09	26.78	20.03	23.41	1.09	22.37	18.6	20.48
1.21	21.26	23.81	22.53	1.21	26.47	20.21	23.34	1.21	26.07	32.43	29.25	1.21	26.56	20.01	23.29	1.21	22.32	18.58	20.45
1.33	21.28	23.72	22.5	1.33	26.38	20.13	23.25	1.33	26.3	32.44	29.37	1.33	26.66	19.92	23.29	1.33	22.28	18.67	20.48
1.45	21.34	23.73	22.54	1.45	26.28	20.16	23.22	1.45	26.2	32.35	29.27	1.45	26.62	19.94	23.28	1.45	22.21	18.64	20.43
1.57	21.27	23.77	22.52	1.57	26.26	20.21	23.24	1.57	26.11	32.35	29.23	1.57	26.65	20.07	23.36	1.57	22.28	18.64	20.46
1.69	21.16	23.72	22.44	1.69	26.35	20.05	23.2	1.69	26.19	32.42	29.31	1.69	26.64	19.87	23.26	1.69	22.28	18.66	20.47
1.81	21.48	23.66	22.57	1.81	26.33	20.17	23.25	1.81	26.17	32.37	29.27	1.81	26.76	19.98	23.37	1.81	22.38	18.72	20.55
1.93	21.11	23.64	22.37	1.93	26.25	20.06	23.16	1.93	26.12	32.2	29.16	1.93	26.64	19.94	23.29	1.93	22.1	18.66	20.38
2.05	21.14	23.73	22.43	2.05	26.26	20.17	23.21	2.05	26.08	32.21	29.15	2.05	26.75	19.96	23.36	2.05	22.2	18.63	20.42
2.17	21.24	23.73	22.49	2.17	26.24	20.16	23.2	2.17	26.19	32.31	29.25	2.17	26.63	20.01	23.32	2.17	22.14	18.63	20.39
2.29	21.16	23.66	22.41	2.29	26.31	20.16	23.24	2.29	26.09	32.46	29.27	2.29	26.51	19.91	23.21	2.29	22.23	18.69	20.46
2.41	21.09	23.7	22.39	2.41	26.19	20.12	23.16	2.41	26.16	32.4	29.28	2.41	26.69	19.88	23.29	2.41	22.27	18.66	20.46
2.53	21.12	23.67	22.4	2.53	26.3	20.03	23.16	2.53	26.3	32.35	29.32	2.53	26.7	20.02	23.36	2.53	22.23	18.62	20.43
2.65	21.1	23.77	22.44	2.65	26.23	20.14	23.18	2.65	26.16	32.34	29.25	2.65	26.74	19.95	23.35	2.65	22.14	18.59	20.37
2.77	21.11	23.59	22.35	2.77	26.21	20.04	23.13	2.77	26.03	32.17	29.1	2.77	26.71	20.07	23.39	2.77	22.3	18.68	20.49
2.89	21.2	23.76	22.48	2.89	26.23	20.16	23.19	2.89	26.04	32.18	29.11	2.89	26.62	20.02	23.32	2.89	22.13	18.66	20.4
3.01	21.1	23.8	22.45	3.01	26.23	20.1	23.17	3.01	26.12	32.16	29.14	3.01	26.51	19.85	23.18	3.01	22.16	18.51	20.34

3.14	21.12	23.79	22.46	3.14	26.21	20.14	23.18	3.14	26.1	32.22	29.16	3.14	26.66	19.97	23.32	3.14	22.29	18.68	20.48
3.26	21.14	23.67	22.41	3.26	26.22	20.11	23.17	3.26	26.12	32.26	29.19	3.26	26.69	19.99	23.34	3.26	22.19	18.66	20.43
3.38	21.28	23.66	22.47	3.38	26.24	20.06	23.15	3.38	26.09	32.29	29.19	3.38	26.58	19.91	23.24	3.38	22.18	18.67	20.43
3.5	21.39	23.68	22.53	3.5	26.12	20.02	23.07	3.5	26.05	32.23	29.14	3.5	26.51	19.84	23.17	3.5	22.2	18.6	20.4
3.62	21.25	23.76	22.51	3.62	26.18	20.19	23.18	3.62	26.11	32.29	29.2	3.62	26.57	19.86	23.21	3.62	22.21	18.72	20.47
3.74	21.14	23.63	22.39	3.74	26.31	20.16	23.23	3.74	25.99	32.32	29.15	3.74	26.71	20.05	23.38	3.74	22.15	18.71	20.43
3.86	21.11	23.59	22.35	3.86	26.36	20.05	23.21	3.86	25.94	32.09	29.02	3.86	26.58	19.96	23.27	3.86	22.2	18.65	20.42
3.98	21.17	23.63	22.4	3.98	26.13	20.03	23.08	3.98	25.98	32.31	29.14	3.98	26.55	19.98	23.26	3.98	22.19	18.58	20.38
4.1	21.14	23.62	22.38	4.1	26.24	20.13	23.19	4.1	26.07	32.33	29.2	4.1	26.6	19.9	23.25	4.1	22.22	18.57	20.39
4.22	21.16	23.67	22.42	4.22	26.24	20.11	23.17	4.22	26.02	32.35	29.18	4.22	26.43	19.85	23.14	4.22	22.05	18.58	20.32
4.34	21.11	23.67	22.39	4.34	26.23	20.15	23.19	4.34	26	32.22	29.11	4.34	26.66	19.98	23.32	4.34	22.18	18.69	20.44
4.46	21.16	23.64	22.4	4.46	26.23	20.12	23.17	4.46	26.01	32.29	29.15	4.46	26.64	19.98	23.31	4.46	22.27	18.69	20.48
4.58	21.21	23.68	22.45	4.58	26.29	20.1	23.19	4.58	26.15	32.27	29.21	4.58	26.61	19.93	23.27	4.58	22.12	18.54	20.33
4.7	21.11	23.56	22.33	4.7	26.2	20.05	23.13	4.7	26.03	32.39	29.21	4.7	26.68	19.88	23.28	4.7	22.36	18.61	20.48
4.82	20.99	23.54	22.27	4.82	26.03	20.01	23.02	4.82	26.04	32.2	29.12	4.82	26.53	19.95	23.24	4.82	22.08	18.63	20.35
4.94	21.19	23.63	22.41	4.94	26.21	20.04	23.13	4.94	26.14	32.09	29.11	4.94	26.67	19.97	23.32	4.94	21.98	18.53	20.26
5.06	21.08	23.69	22.38	5.06	26.25	20.09	23.17	5.06	25.96	32.09	29.03	5.06	26.53	19.94	23.23	5.06	22.1	18.54	20.32
5.19	21.1	23.62	22.36	5.19	26.09	20.06	23.08	5.18	26.04	32.12	29.08	5.19	26.66	19.98	23.32	5.19	21.96	18.57	20.27
5.31	21.04	23.53	22.29	5.31	26.16	20.02	23.09	5.31	26.13	32.33	29.23	5.31	26.54	19.81	23.18	5.31	22.19	18.65	20.42
5.43	21.06	23.6	22.33	5.43	26.09	20.05	23.07	5.43	26.17	32.41	29.29	5.43	26.54	19.93	23.24	5.43	21.99	18.55	20.27
5.55	20.97	23.6	22.28	5.55	26.14	20.07	23.1	5.55	25.99	32.19	29.09	5.55	26.68	19.76	23.22	5.55	22.03	18.47	20.25
5.67	21.04	23.42	22.23	5.67	26.18	20.06	23.12	5.67	26.07	32.23	29.15	5.67	26.55	19.99	23.27	5.67	22.05	18.63	20.34
5.79	21.02	23.53	22.28	5.79	26.13	20.08	23.11	5.79	26.03	32.27	29.15	5.79	26.5	19.95	23.23	5.79	22.03	18.53	20.28
5.91	21.03	23.62	22.33	5.91	26.26	20.14	23.2	5.91	25.95	32.21	29.08	5.91	26.55	19.87	23.21	5.91	22.1	18.58	20.34
6.03	21.05	23.54	22.3	6.03	26.16	20.05	23.1	6.03	26.09	32.35	29.22	6.03	26.59	19.99	23.29	6.03	22.06	18.51	20.29
6.15	21.07	23.55	22.31	6.15	26.21	19.98	23.09	6.15	25.98	32.27	29.13	6.15	26.68	19.85	23.27	6.15	21.9	18.45	20.17
6.27	20.95	23.45	22.2	6.27	26.13	20.04	23.08	6.27	26.18	32.27	29.22	6.27	26.53	19.8	23.16	6.27	22.05	18.5	20.27
6.39	21.02	23.6	22.31	6.39	26.14	20.03	23.09	6.39	26.01	32.17	29.09	6.39	26.66	19.88	23.27	6.39	22.1	18.47	20.29
6.51	20.99	23.52	22.25	6.51	26.11	19.94	23.03	6.51	25.95	32.3	29.13	6.51	26.51	19.97	23.24	6.51	22.11	18.49	20.3
6.63	21.05	23.59	22.32	6.63	26.12	20	23.06	6.63	26.07	32.28	29.18	6.63	26.46	19.73	23.09	6.63	22.01	18.57	20.29

6.75	21.11	23.55	22.33	6.75	26.16	20.06	23.11	6.75	25.99	32.21	29.1	6.75	26.56	19.84	23.2	6.75	21.97	18.53	20.25
6.87	20.97	23.62	22.29	6.87	26.1	20	23.05	6.87	25.9	32.12	29.01	6.87	26.46	19.75	23.1	6.87	22.04	18.6	20.32
6.99	21	23.52	22.26	6.99	26.26	19.98	23.12	6.99	25.97	32.22	29.09	6.99	26.6	19.88	23.24	6.99	22.01	18.56	20.29
7.11	21.07	23.51	22.29	7.11	26.01	20.02	23.02	7.11	26.04	32.12	29.08	7.11	26.49	19.71	23.1	7.11	21.95	18.5	20.22
7.23	21.08	23.58	22.33	7.23	26.2	19.99	23.1	7.23	25.86	31.94	28.9	7.23	26.46	19.77	23.12	7.23	22	18.46	20.23
7.36	21.1	23.44	22.27	7.36	26.15	19.91	23.03	7.36	26	32.25	29.12	7.36	26.56	19.8	23.18	7.36	22.03	18.51	20.27
7.48	20.95	23.42	22.18	7.48	25.99	19.92	22.96	7.48	26.06	32.09	29.08	7.48	26.63	19.83	23.23	7.48	21.97	18.62	20.3
7.6	20.99	23.51	22.25	7.6	26.1	19.92	23.01	7.6	25.88	32.07	28.97	7.6	26.44	19.84	23.14	7.6	22	18.58	20.29
7.72	20.95	23.43	22.19	7.72	26.11	20	23.06	7.72	25.94	32.21	29.08	7.72	26.61	19.72	23.17	7.72	22	18.53	20.26
7.84	20.93	23.44	22.18	7.84	26.16	19.86	23.01	7.84	25.99	31.98	28.98	7.84	26.41	19.87	23.14	7.84	21.9	18.47	20.19
7.96	20.92	23.44	22.18	7.96	26.19	19.94	23.07	7.96	25.99	32.13	29.06	7.96	26.31	19.73	23.02	7.96	21.97	18.51	20.24
8.08	21.07	23.45	22.26	8.08	26.05	19.95	23	8.08	25.9	32.26	29.08	8.08	26.41	19.74	23.08	8.08	21.95	18.56	20.25
8.2	21	23.48	22.24	8.2	25.97	19.85	22.91	8.2	25.82	32.03	28.92	8.2	26.52	19.76	23.14	8.2	21.98	18.47	20.23
8.32	20.95	23.53	22.24	8.32	26.12	19.99	23.05	8.32	26	32.16	29.08	8.32	26.43	19.73	23.08	8.32	21.97	18.51	20.24
8.44	20.97	23.53	22.25	8.44	26.12	20.04	23.08	8.44	26	32.18	29.09	8.44	26.53	19.91	23.22	8.44	22.03	18.49	20.26
8.56	20.89	23.53	22.21	8.56	26.11	19.93	23.02	8.56	25.9	32.24	29.07	8.56	26.53	19.81	23.17	8.56	21.97	18.57	20.27
8.68	21	23.44	22.22	8.68	26.14	19.99	23.06	8.68	25.93	32.1	29.01	8.68	26.42	19.77	23.1	8.68	21.89	18.46	20.17
8.8	20.96	23.5	22.23	8.8	26.06	20.04	23.05	8.8	26.02	32.19	29.1	8.8	26.51	19.78	23.15	8.8	22.04	18.55	20.3
8.92	20.91	23.51	22.21	8.92	26.09	20.01	23.05	8.92	25.97	32.13	29.05	8.92	26.4	19.75	23.07	8.92	21.91	18.59	20.25
9.04	20.93	23.53	22.23	9.04	26.1	19.94	23.02	9.04	26.02	32.18	29.1	9.04	26.49	19.82	23.16	9.04	22.05	18.47	20.26
9.16	20.96	23.48	22.22	9.16	26.06	19.98	23.02	9.16	25.81	32.03	28.92	9.16	26.46	19.78	23.12	9.16	21.98	18.45	20.21
9.28	20.87	23.48	22.17	9.29	25.99	19.94	22.96	9.28	25.82	32.12	28.97	9.28	26.39	19.77	23.08	9.28	21.97	18.5	20.23
9.41	20.85	23.51	22.18	9.41	25.93	19.78	22.85	9.41	25.92	32.14	29.03	9.41	26.52	19.71	23.12	9.41	21.85	18.44	20.15
9.53	20.95	23.42	22.18	9.53	26.05	19.94	23	9.53	25.86	32.07	28.96	9.53	26.51	19.74	23.13	9.53	21.87	18.51	20.19
9.65	20.83	23.51	22.17	9.65	26.16	19.98	23.07	9.65	25.85	32.13	28.99	9.65	26.47	19.67	23.07	9.65	22	18.52	20.26
9.77	20.9	23.37	22.14	9.77	25.95	19.91	22.93	9.77	25.95	32.01	28.98	9.77	26.38	19.8	23.09	9.77	21.87	18.48	20.17
9.89	20.92	23.37	22.15	9.89	26.06	19.91	22.99	9.89	25.89	32.17	29.03	9.89	26.45	19.67	23.06	9.89	21.99	18.46	20.22
			22.352			20.058					29.143				23.241				20.352
		STDEV:	0.1231		STDEV:	0.0989				STDEV:	0.1089			STDEV:	0.1087			STDEV:	0.1124

Table 7.12: Contact angle measurement for millerite electrode at pH 12 conditioned at 0 V potential under 0.01 M KEX

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0	40.93	41.61	41.27	0	44.99	43.07	44.03	0	43.65	48.7	46.18	0	45.6	48.64	47.12	0	45.01	47.96	46.49
0.06	40.85	41.71	41.28	0.06	44.92	43.02	43.97	0.06	43.71	48.72	46.22	0.06	45.51	48.81	47.16	0.06	44.9	48.17	46.54
0.12	40.97	41.66	41.32	0.12	45.04	43.06	44.05	0.12	43.75	48.63	46.19	0.12	45.65	48.65	47.15	0.12	44.99	48	46.49
0.18	40.99	41.76	41.38	0.18	45.11	43.1	44.1	0.18	43.65	48.74	46.19	0.18	45.5	48.67	47.09	0.18	44.99	48.04	46.52
0.24	40.92	41.54	41.23	0.24	45.1	43.15	44.12	0.24	43.78	48.64	46.21	0.24	45.5	48.68	47.09	0.24	44.83	48.1	46.46
0.3	40.97	41.69	41.33	0.3	44.91	43.01	43.96	0.3	43.66	48.62	46.14	0.3	45.56	48.85	47.21	0.3	44.81	48.11	46.46
0.36	40.92	41.71	41.31	0.36	45.14	43.15	44.15	0.36	43.58	48.57	46.08	0.36	45.4	48.63	47.01	0.36	44.99	48.1	46.54
0.42	40.86	41.62	41.24	0.42	44.89	42.94	43.92	0.42	43.86	48.88	46.37	0.42	45.48	48.7	47.09	0.42	44.93	48.04	46.48
0.48	40.85	41.76	41.3	0.48	45.09	43.04	44.07	0.48	43.61	48.77	46.19	0.48	45.54	48.67	47.11	0.48	44.9	48.15	46.52
0.54	40.96	41.66	41.31	0.54	45.01	42.89	43.95	0.54	43.75	48.77	46.26	0.54	45.45	48.72	47.08	0.54	44.86	48.14	46.5
0.6	41.01	41.61	41.31	0.6	44.97	43.1	44.04	0.6	43.67	48.66	46.17	0.6	45.57	48.81	47.19	0.6	44.85	48.07	46.46
0.66	40.95	41.74	41.35	0.66	44.96	43.05	44	0.66	43.53	48.66	46.09	0.66	45.42	48.46	46.94	0.66	44.95	48.11	46.53
0.72	41.01	41.77	41.39	0.72	44.82	42.77	43.8	0.72	43.72	48.85	46.29	0.72	45.51	48.81	47.16	0.72	45	48.02	46.51
0.78	40.88	41.6	41.24	0.78	44.97	43.02	44	0.78	43.54	48.55	46.04	0.78	45.7	48.91	47.3	0.78	44.8	48.1	46.45
0.84	40.8	41.62	41.21	0.84	44.94	42.95	43.95	0.84	43.58	48.57	46.08	0.84	45.48	48.57	47.03	0.84	44.91	48.19	46.55
0.9	40.84	41.73	41.29	0.9	44.97	43.02	44	0.9	43.68	48.69	46.18	0.9	45.68	48.8	47.24	0.9	44.87	48.04	46.45
0.96	40.89	41.77	41.33	0.96	44.96	42.9	43.93	0.96	43.53	48.66	46.1	0.96	45.52	48.91	47.22	0.96	44.85	48.18	46.52
1.02	40.96	41.69	41.32	1.03	45.14	43.11	44.13	1.02	43.71	48.71	46.21	1.02	45.57	48.85	47.21	1.02	45.01	48.09	46.55
1.09	40.92	41.7	41.31	1.09	45.09	43.07	44.08	1.09	43.8	48.84	46.32	1.09	45.52	48.88	47.2	1.08	44.99	48.06	46.53
1.15	40.95	41.57	41.26	1.15	45.2	43.13	44.16	1.15	43.7	48.7	46.2	1.15	45.67	48.96	47.32	1.15	44.78	48.05	46.41
1.21	40.96	41.77	41.37	1.21	44.99	43.07	44.03	1.21	43.7	48.76	46.23	1.21	45.53	48.74	47.13	1.21	45.02	48	46.51
1.27	40.85	41.48	41.17	1.27	45.14	43.2	44.17	1.27	43.64	48.61	46.12	1.27	45.63	48.82	47.23	1.27	44.82	48.14	46.48
1.33	40.76	41.61	41.18	1.33	45.13	43.05	44.09	1.33	43.65	48.84	46.25	1.33	45.58	48.69	47.13	1.33	44.82	48.13	46.47
1.39	40.87	41.73	41.3	1.39	45.19	43.1	44.14	1.39	43.79	48.8	46.3	1.39	45.53	48.72	47.13	1.39	44.94	47.96	46.45
1.45	40.81	41.58	41.2	1.45	45.17	43.18	44.17	1.45	43.76	48.86	46.31	1.45	45.49	48.63	47.06	1.45	44.77	48.04	46.4
1.51	40.91	41.62	41.26	1.51	45.1	43.06	44.08	1.51	43.69	48.63	46.16	1.51	45.78	49.03	47.4	1.51	44.81	48.05	46.43

1.57	40.92	41.73	41.33	1.57	44.97	43.06	44.01	1.57	43.58	48.76	46.17	1.57	45.48	48.44	46.96	1.57	44.84	48	46.42
1.63	40.87	41.68	41.28	1.63	45.16	43.07	44.12	1.63	43.67	48.66	46.17	1.63	45.55	48.61	47.08	1.63	44.79	48.1	46.45
1.69	40.86	41.56	41.21	1.69	45.16	43.04	44.1	1.69	43.71	48.67	46.19	1.69	45.56	48.72	47.14	1.69	44.92	48.1	46.51
1.75	40.83	41.69	41.26	1.75	45.06	43.03	44.05	1.75	43.57	48.58	46.07	1.75	45.46	48.69	47.08	1.75	44.77	47.95	46.36
1.81	40.89	41.78	41.33	1.81	45.07	43.04	44.06	1.81	43.56	48.56	46.06	1.81	45.51	48.83	47.17	1.81	44.88	47.98	46.43
1.87	40.8	41.56	41.18	1.87	45.07	43.11	44.09	1.87	43.69	48.87	46.28	1.87	45.45	48.71	47.08	1.87	44.85	48.06	46.46
1.93	40.84	41.69	41.27	1.93	45.12	43.04	44.08	1.93	43.64	48.59	46.12	1.93	45.45	48.9	47.18	1.93	44.76	48.14	46.45
1.99	40.96	41.71	41.34	1.99	45.08	42.98	44.03	1.99	43.67	48.64	46.16	1.99	45.55	48.8	47.17	1.99	44.91	48.06	46.49
2.05	40.93	41.57	41.25	2.05	45.12	43.14	44.13	2.05	43.68	48.71	46.19	2.05	45.67	48.8	47.23	2.05	44.92	48.03	46.47
2.11	40.88	41.72	41.3	2.11	45.07	43.05	44.06	2.11	43.75	48.63	46.19	2.11	45.4	48.51	46.96	2.11	44.76	47.97	46.37
2.17	40.8	41.7	41.25	2.17	45.12	43.15	44.13	2.17	43.58	48.78	46.18	2.17	45.49	48.98	47.24	2.17	44.78	47.93	46.36
2.23	40.72	41.62	41.17	2.23	45.15	43.11	44.13	2.23	43.6	48.56	46.08	2.23	45.62	48.69	47.16	2.23	44.88	48.06	46.47
2.29	40.86	41.61	41.23	2.29	45.12	43.03	44.07	2.29	43.67	48.73	46.2	2.29	45.61	48.86	47.23	2.29	44.88	47.99	46.43
2.35	40.91	41.63	41.27	2.35	45.15	43.05	44.1	2.35	43.61	48.68	46.15	2.35	45.51	48.76	47.14	2.35	44.8	48.01	46.41
2.41	40.91	41.66	41.29	2.41	45.01	43.09	44.05	2.41	43.69	48.68	46.19	2.41	45.5	48.86	47.18	2.41	44.87	47.95	46.41
2.47	40.72	41.69	41.21	2.47	45.14	43.02	44.08	2.47	43.68	48.79	46.23	2.47	45.47	48.73	47.1	2.47	44.93	48.05	46.49
2.53	40.87	41.59	41.23	2.53	45.16	43.21	44.18	2.53	44.07	48.32	46.19	2.53	45.7	48.88	47.29	2.53	44.87	48	46.43
2.59	40.74	41.51	41.13	2.59	45.13	43.21	44.17	2.59	43.57	48.81	46.19	2.59	45.51	48.76	47.13	2.59	44.86	47.92	46.39
2.65	40.9	41.63	41.26	2.65	45.11	43.01	44.06	2.65	43.49	48.61	46.05	2.65	45.43	48.69	47.06	2.65	44.87	48.06	46.46
2.71	40.83	41.59	41.21	2.71	45.12	43.1	44.11	2.71	43.69	48.67	46.18	2.71	45.66	48.72	47.19	2.71	44.81	48.07	46.44
2.77	40.91	41.66	41.29	2.77	45.06	43.02	44.04	2.77	43.68	48.71	46.19	2.77	45.49	48.75	47.12	2.77	44.87	47.97	46.42
2.83	41.02	41.76	41.39	2.83	45.02	43.17	44.1	2.83	45.67	45.72	45.7	2.83	45.44	48.58	47.01	2.83	44.81	48.06	46.43
2.89	40.9	41.57	41.24	2.89	45.09	43.12	44.1	2.89	43.53	48.78	46.15	2.89	45.58	48.59	47.09	2.89	44.78	48.04	46.41
2.95	40.81	41.57	41.19	2.95	45.12	43.02	44.07	2.95	43.63	48.64	46.13	2.95	45.48	48.74	47.11	2.95	44.86	48.01	46.43
3.01	40.81	41.6	41.21	3.01	45.01	43.14	44.08	3.01	43.58	48.68	46.13	3.01	45.54	48.88	47.21	3.01	44.88	47.95	46.41
3.07	40.82	41.53	41.18	3.08	45.03	43.03	44.03	3.07	43.44	48.57	46.01	3.07	45.53	48.91	47.22	3.07	44.82	48.1	46.46
3.14	40.86	41.51	41.18	3.14	45.13	43.02	44.07	3.14	43.65	48.69	46.17	3.14	45.46	48.64	47.05	3.13	44.77	47.91	46.34
3.2	40.8	41.55	41.18	3.2	45.02	43.14	44.08	3.2	43.53	48.6	46.06	3.2	45.64	48.95	47.3	3.2	44.86	48.01	46.44
3.26	40.83	41.7	41.27	3.26	45.05	42.98	44.02	3.26	43.56	48.68	46.12	3.26	45.34	48.49	46.92	3.26	44.9	48.06	46.48
3.32	40.91	41.56	41.24	3.32	45	43.1	44.05	3.32	43.67	48.63	46.15	3.32	45.33	48.55	46.94	3.32	44.75	47.96	46.35

3.38	40.9	41.48	41.19	3.38	45.08	43.18	44.13	3.38	43.56	48.65	46.11	3.38	45.47	48.73	47.1	3.38	44.8	48.05	46.43
3.44	40.86	41.63	41.24	3.44	45.18	43.1	44.14	3.44	43.61	48.73	46.17	3.44	45.47	48.75	47.11	3.44	44.91	48.04	46.47
3.5	40.71	41.46	41.09	3.5	44.96	43.12	44.04	3.5	43.71	48.76	46.23	3.5	45.54	48.83	47.19	3.5	44.75	47.96	46.35
3.56	40.83	41.54	41.18	3.56	45.07	43.06	44.07	3.56	43.53	48.67	46.1	3.56	45.47	48.68	47.07	3.56	44.74	48.03	46.39
3.62	40.9	41.73	41.31	3.62	45.05	43.17	44.11	3.62	43.78	48.83	46.3	3.62	45.27	48.37	46.82	3.62	44.87	47.95	46.41
3.68	40.81	41.55	41.18	3.68	45.06	43.13	44.09	3.68	43.67	48.87	46.27	3.68	45.59	48.78	47.19	3.68	44.74	48.03	46.39
3.74	40.75	41.53	41.14	3.74	45.02	43.03	44.02	3.74	43.62	48.58	46.1	3.74	45.41	48.64	47.02	3.74	44.85	47.98	46.42
3.8	40.81	41.62	41.22	3.8	44.95	43.16	44.05	3.8	43.45	48.62	46.04	3.8	45.41	48.59	47	3.8	44.78	47.96	46.37
3.86	40.75	41.58	41.17	3.86	45.11	43.01	44.06	3.86	43.6	48.65	46.12	3.86	45.59	48.98	47.29	3.86	44.72	48.06	46.39
3.92	40.92	41.65	41.28	3.92	44.94	43.08	44.01	3.92	43.64	48.64	46.14	3.92	45.42	48.72	47.07	3.92	44.78	48.08	46.43
3.98	40.84	41.63	41.24	3.98	45.05	43.07	44.06	3.98	43.59	48.65	46.12	3.98	45.57	48.85	47.21	3.98	44.86	48.14	46.5
4.04	40.9	41.6	41.25	4.04	45.02	43.08	44.05	4.04	43.62	48.59	46.1	4.04	45.56	48.5	47.03	4.04	44.75	47.9	46.33
4.1	40.71	41.55	41.13	4.1	45.1	43.12	44.11	4.1	43.57	48.53	46.05	4.1	45.37	48.66	47.01	4.1	44.84	48.09	46.46
4.16	40.78	41.58	41.18	4.16	45.03	43.07	44.05	4.16	43.63	48.7	46.17	4.16	45.43	48.65	47.04	4.16	44.72	47.94	46.33
4.22	40.82	41.62	41.22	4.22	45.04	43.09	44.06	4.22	43.58	48.55	46.07	4.22	45.39	48.49	46.94	4.22	44.79	47.87	46.33
4.28	40.82	41.48	41.15	4.28	44.98	43.06	44.02	4.28	43.56	48.74	46.15	4.28	45.4	48.7	47.05	4.28	44.72	48.01	46.37
4.34	40.87	41.6	41.24	4.34	44.92	42.99	43.96	4.34	43.59	48.48	46.03	4.34	45.69	48.94	47.32	4.34	44.72	48	46.36
4.4	40.74	41.6	41.17	4.4	44.95	43.05	44	4.4	43.64	48.47	46.05	4.4	45.46	48.88	47.17	4.4	44.78	48.05	46.41
4.46	40.81	41.58	41.2	4.46	45.04	43.02	44.03	4.46	43.51	48.59	46.05	4.46	45.54	48.8	47.17	4.46	44.78	48.06	46.42
4.52	40.66	41.67	41.16	4.52	45.19	43.14	44.16	4.52	43.53	48.47	46	4.52	45.41	48.65	47.03	4.52	44.9	47.96	46.43
4.58	40.75	41.32	41.03	4.58	45.06	43.16	44.11	4.58	43.5	48.68	46.09	4.58	45.3	48.55	46.92	4.58	44.74	47.92	46.33
4.64	40.88	41.6	41.24	4.64	45.16	43.1	44.13	4.64	43.68	48.56	46.12	4.64	45.56	48.64	47.1	4.64	44.72	47.87	46.29
4.7	40.77	41.57	41.17	4.7	45.11	43.02	44.07	4.7	43.54	48.48	46.01	4.7	45.46	48.87	47.17	4.7	44.82	48	46.41
4.76	40.61	41.54	41.08	4.76	45.01	43.06	44.03	4.76	43.52	48.72	46.12	4.76	45.46	48.77	47.12	4.76	44.78	48.06	46.42
4.82	40.48	41.52	41	4.82	45.02	42.92	43.97	4.82	43.52	48.52	46.02	4.82	45.63	48.94	47.28	4.82	44.74	47.94	46.34
4.88	40.81	41.48	41.15	4.88	45.06	43.08	44.07	4.88	43.47	48.67	46.07	4.88	45.45	48.45	46.95	4.88	44.93	48.07	46.5
4.94	40.7	41.37	41.04	4.94	45.15	43.03	44.09	4.94	43.6	48.56	46.08	4.94	45.51	48.55	47.03	4.94	44.77	47.89	46.33
5	40.75	41.51	41.13	5	45.16	43.01	44.09	5	43.63	48.6	46.11	5	45.34	48.56	46.95	5	44.79	48.01	46.4
5.06	40.75	41.51	41.13	5.06	45.1	43.16	44.13	5.06	43.49	48.63	46.06	5.06	45.37	48.67	47.02	5.06	44.72	47.99	46.36
5.12	40.83	41.5	41.17	5.12	45.1	43.03	44.07	5.12	43.67	48.57	46.12	5.12	45.37	48.67	47.02	5.12	44.77	47.88	46.33

5.19	40.85	41.56	41.21	5.19	44.95	42.88	43.92	5.19	43.44	48.62	46.03	5.18	45.55	48.67	47.11	5.18	44.8	48	46.4
5.25	40.75	41.54	41.15	5.25	44.93	43.18	44.05	5.25	43.64	48.62	46.13	5.25	45.2	48.44	46.82	5.24	44.68	47.97	46.33
5.31	40.73	41.56	41.14	5.31	45.05	43.02	44.04	5.31	43.54	48.62	46.08	5.31	45.3	48.39	46.84	5.31	44.85	47.95	46.4
5.37	40.9	41.56	41.23	5.37	44.95	42.97	43.96	5.37	43.51	48.52	46.01	5.37	45.59	48.79	47.19	5.37	44.79	47.95	46.37
5.43	40.82	41.65	41.23	5.43	45.08	42.91	43.99	5.43	43.55	48.49	46.02	5.43	45.44	48.74	47.09	5.43	44.74	47.96	46.35
5.49	40.73	41.49	41.11	5.49	45.05	43.03	44.04	5.49	43.49	48.59	46.04	5.49	45.36	48.58	46.97	5.49	44.76	47.91	46.34
5.55	40.74	41.55	41.15	5.55	45.04	43.09	44.07	5.55	43.59	48.76	46.18	5.55	45.5	48.63	47.06	5.55	44.76	47.96	46.36
5.61	40.78	41.55	41.17	5.61	45	43.02	44.01	5.61	43.55	48.56	46.05	5.61	45.41	48.69	47.05	5.61	44.81	47.97	46.39
5.67	40.73	41.48	41.11	5.67	44.97	43.02	43.99	5.67	43.54	48.72	46.13	5.67	45.42	48.9	47.16	5.67	44.73	47.94	46.33
5.73	40.8	41.58	41.19	5.73	44.93	43.02	43.97	5.73	43.46	48.46	45.96	5.73	45.45	48.66	47.05	5.73	44.71	47.94	46.33
5.79	40.68	41.59	41.13	5.79	44.98	43.11	44.05	5.79	43.47	48.38	45.92	5.79	45.69	48.86	47.27	5.79	44.76	47.93	46.35
5.85	40.69	41.46	41.08	5.85	44.97	43	43.98	5.85	43.45	48.59	46.02	5.85	45.34	48.49	46.92	5.85	44.76	47.96	46.36
5.91	40.69	41.46	41.08	5.91	45.1	43.1	44.1	5.91	43.66	48.6	46.13	5.91	45.39	48.54	46.96	5.91	44.78	47.91	46.34
5.97	40.81	41.42	41.12	5.97	45.03	43.04	44.03	5.97	43.54	48.58	46.06	5.97	45.41	48.43	46.92	5.97	44.71	47.87	46.29
6.03	40.65	41.58	41.11	6.03	45.06	43.04	44.05	6.03	43.59	48.44	46.01	6.03	45.45	48.62	47.04	6.03	44.81	48.13	46.47
6.09	40.83	41.56	41.19	6.09	45	43.04	44.02	6.09	43.63	48.72	46.18	6.09	45.4	48.64	47.02	6.09	44.77	47.84	46.31
6.15	40.72	41.43	41.07	6.15	44.94	42.9	43.92	6.15	43.57	48.68	46.13	6.15	45.48	48.72	47.1	6.15	44.66	47.97	46.31
6.21	40.71	41.54	41.13	6.21	45.03	42.97	44	6.21	43.42	48.32	45.87	6.21	45.21	48.61	46.91	6.21	44.72	47.93	46.32
6.27	40.88	41.64	41.26	6.27	44.96	43.01	43.98	6.27	43.52	48.69	46.1	6.27	45.45	48.84	47.14	6.27	44.71	47.92	46.31
6.33	40.83	41.51	41.17	6.33	45	43.03	44.02	6.33	43.44	48.42	45.93	6.33	45.4	48.57	46.98	6.33	44.79	47.98	46.39
6.39	40.66	41.52	41.09	6.39	44.94	43.11	44.02	6.39	43.34	48.27	45.8	6.39	45.42	48.68	47.05	6.39	44.73	47.92	46.33
6.45	40.67	41.58	41.13	6.45	44.86	42.97	43.91	6.45	43.55	48.72	46.14	6.45	45.36	48.54	46.95	6.45	44.72	47.99	46.36
6.51	40.77	41.64	41.2	6.51	44.9	43.1	44	6.51	43.65	48.54	46.09	6.51	45.51	48.81	47.16	6.51	44.8	47.99	46.39
6.57	40.74	41.59	41.16	6.57	44.97	42.89	43.93	6.57	43.5	48.57	46.04	6.57	45.33	48.5	46.92	6.57	44.74	47.92	46.33
6.63	40.72	41.44	41.08	6.63	45.04	42.91	43.97	6.63	43.65	48.65	46.15	6.63	45.45	48.61	47.03	6.63	44.81	47.96	46.38
6.69	40.71	41.51	41.11	6.69	44.9	42.99	43.95	6.69	43.44	48.41	45.93	6.69	45.33	48.64	46.99	6.69	44.72	47.77	46.24
6.75	40.73	41.59	41.16	6.75	44.99	42.99	43.99	6.75	43.49	48.58	46.03	6.75	45.42	48.49	46.95	6.75	44.65	47.82	46.24
6.81	40.67	41.52	41.1	6.81	44.95	42.86	43.9	6.81	43.52	48.4	45.96	6.81	45.44	48.79	47.11	6.81	44.8	47.89	46.34
6.87	40.82	41.41	41.12	6.87	44.97	43.08	44.02	6.87	43.54	48.6	46.07	6.87	45.34	48.63	46.98	6.87	44.7	47.9	46.3
6.93	40.73	41.57	41.15	6.93	44.98	43.08	44.03	6.93	43.6	48.67	46.13	6.93	45.56	48.55	47.06	6.93	44.73	47.99	46.36

6.99	40.78	41.54	41.16	6.99	45.07	42.96	44.02	6.99	43.61	48.57	46.09	6.99	45.38	48.71	47.05	6.99	44.79	47.92	46.35
7.05	40.73	41.66	41.2	7.05	44.94	43.04	43.99	7.05	43.49	48.65	46.07	7.05	45.46	48.77	47.12	7.05	44.7	47.86	46.28
7.11	40.73	41.49	41.11	7.11	45.09	42.93	44.01	7.11	43.69	48.59	46.14	7.11	45.23	48.51	46.87	7.11	44.73	47.93	46.33
7.17	40.68	41.44	41.06	7.17	44.99	42.95	43.97	7.17	43.6	48.54	46.07	7.17	45.54	48.67	47.1	7.17	44.76	47.88	46.32
7.23	40.77	41.5	41.13	7.23	44.99	43.01	44	7.23	43.52	48.67	46.09	7.23	45.33	48.54	46.94	7.23	44.57	48.01	46.29
7.3	40.75	41.47	41.11	7.3	45.07	43.05	44.06	7.3	43.59	48.48	46.04	7.3	45.19	48.42	46.81	7.29	44.7	47.86	46.28
7.36	40.7	41.46	41.08	7.36	45.05	42.97	44.01	7.36	43.52	48.56	46.04	7.36	45.45	48.67	47.06	7.36	44.72	47.85	46.28
7.42	40.75	41.46	41.1	7.42	44.98	42.94	43.96	7.42	43.57	48.63	46.1	7.42	45.41	48.49	46.95	7.42	44.71	47.89	46.3
7.48	40.71	41.46	41.09	7.48	44.91	42.95	43.93	7.48	43.6	48.46	46.03	7.48	45.35	48.59	46.97	7.48	44.73	47.92	46.33
7.54	40.77	41.46	41.11	7.54	44.94	42.92	43.93	7.54	43.54	48.62	46.08	7.54	45.47	48.75	47.11	7.54	44.63	47.77	46.2
7.6	40.77	41.49	41.13	7.6	45.06	42.95	44	7.6	43.44	48.54	45.99	7.6	45.39	48.8	47.1	7.6	44.92	47.99	46.46
7.66	40.71	41.52	41.11	7.66	44.92	42.96	43.94	7.66	43.61	48.53	46.07	7.66	45.48	48.86	47.17	7.66	44.73	47.81	46.27
7.72	40.68	41.46	41.07	7.72	45.03	43.02	44.02	7.72	43.4	48.54	45.97	7.72	45.51	48.65	47.08	7.72	44.67	47.93	46.3
7.78	40.74	41.49	41.12	7.78	44.89	42.86	43.88	7.78	43.63	48.59	46.11	7.78	45.5	48.59	47.04	7.78	44.74	47.97	46.35
7.84	40.69	41.54	41.11	7.84	44.86	42.95	43.91	7.84	43.42	48.6	46.01	7.84	45.44	48.49	46.97	7.84	44.73	48.03	46.38
7.9	40.9	41.55	41.23	7.9	45.07	43.06	44.07	7.9	43.54	48.49	46.01	7.9	45.28	48.45	46.87	7.9	44.83	47.83	46.33
7.96	40.77	41.53	41.15	7.96	44.94	42.93	43.94	7.96	43.51	48.44	45.98	7.96	45.41	48.51	46.96	7.96	44.72	47.92	46.32
8.02	40.72	41.5	41.11	8.02	44.98	43.09	44.03	8.02	43.44	48.63	46.04	8.02	45.44	48.64	47.04	8.02	44.72	47.93	46.32
8.08	40.77	41.47	41.12	8.08	44.86	42.85	43.85	8.08	43.63	48.68	46.16	8.08	45.38	48.5	46.94	8.08	44.72	47.8	46.26
8.14	40.76	41.5	41.13	8.14	44.95	42.96	43.95	8.14	43.6	48.74	46.17	8.14	45.35	48.51	46.93	8.14	44.76	48.05	46.41
8.2	40.73	41.51	41.12	8.2	45.08	43.04	44.06	8.2	43.45	48.57	46.01	8.2	45.51	48.74	47.13	8.2	44.7	47.89	46.3
8.26	40.68	41.53	41.1	8.26	44.95	43	43.98	8.26	43.6	48.43	46.02	8.26	45.41	48.46	46.93	8.26	44.78	47.92	46.35
8.32	40.68	41.54	41.11	8.32	44.86	42.85	43.85	8.32	43.44	48.64	46.04	8.32	45.12	48.27	46.7	8.32	44.61	47.92	46.27
8.38	40.74	41.45	41.09	8.38	44.94	42.83	43.89	8.38	43.47	48.41	45.94	8.38	45.33	48.65	46.99	8.38	44.73	47.91	46.32
8.44	40.78	41.49	41.13	8.44	45.01	42.99	44	8.44	43.54	48.58	46.06	8.44	45.51	48.81	47.16	8.44	44.77	47.86	46.31
8.5	40.72	41.5	41.11	8.5	45.01	42.98	43.99	8.5	43.52	48.58	46.05	8.5	45.53	48.76	47.15	8.5	44.72	47.81	46.27
8.56	40.72	41.43	41.07	8.56	45.04	42.89	43.96	8.56	43.47	48.53	46	8.56	45.39	48.6	46.99	8.56	44.78	47.81	46.29
8.62	40.77	41.55	41.16	8.62	44.96	42.99	43.98	8.62	43.56	48.63	46.1	8.62	45.39	48.61	47	8.62	44.6	47.92	46.26
8.68	40.74	41.45	41.09	8.68	44.97	42.98	43.97	8.68	43.49	48.54	46.01	8.68	45.35	48.7	47.03	8.68	44.68	47.8	46.24
8.74	40.64	41.41	41.02	8.74	44.99	42.97	43.98	8.74	43.54	48.53	46.04	8.74	45.44	48.6	47.02	8.74	44.62	47.79	46.2

8.8	40.72	41.39	41.06	8.8	44.98	42.88	43.93	8.8	43.46	48.52	45.99	8.8	45.25	48.32	46.78	8.8	44.72	47.89	46.31
8.86	40.73	41.4	41.07	8.86	45.03	42.97	44	8.86	43.49	48.38	45.93	8.86	45.39	48.54	46.97	8.86	44.7	47.89	46.29
8.92	40.65	41.43	41.04	8.92	44.98	42.92	43.95	8.92	43.51	48.58	46.04	8.92	45.43	48.59	47.01	8.92	44.66	47.81	46.24
8.98	40.69	41.5	41.09	8.98	44.87	43.02	43.95	8.98	43.56	48.69	46.13	8.98	45.26	48.47	46.87	8.98	44.61	47.9	46.25
9.04	40.76	41.52	41.14	9.04	44.88	42.88	43.88	9.04	43.57	48.54	46.05	9.04	45.17	48.2	46.68	9.04	44.77	47.99	46.38
9.1	40.76	41.47	41.11	9.1	44.94	42.95	43.95	9.1	43.37	48.41	45.89	9.1	45.59	48.78	47.18	9.1	44.78	47.8	46.29
9.16	40.76	41.46	41.11	9.16	45.06	42.8	43.93	9.16	43.59	48.59	46.09	9.16	45.43	48.59	47.01	9.16	44.64	47.9	46.27
9.22	40.63	41.58	41.1	9.22	44.95	43.17	44.06	9.22	43.56	48.6	46.08	9.22	45.43	48.63	47.03	9.22	44.61	47.81	46.21
9.28	40.73	41.4	41.06	9.28	44.97	43.03	44	9.28	43.44	48.55	46	9.28	45.59	48.65	47.12	9.28	44.71	47.8	46.26
9.35	40.62	41.49	41.05	9.35	44.95	42.92	43.94	9.35	43.39	48.19	45.79	9.35	45.49	48.62	47.06	9.34	44.69	47.77	46.23
9.41	40.74	41.36	41.05	9.41	44.84	42.9	43.87	9.41	43.45	48.52	45.98	9.41	45.18	48.31	46.74	9.41	44.65	47.77	46.21
9.47	40.73	41.39	41.06	9.47	44.92	42.87	43.89	9.47	43.46	48.33	45.89	9.47	45.35	48.72	47.03	9.47	44.62	47.94	46.28
9.53	40.66	41.43	41.04	9.53	44.96	43.01	43.98	9.53	43.55	48.63	46.09	9.53	45.45	48.72	47.09	9.53	44.72	47.78	46.25
9.59	40.69	41.52	41.1	9.59	44.94	42.83	43.89	9.59	43.33	48.49	45.91	9.59	45.29	48.53	46.91	9.59	44.6	48	46.3
9.65	40.71	41.51	41.11	9.65	44.87	42.94	43.91	9.65	43.5	48.45	45.98	9.65	45.29	48.41	46.85	9.65	44.64	47.82	46.23
9.71	40.69	41.47	41.08	9.71	44.91	42.87	43.89	9.71	43.5	48.59	46.05	9.71	45.4	48.48	46.94	9.71	44.67	47.84	46.26
9.77	40.72	41.38	41.05	9.77	44.95	42.93	43.94	9.77	43.41	48.4	45.91	9.77	45.3	48.59	46.94	9.77	44.52	47.91	46.22
9.83	40.78	41.42	41.1	9.83	44.99	43.05	44.02	9.83	43.51	48.53	46.02	9.83	45.34	48.41	46.87	9.83	44.68	47.8	46.24
9.89	40.7	41.38	41.04	9.89	44.84	42.87	43.86	9.89	43.42	48.55	45.98	9.89	45.4	48.74	47.07	9.89	44.65	47.82	46.24
9.95	40.64	41.45	41.05	9.95	44.92	42.93	43.92	9.95	43.63	48.57	46.1	9.95	45.33	48.7	47.02	9.95	44.72	48.04	46.38
10.01	40.48	41.37	40.93					10.01	43.3	48.37	45.84					10.01	44.78	47.74	46.26
			41.171				44.02				46.087				47.06				46.37

Table 7.13: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.1 V potential under 0.01 M KEX

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0	56.09	56.11	56.1	0	54.83	55.55	55.19	0	55.43	54.64	55.03	0	56.82	58.68	57.75	0	56.9	54.31	55.61
0.06	56.13	56.12	56.13	0.06	54.75	55.54	55.15	0.06	55.36	54.67	55.02	0.06	57.03	58.55	57.79	0.06	57.12	54.96	56.04
0.12	56.27	56	56.14	0.12	54.86	55.48	55.17	0.12	55.46	54.74	55.1	0.12	56.78	58.63	57.7	0.12	57.21	54.89	56.05
0.18	56.21	56.22	56.21	0.18	54.85	55.49	55.17	0.18	55.23	54.69	54.96	0.18	56.96	58.47	57.72	0.18	57.03	54.73	55.88
0.24	56.1	56.04	56.07	0.24	54.84	55.48	55.16	0.24	55.34	54.71	55.02	0.24	56.82	58.58	57.7	0.24	56.81	54.35	55.58
0.3	56.05	56.22	56.14	0.3	54.95	55.37	55.16	0.3	55.37	54.81	55.09	0.3	56.93	58.57	57.75	0.3	56.99	54.62	55.8
0.36	56.13	56.1	56.11	0.36	54.96	55.5	55.23	0.36	55.35	54.82	55.09	0.36	56.87	58.59	57.73	0.36	57	54.98	55.99
0.42	56.08	56.07	56.08	0.42	54.84	55.48	55.16	0.42	55.22	54.77	54.99	0.42	56.76	58.68	57.72	0.42	57.48	54.88	56.18
0.48	56.15	55.92	56.03	0.48	54.86	55.64	55.25	0.48	55.41	54.63	55.02	0.48	56.94	58.5	57.72	0.48	57.07	54.84	55.96
0.54	56.11	56.26	56.18	0.54	54.94	55.43	55.19	0.54	55.37	54.66	55.01	0.54	56.77	58.7	57.73	0.54	56.61	54.37	55.49
0.6	56.14	56.18	56.16	0.6	54.93	55.39	55.16	0.6	55.36	54.79	55.07	0.6	57.03	58.57	57.8	0.6	57.21	55.08	56.15
0.66	56.01	56.1	56.06	0.66	54.82	55.49	55.15	0.66	55.27	54.74	55.01	0.66	56.93	58.47	57.7	0.66	56.97	54.94	55.95
0.72	55.91	56.22	56.06	0.72	54.77	55.46	55.11	0.72	55.36	54.64	55	0.72	56.91	58.63	57.77	0.72	57.07	54.76	55.92
0.78	56.06	56.17	56.11	0.78	54.89	55.59	55.24	0.78	55.3	54.58	54.94	0.78	56.72	58.35	57.54	0.78	56.77	54.49	55.63
0.84	56.04	56.15	56.1	0.84	54.88	55.32	55.1	0.84	55.26	54.62	54.94	0.84	56.74	58.59	57.66	0.84	57.1	54.91	56.01
0.9	56.28	56.07	56.17	0.9	55	55.29	55.14	0.9	55.38	54.65	55.02	0.9	56.88	58.47	57.67	0.9	56.83	54.54	55.69
0.96	56.08	55.97	56.03	0.96	54.87	55.38	55.13	0.96	55.24	54.7	54.97	0.96	56.72	58.74	57.73	0.96	56.6	54.36	55.48
1.02	56.14	56.01	56.07	1.02	54.66	55.58	55.12	1.02	55.28	54.66	54.97	1.02	56.86	58.46	57.66	1.02	56.96	54.75	55.86
1.09	55.99	55.89	55.94	1.09	54.78	55.53	55.15	1.08	55.36	54.59	54.98	1.09	56.66	58.7	57.68	1.09	56.9	54.71	55.81
1.15	55.95	56.11	56.03	1.15	55.04	55.3	55.17	1.15	55.29	54.67	54.98	1.15	56.93	58.38	57.65	1.15	57.12	54.9	56.01
1.21	56.03	55.98	56.01	1.21	54.73	55.46	55.1	1.21	55.24	54.67	54.95	1.21	56.8	58.5	57.65	1.21	57.13	54.69	55.91
1.27	56.08	55.97	56.03	1.27	54.79	55.5	55.14	1.27	55.4	54.6	55	1.27	56.83	58.65	57.74	1.27	57.01	54.89	55.95
1.33	56.04	56.21	56.12	1.33	54.8	55.45	55.12	1.33	55.35	54.71	55.03	1.33	56.84	58.53	57.68	1.33	56.93	54.73	55.83
1.39	56.13	55.99	56.06	1.39	54.81	55.5	55.15	1.39	55.31	54.69	55	1.39	56.75	58.71	57.73	1.39	56.88	54.6	55.74
1.45	56.11	56.04	56.07	1.45	54.82	55.51	55.17	1.45	55.34	54.7	55.02	1.45	57.01	58.44	57.73	1.45	56.91	54.5	55.71
1.51	55.93	56.11	56.02	1.51	54.71	55.43	55.07	1.51	55.45	54.67	55.06	1.51	56.66	58.64	57.65	1.51	57.38	54.71	56.05

1.57	56.15	56.07	56.11	1.57	54.83	55.48	55.16	1.57	55.36	54.6	54.98	1.57	56.94	58.48	57.71	1.57	57.06	54.81	55.93
1.63	56.01	55.95	55.98	1.63	54.79	55.46	55.13	1.63	55.27	54.68	54.98	1.63	56.83	58.66	57.75	1.63	56.95	54.74	55.85
1.69	56.05	56	56.03	1.69	55.01	55.66	55.34	1.69	55.17	54.7	54.94	1.69	56.99	58.41	57.7	1.69	57.23	54.82	56.02
1.75	56.02	56.04	56.03	1.75	54.8	55.48	55.14	1.75	55.35	54.78	55.06	1.75	56.87	58.5	57.69	1.75	57.1	54.74	55.92
1.81	55.96	56.03	55.99	1.81	54.82	55.41	55.12	1.81	55.36	54.62	54.99	1.81	56.7	58.5	57.6	1.81	56.93	54.74	55.83
1.87	56.34	56.09	56.21	1.87	54.88	55.32	55.1	1.87	55.33	54.58	54.95	1.87	56.91	58.5	57.7	1.87	57.14	54.94	56.04
1.93	55.94	56.23	56.08	1.93	54.79	55.42	55.11	1.93	55.13	54.66	54.9	1.93	56.61	58.61	57.61	1.93	57.14	54.6	55.87
1.99	56.07	56.02	56.05	1.99	54.79	55.53	55.16	1.99	55.29	54.69	54.99	1.99	56.93	58.44	57.68	1.99	56.7	54.36	55.53
2.05	56.05	56.07	56.06	2.05	54.81	55.44	55.12	2.05	55.25	54.69	54.97	2.05	56.78	58.52	57.65	2.05	56.98	54.77	55.87
2.11	55.88	56.05	55.96	2.11	54.73	55.41	55.07	2.11	55.38	54.54	54.96	2.11	56.77	58.45	57.61	2.11	57.2	54.84	56.02
2.17	56.12	56.11	56.12	2.17	54.73	55.46	55.1	2.17	55.19	54.63	54.91	2.17	56.81	58.39	57.6	2.17	56.93	54.77	55.85
2.23	56.12	56.08	56.1	2.23	54.94	55.26	55.1	2.23	55.35	54.76	55.05	2.23	56.77	58.46	57.61	2.23	57.21	55.02	56.11
2.29	56.15	55.97	56.06	2.29	54.82	55.43	55.12	2.29	55.43	54.67	55.05	2.29	56.74	58.38	57.56	2.29	57.17	54.9	56.04
2.35	55.99	56.21	56.1	2.35	54.67	55.39	55.03	2.35	55.33	54.64	54.99	2.35	56.59	58.69	57.64	2.35	57.13	54.8	55.97
2.41	55.95	56.08	56.01	2.41	54.76	55.52	55.14	2.41	55.49	54.64	55.07	2.41	56.87	58.45	57.66	2.41	57.38	54.91	56.15
2.47	56.15	56.12	56.14	2.47	54.76	55.53	55.14	2.47	55.22	54.58	54.9	2.47	56.71	58.6	57.66	2.47	57.18	54.86	56.02
2.53	56.04	55.89	55.97	2.53	54.87	55.47	55.17	2.53	55.33	54.79	55.06	2.53	56.95	58.38	57.67	2.53	57.29	55.02	56.16
2.59	55.95	56.03	55.99	2.59	54.7	55.45	55.08	2.59	55.26	54.56	54.91	2.59	56.65	58.61	57.63	2.59	57.11	54.46	55.79
2.65	56.12	55.89	56	2.65	54.82	55.41	55.11	2.65	55.41	54.57	54.99	2.65	56.86	58.43	57.65	2.65	56.95	54.87	55.91
2.71	56.1	56.11	56.11	2.71	54.95	55.39	55.17	2.71	55.21	54.73	54.97	2.71	56.79	58.54	57.66	2.71	56.96	54.54	55.75
2.77	56.13	55.94	56.03	2.77	54.77	55.48	55.13	2.77	55.11	54.69	54.9	2.77	56.68	58.42	57.55	2.77	57.05	54.55	55.8
2.83	56.12	55.83	55.97	2.83	54.88	55.36	55.12	2.83	55.37	54.55	54.96	2.83	56.75	58.49	57.62	2.83	57.07	54.78	55.93
2.89	56.03	56.09	56.06	2.89	54.77	55.46	55.12	2.89	55.45	54.54	54.99	2.89	56.67	58.56	57.62	2.89	57.01	54.5	55.76
2.95	56.08	55.96	56.02	2.95	54.83	55.43	55.13	2.95	55.34	54.69	55.02	2.95	56.85	58.47	57.66	2.95	56.82	54.71	55.77
3.01	55.92	56.15	56.03	3.01	54.77	55.47	55.12	3.01	55.45	54.71	55.08	3.01	56.7	58.46	57.58	3.01	56.81	54.53	55.67
3.07	55.79	56.18	55.98	3.07	54.71	55.41	55.06	3.07	55.51	54.54	55.03	3.07	56.92	58.33	57.62	3.07	56.99	54.35	55.67
3.14	56.07	55.92	55.99	3.14	54.61	55.47	55.04	3.13	55.34	54.53	54.93	3.14	56.6	58.61	57.6	3.14	56.99	54.67	55.83
3.2	56.01	56.06	56.04	3.2	54.86	55.37	55.11	3.2	55.34	54.57	54.95	3.2	56.81	58.41	57.61	3.2	57.03	54.67	55.85
3.26	56.03	55.93	55.98	3.26	54.84	55.29	55.06	3.26	55.21	54.64	54.92	3.26	56.67	58.5	57.59	3.26	57.03	54.68	55.86
3.32	56	56.13	56.06	3.32	54.92	55.29	55.1	3.32	55.34	54.63	54.99	3.32	56.7	58.4	57.55	3.32	57.05	54.67	55.86

3.38	55.9	56.04	55.97	3.38	54.83	55.42	55.13	3.38	55.42	54.42	54.92	3.38	56.68	58.56	57.62	3.38	57.03	54.72	55.88
3.44	55.92	56.02	55.97	3.44	54.76	55.44	55.1	3.44	55.39	54.68	55.04	3.44	56.84	58.51	57.67	3.44	57.06	54.77	55.91
3.5	55.98	56.02	56	3.5	54.78	55.35	55.07	3.5	55.24	54.6	54.92	3.5	56.78	58.39	57.59	3.5	56.92	54.57	55.74
3.56	55.92	56.12	56.02	3.56	54.68	55.44	55.06	3.56	55.29	54.64	54.96	3.56	56.75	58.48	57.61	3.56	57.17	54.63	55.9
3.62	56.12	55.99	56.06	3.62	54.67	55.54	55.11	3.62	55.48	54.54	55.01	3.62	56.79	58.42	57.61	3.62	56.79	54.67	55.73
3.68	55.97	55.99	55.98	3.68	54.73	55.46	55.09	3.68	55.38	54.63	55.01	3.68	56.75	58.3	57.52	3.68	56.89	54.63	55.76
3.74	56.18	55.59	55.89	3.74	54.87	55.27	55.07	3.74	55.24	54.52	54.88	3.74	56.67	58.35	57.51	3.74	56.88	54.57	55.72
3.8	55.78	56.09	55.93	3.8	54.74	55.41	55.08	3.8	55.11	54.58	54.85	3.8	56.8	58.36	57.58	3.8	56.77	54.48	55.63
3.86	55.43	56.45	55.94	3.86	54.79	55.42	55.1	3.86	55.21	54.71	54.96	3.86	56.63	58.51	57.57	3.86	56.95	54.68	55.82
3.92	56.12	56.04	56.08	3.92	54.68	55.42	55.05	3.92	55.2	54.51	54.86	3.92	56.78	58.3	57.54	3.92	57.08	54.92	56
3.98	56.13	55.98	56.06	3.98	54.79	55.43	55.11	3.98	55.09	54.62	54.85	3.98	56.6	58.47	57.53	3.98	57.15	54.61	55.88
4.04	56.07	55.8	55.94	4.04	54.73	55.55	55.14	4.04	55.28	54.69	54.99	4.04	56.8	58.46	57.63	4.04	57.33	54.91	56.12
4.1	56.18	56.06	56.12	4.1	54.69	55.48	55.09	4.1	55.21	54.47	54.84	4.1	56.67	58.4	57.53	4.1	56.85	54.76	55.81
4.16	56.08	56	56.04	4.16	54.76	55.45	55.1	4.16	55.21	54.64	54.92	4.16	56.75	58.34	57.55	4.16	56.93	54.54	55.74
4.22	56.02	55.99	56	4.22	54.7	55.45	55.08	4.22	55.25	54.74	54.99	4.22	56.65	58.32	57.48	4.22	57.07	54.72	55.9
4.28	56.16	56	56.08	4.28	54.85	55.36	55.11	4.28	55.33	54.62	54.98	4.28	56.67	58.49	57.58	4.28	57.03	54.72	55.87
4.34	56.01	55.88	55.95	4.34	54.75	55.57	55.16	4.34	55.31	54.51	54.91	4.34	56.8	58.34	57.57	4.34	57.13	54.39	55.76
4.4	55.93	55.92	55.93	4.4	54.76	55.39	55.08	4.4	55.25	54.57	54.91	4.4	56.63	58.45	57.54	4.4	57.01	54.74	55.87
4.46	55.76	56.13	55.95	4.46	54.8	55.37	55.08	4.46	55.34	54.59	54.96	4.46	56.72	58.22	57.47	4.46	56.98	54.86	55.92
4.52	55.91	56.08	56	4.52	54.84	55.32	55.08	4.52	55.33	54.67	55	4.52	56.64	58.41	57.52	4.52	57.15	54.63	55.89
4.58	56.03	55.96	55.99	4.58	54.78	55.43	55.11	4.58	55.2	54.59	54.89	4.58	56.75	58.41	57.58	4.58	56.83	54.4	55.62
4.64	56.04	55.92	55.98	4.64	54.69	55.48	55.08	4.64	55.22	54.61	54.92	4.64	56.58	58.33	57.46	4.64	57.07	54.57	55.82
4.7	55.94	56.17	56.05	4.7	54.77	55.3	55.03	4.7	55.28	54.63	54.95	4.7	56.68	58.49	57.58	4.7	57.05	54.51	55.78
4.76	56.08	55.87	55.98	4.76	54.72	55.4	55.06	4.76	55.17	54.62	54.9	4.76	56.77	58.36	57.57	4.76	56.92	54.68	55.8
4.82	55.98	56.08	56.03	4.82	54.74	55.41	55.08	4.82	55.28	54.69	54.98	4.82	56.67	58.46	57.56	4.82	57.21	54.8	56.01
4.88	56.02	56.12	56.07	4.88	54.83	55.33	55.08	4.88	55.14	54.56	54.85	4.88	56.63	58.26	57.44	4.88	57.24	54.85	56.05
4.94	55.83	55.95	55.89	4.94	54.67	55.46	55.06	4.94	55.22	54.71	54.97	4.94	56.65	58.48	57.56	4.94	57.05	54.87	55.96
5	55.88	55.96	55.92	5	54.7	55.42	55.06	5	55.22	54.56	54.89	5	56.85	58.31	57.58	5	57.09	54.84	55.96
5.07	56.13	56.05	56.09	5.06	54.73	55.55	55.14	5.06	55.24	54.57	54.91	5.06	56.61	58.49	57.55	5.06	56.98	54.61	55.8
5.12	56.09	55.92	56.01	5.12	54.85	55.44	55.14	5.12	55.34	54.6	54.97	5.12	56.68	58.27	57.48	5.12	56.85	54.63	55.74

5.18	55.92	56.03	55.97	5.18	54.85	55.28	55.07	5.18	55.23	54.58	54.9	5.19	56.56	58.45	57.51	5.19	56.86	54.55	55.7
5.25	55.97	56.09	56.03	5.25	54.58	55.42	55	5.25	55.27	54.59	54.93	5.25	56.82	58.37	57.6	5.25	57.03	54.69	55.86
5.31	55.94	55.87	55.9	5.31	54.66	55.5	55.08	5.31	55.19	54.46	54.82	5.31	56.64	58.45	57.54	5.31	57.41	54.88	56.15
5.37	56.01	55.89	55.95	5.37	54.88	55.43	55.16	5.37	55.24	54.53	54.89	5.37	56.69	58.49	57.59	5.37	57.06	54.55	55.81
5.43	56.2	55.87	56.03	5.43	54.74	55.45	55.1	5.43	55.15	54.7	54.93	5.43	56.71	58.27	57.49	5.43	56.81	54.63	55.72
5.49	56.03	55.96	55.99	5.49	54.7	55.46	55.08	5.49	55.14	54.58	54.86	5.49	56.56	58.52	57.54	5.49	56.96	54.63	55.79
5.55	55.93	56.09	56.01	5.55	54.76	55.37	55.06	5.55	55.21	54.55	54.88	5.55	56.75	58.22	57.49	5.55	56.92	54.63	55.77
5.61	56.19	55.82	56.01	5.61	54.83	55.38	55.11	5.61	55.34	54.61	54.97	5.61	56.4	58.36	57.38	5.61	57.04	54.65	55.85
5.67	56.01	56.19	56.1	5.67	54.8	55.33	55.07	5.67	55.36	54.48	54.92	5.67	56.76	58.27	57.51	5.67	57.11	54.75	55.93
5.73	55.88	55.83	55.85	5.73	54.68	55.46	55.07	5.73	55.28	54.59	54.93	5.73	56.43	58.45	57.44	5.73	57.03	54.54	55.78
5.79	56.04	55.94	55.99	5.79	54.83	55.31	55.07	5.79	55.28	54.58	54.93	5.79	56.66	58.23	57.45	5.79	56.97	54.44	55.71
5.85	55.95	55.88	55.92	5.85	54.74	55.28	55.01	5.85	55.18	54.53	54.85	5.85	56.7	58.46	57.58	5.85	57.05	54.76	55.9
5.91	55.98	56.09	56.03	5.91	54.67	55.5	55.08	5.91	55.22	54.45	54.83	5.91	56.8	58.3	57.55	5.91	56.84	54.76	55.8
5.97	55.98	55.89	55.94	5.97	54.64	55.31	54.97	5.97	55.18	54.49	54.83	5.97	56.62	58.24	57.43	5.97	56.87	54.5	55.69
6.03	55.98	56.13	56.05	6.03	54.81	55.25	55.03	6.03	55.13	54.52	54.83	6.03	56.5	58.42	57.46	6.03	57.1	54.76	55.93
6.09	56.01	55.81	55.91	6.09	54.86	55.21	55.03	6.09	55.23	54.53	54.88	6.09	56.75	58.37	57.56	6.09	57.03	54.53	55.78
6.15	56.05	55.97	56.01	6.15	54.73	55.44	55.08	6.15	55.05	54.66	54.85	6.15	56.52	58.42	57.47	6.15	57.32	54.78	56.05
6.21	55.82	55.96	55.89	6.21	54.6	55.49	55.05	6.21	55.23	54.53	54.88	6.21	56.79	58.14	57.47	6.21	57.03	54.74	55.88
6.27	55.97	55.93	55.95	6.27	54.78	55.39	55.09	6.27	55.19	54.43	54.81	6.27	56.6	58.43	57.51	6.27	57.13	54.68	55.9
6.33	55.79	55.92	55.85	6.33	54.72	55.33	55.03	6.33	55.2	54.67	54.93	6.33	56.7	58.25	57.47	6.33	56.9	54.63	55.76
6.39	56.14	56	56.07	6.39	54.72	55.35	55.04	6.39	55.24	54.58	54.91	6.39	56.46	58.28	57.37	6.39	56.93	54.61	55.77
6.45	56.03	55.96	56	6.45	54.64	55.33	54.98	6.45	55.18	54.63	54.9	6.45	56.76	58.32	57.54	6.45	57.06	54.59	55.82
6.51	55.79	55.93	55.86	6.51	54.77	55.38	55.07	6.51	55.24	54.53	54.88	6.51	56.72	58.41	57.56	6.51	56.74	54.38	55.56
6.57	56.08	56.01	56.05	6.57	54.76	55.29	55.03	6.57	55.17	54.58	54.88	6.57	56.68	58.4	57.54	6.57	56.92	54.57	55.75
6.63	55.87	56.08	55.97	6.63	54.76	55.31	55.04	6.63	55.07	54.56	54.82	6.63	56.61	58.23	57.42	6.63	56.89	54.8	55.85
6.69	56.06	55.77	55.92	6.69	54.74	55.2	54.97	6.69	55.32	54.56	54.94	6.69	56.61	58.41	57.51	6.69	56.74	54.25	55.5
6.75	56.17	55.96	56.06	6.75	54.7	55.32	55.01	6.75	55.29	54.57	54.93	6.75	56.77	58.3	57.53	6.75	56.91	54.58	55.75
6.81	55.95	55.91	55.93	6.81	54.6	55.42	55.01	6.81	55.21	54.57	54.89	6.81	56.75	58.28	57.51	6.81	56.34	54.3	55.32
6.87	55.96	55.88	55.92	6.87	54.59	55.37	54.98	6.87	55.15	54.5	54.82	6.87	56.51	58.36	57.43	6.87	56.91	54.6	55.76
6.93	55.96	55.89	55.92	6.93	54.67	55.44	55.05	6.93	55.23	54.59	54.91	6.93	56.75	58.23	57.49	6.93	56.87	54.65	55.76

6.99	55.97	55.99	55.98	6.99	54.84	55.2	55.02	6.99	55.22	54.59	54.9	6.99	56.46	58.47	57.46	6.99	57	54.56	55.78
7.05	56.12	55.82	55.97	7.05	54.8	55.43	55.11	7.05	55.21	54.49	54.85	7.05	56.73	58.09	57.41	7.05	56.59	54.16	55.38
7.11	56.08	56.01	56.05	7.11	54.67	55.42	55.04	7.11	55.07	54.59	54.83	7.11	56.52	58.45	57.49	7.11	56.94	54.49	55.71
7.17	55.96	55.97	55.96	7.17	54.75	55.28	55.01	7.17	55.08	54.64	54.86	7.17	56.88	58.19	57.54	7.17	57.08	54.64	55.86
7.23	55.9	55.97	55.93	7.24	54.58	55.36	54.97	7.23	55.21	54.53	54.87	7.24	56.43	58.48	57.45	7.23	56.41	54.16	55.29
7.3	55.84	56.11	55.97	7.3	54.71	55.37	55.04	7.29	55.08	54.49	54.79	7.3	56.72	58.23	57.48	7.3	56.89	54.58	55.74
7.36	56.14	55.79	55.97	7.36	54.74	55.38	55.06	7.36	55.16	54.63	54.89	7.36	56.5	58.17	57.34	7.36	56.6	54.04	55.32
7.42	55.9	55.85	55.88	7.42	54.71	55.23	54.97	7.42	55.11	54.41	54.76	7.42	56.57	58.32	57.45	7.42	57.08	54.79	55.94
7.48	56.05	55.75	55.9	7.48	54.7	55.33	55.01	7.48	55.19	54.49	54.84	7.48	56.62	58.34	57.48	7.48	56.79	54.48	55.63
7.54	55.88	56	55.94	7.54	54.56	55.32	54.94	7.54	55.12	54.65	54.88	7.54	56.59	58.37	57.48	7.54	57.09	54.88	55.99
7.6	55.97	55.87	55.92	7.6	54.68	55.31	54.99	7.6	55.17	54.52	54.85	7.6	56.69	58.17	57.43	7.6	57.24	54.7	55.97
7.66	56.09	55.85	55.97	7.66	54.61	55.24	54.93	7.66	55.27	54.49	54.88	7.66	56.56	58.46	57.51	7.66	56.59	54.35	55.47
7.72	55.96	55.97	55.96	7.72	54.66	55.31	54.99	7.72	55.21	54.47	54.84	7.72	56.69	58.26	57.48	7.72	56.95	54.74	55.85
7.78	55.84	55.86	55.85	7.78	54.71	55.37	55.04	7.78	55.12	54.62	54.87	7.78	56.63	58.32	57.47	7.78	56.85	54.54	55.7
7.84	55.89	55.83	55.86	7.84	54.57	55.39	54.98	7.84	55.26	54.53	54.9	7.84	56.47	58.25	57.36	7.84	56.56	54.33	55.44
7.9	55.95	55.78	55.87	7.9	54.66	55.19	54.92	7.9	55.2	54.34	54.77	7.9	56.74	58.17	57.46	7.9	57.04	54.85	55.95
7.96	56.01	55.83	55.92	7.96	54.6	55.27	54.94	7.96	55.08	54.65	54.86	7.96	56.44	58.39	57.42	7.96	56.91	54.64	55.78
8.02	55.99	56.03	56.01	8.02	54.6	55.41	55	8.02	55.21	54.41	54.81	8.02	56.71	58.07	57.39	8.02	56.44	54.17	55.3
8.08	55.92	55.97	55.94	8.08	54.6	55.35	54.98	8.08	55.12	54.55	54.83	8.08	56.49	58.47	57.48	8.08	56.88	54.48	55.68
8.14	55.89	55.96	55.92	8.14	54.61	55.3	54.96	8.14	55.15	54.44	54.79	8.14	56.77	58.19	57.48	8.14	56.53	54.51	55.52
8.2	55.94	56.09	56.01	8.2	54.71	55.31	55.01	8.2	55.17	54.55	54.86	8.2	56.4	58.49	57.44	8.2	56.89	54.54	55.71
8.26	55.89	55.92	55.9	8.26	54.74	55.25	54.99	8.26	55.04	54.6	54.82	8.26	56.6	58.17	57.39	8.26	56.69	54.36	55.53
8.32	56.06	55.75	55.9	8.32	54.69	55.39	55.04	8.32	55.1	54.44	54.77	8.32	56.46	58.46	57.46	8.32	56.99	54.77	55.88
8.38	56.11	55.82	55.96	8.38	54.54	55.32	54.93	8.38	55.27	54.47	54.87	8.38	56.54	58.32	57.43	8.38	56.79	54.64	55.71
8.44	55.94	55.99	55.97	8.44	54.67	55.27	54.97	8.44	55.29	54.42	54.86	8.44	56.61	58.34	57.47	8.44	56.53	54.24	55.39
8.5	55.87	56.02	55.95	8.5	54.62	55.36	54.99	8.5	55.05	54.45	54.75	8.5	56.49	58.25	57.37	8.5	57.05	54.68	55.86
8.56	55.92	55.8	55.86	8.56	54.56	55.33	54.95	8.56	55.25	54.53	54.89	8.56	56.73	58.27	57.5	8.56	56.95	54.71	55.83
8.62	55.82	56.09	55.95	8.62	54.6	55.39	54.99	8.62	55.11	54.39	54.75	8.62	56.68	58.53	57.6	8.62	56.89	54.49	55.69
8.68	55.93	56.05	55.99	8.68	54.77	55.25	55.01	8.68	55.2	54.48	54.84	8.68	56.59	58.27	57.43	8.68	56.75	54.49	55.62
8.74	55.94	55.99	55.96	8.74	54.57	55.26	54.91	8.74	54.93	54.59	54.76	8.74	56.38	58.33	57.36	8.74	56.97	54.57	55.77

8.8	55.88	55.96	55.92	8.8	54.55	55.38	54.97	8.8	55.22	54.37	54.79	8.8	56.66	58.37	57.51	8.8	56.79	54.38	55.59
8.86	55.9	56.03	55.97	8.86	54.75	55.17	54.96	8.86	55.26	54.35	54.8	8.86	56.73	58.16	57.45	8.86	56.94	54.67	55.81
8.92	55.94	55.81	55.87	8.92	54.62	55.38	55	8.92	55.06	54.43	54.74	8.92	56.4	58.35	57.37	8.92	56.88	54.65	55.76
8.98	55.99	55.95	55.97	8.98	54.65	55.3	54.97	8.98	55.13	54.55	54.84	8.98	56.68	58.03	57.36	8.98	56.64	54.45	55.54
9.04	55.87	55.85	55.86	9.04	54.68	55.19	54.93	9.04	55.13	54.46	54.8	9.04	56.42	58.4	57.41	9.04	56.46	54.06	55.26
9.1	55.85	55.91	55.88	9.1	54.64	55.38	55.01	9.1	55.19	54.46	54.82	9.1	56.78	58.02	57.4	9.1	57.03	54.62	55.82
9.16	56.01	55.83	55.92	9.16	54.84	55.24	55.04	9.16	55.1	54.6	54.85	9.16	56.49	58.38	57.43	9.16	56.93	54.69	55.81
9.22	55.9	55.93	55.92	9.22	54.7	55.21	54.96	9.22	55.03	54.43	54.73	9.22	56.71	58.16	57.43	9.22	57.07	54.6	55.84
9.28	55.75	55.79	55.77	9.28	54.58	55.33	54.96	9.28	55.17	54.48	54.83	9.28	56.41	58.32	57.36	9.28	57.18	54.82	56
9.35	55.81	55.94	55.87	9.35	54.74	55.25	54.99	9.34	55.12	54.49	54.8	9.35	56.66	58.29	57.47	9.35	56.9	54.64	55.77
9.41	56.1	55.92	56.01	9.41	54.67	55.11	54.89	9.41	55.2	54.45	54.82	9.41	56.61	58.31	57.46	9.41	57.06	54.87	55.97
9.47	55.96	55.99	55.97	9.47	54.76	55.23	55	9.47	55.07	54.56	54.81	9.47	56.44	58.23	57.34	9.47	56.8	54.55	55.68
9.53	55.87	55.95	55.91	9.53	54.54	55.27	54.91	9.53	55.07	54.43	54.75	9.53	56.6	58.17	57.39	9.53	56.65	54.43	55.54
9.59	55.95	55.91	55.93	9.59	54.57	55.34	54.95	9.59	55.21	54.32	54.77	9.59	56.54	58.29	57.42	9.59	56.86	54.42	55.64
9.65	55.87	56.04	55.96	9.65	54.69	55.16	54.92	9.65	54.99	54.46	54.72	9.65	56.67	58.15	57.41	9.65	56.9	54.49	55.7
9.71	55.85	55.89	55.87	9.71	54.72	55.34	55.03	9.71	55.07	54.52	54.8	9.71	56.46	58.28	57.37	9.71	56.75	54.49	55.62
9.77	56.01	55.89	55.95	9.77	54.57	55.27	54.92	9.77	55.05	54.46	54.76	9.77	56.59	58.33	57.46	9.77	56.77	54.57	55.67
9.83	55.99	55.87	55.93	9.83	54.58	55.25	54.92	9.83	55.22	54.32	54.77	9.83	56.49	58.29	57.39	9.83	56.78	54.33	55.56
9.89	55.93	55.91	55.92	9.89	54.73	55.25	54.99	9.89	55.08	54.39	54.74	9.89	56.5	58.3	57.4	9.89	56.98	54.57	55.77
9.95	55.82	55.9	55.86	9.95	54.69	55.29	54.99	9.95	55	54.51	54.76	9.95	56.63	58.2	57.42	9.95	57.09	54.43	55.76
10.01	55.96	55.83	55.9									10.01	56.35	58.42	57.38				
			55.989				55.062				54.906				57.539				55.796

Table 7.14: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.2 V potential under 0.01 M KEX

Trial 1				Trial 2				Trial 3					Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Volume [µl]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0	61.8	62.27	62.04	0	62.21	62.29	62.25	0	61.42	60.46	60.94	7.51	0	59.06	59.62	59.34	0	58.32	59.35	58.83
0.06	61.98	62.55	62.27	0.06	61.67	61.78	61.73	0.06	61.49	60.64	61.06	7.55	0.03	59.16	59.58	59.37	0.03	58.15	59.25	58.7
0.12	62.15	62.5	62.32	0.12	61.98	62.16	62.07	0.12	61.19	60.49	60.84	7.5	0.06	58.94	59.52	59.23	0.06	58.52	59.37	58.94
0.18	62.05	62.55	62.3	0.18	62.27	62.28	62.28	0.18	61.15	59.82	60.49	7.22	0.09	58.96	59.54	59.25	0.09	58.27	59.3	58.79
0.24	62.24	62.53	62.38	0.24	62.26	62.38	62.32	0.24	61.38	60.24	60.81	7.24	0.12	59.08	59.51	59.29	0.12	58.24	59.3	58.77
0.3	62.35	62.69	62.52	0.3	61.83	62.06	61.94	0.3	61.6	60.27	60.93	7.28	0.15	58.84	59.54	59.19	0.15	58.68	59.73	59.21
0.36	62.33	62.52	62.42	0.36	61.97	62.22	62.09	0.36	61.52	60.12	60.82	7.16	0.18	58.87	59.5	59.19	0.18	58.48	59.41	58.94
0.42	62.31	62.59	62.45	0.42	61.98	62.37	62.18	0.42	61.78	60.52	61.15	7.3	0.21	59.05	59.59	59.32	0.21	58.45	59.52	58.99
0.48	62.17	62.38	62.28	0.48	61.93	62.25	62.09	0.48	61.63	60.28	60.96	7.21	0.24	59.08	59.61	59.35	0.24	58.25	59.03	58.64
0.54	62.07	62.71	62.39	0.54	61.64	61.86	61.75	0.54	61.27	60.14	60.7	7.33	0.27	59.1	59.45	59.27	0.27	58.49	59.62	59.05
0.6	62.21	62.75	62.48	0.6	62.02	62.17	62.1	0.6	61.51	60.47	60.99	7.37	0.3	58.95	59.52	59.24	0.3	58.64	59.46	59.05
0.66	62.02	62.61	62.31	0.66	62.12	61.99	62.05	0.66	61.85	60.81	61.33	7.52	0.33	58.84	59.36	59.1	0.33	58.37	59.46	58.91
0.72	61.92	62.45	62.19	0.72	62.15	62.15	62.15	0.72	61.43	60.3	60.87	7.36	0.36	58.99	59.47	59.23	0.36	58.59	59.5	59.05
0.78	62.01	62.7	62.36	0.78	62.08	61.81	61.94	0.78	61.38	60.29	60.84	7.38	0.39	58.99	59.37	59.18	0.39	58.39	59.46	58.92
0.84	62.16	62.53	62.35	0.84	62.27	62.11	62.19	0.84	61.26	60.05	60.66	7.25	0.42	58.92	59.56	59.24	0.42	58.32	59.39	58.85
0.9	62.06	62.56	62.31	0.9	62.15	62.23	62.19	0.9	62.06	60.77	61.42	7.4	0.45	58.81	59.52	59.17	0.45	58.23	59.19	58.71
0.96	62.14	62.69	62.41	0.96	62.01	62.05	62.03	0.96	61.26	60.06	60.66	7.18	0.48	59.14	59.52	59.33	0.48	58.34	59.38	58.86
1.02	61.97	62.59	62.28	1.02	62.03	62.07	62.05	1.02	61.52	60.4	60.96	7.33	0.51	58.88	59.47	59.17	0.51	58.31	59.44	58.88
1.09	62.01	62.61	62.31	1.09	61.95	61.93	61.94	1.09	61.59	60.5	61.05	7.45	0.54	59.13	59.71	59.42	0.54	57.94	58.88	58.41
1.15	61.9	62.43	62.16	1.15	62.12	62.3	62.21	1.15	61.53	60.36	60.95	7.36	0.57	59.18	59.59	59.39	0.57	58.46	59.44	58.95
1.21	61.95	62.42	62.18	1.21	62	62.15	62.07	1.21	61.38	60.4	60.89	7.35	0.6	58.78	59.4	59.09	0.6	58.33	59.2	58.76
1.27	61.9	62.36	62.13	1.27	62.55	62.55	62.55	1.27	61.45	60.22	60.83	7.29	0.63	58.82	59.52	59.17	0.63	58.24	59.26	58.75
1.33	62.16	62.63	62.39	1.33	61.84	61.98	61.91	1.33	61.68	60.38	61.03	7.26	0.66	59.09	59.51	59.3	0.66	58.27	59.23	58.75
1.39	62.31	62.66	62.48	1.39	62.24	62.38	62.31	1.39	61.19	59.68	60.43	7.11	0.69	58.92	59.51	59.22	0.69	58.64	59.53	59.09
1.45	61.99	62.4	62.2	1.45	62.11	62.25	62.18	1.45	61.74	60.44	61.09	7.36	0.72	58.8	59.44	59.12	0.72	58.91	59.76	59.33

1.51	62.01	62.49	62.25	1.51	62.51	62.39	62.45	1.51	61.69	60.6	61.14	7.39	0.75	58.72	59.59	59.16	0.75	58.54	59.66	59.1
1.57	62.22	62.52	62.37	1.57	62.32	62.28	62.3	1.57	61.71	60.33	61.02	7.24	0.78	58.81	59.32	59.07	0.78	58.56	59.52	59.04
1.63	61.92	62.29	62.11	1.63	61.94	62	61.97	1.63	61.24	59.96	60.6	7.08	0.81	59	59.45	59.22	0.81	58.5	59.48	58.99
1.69	62.18	62.7	62.44	1.69	61.92	62.02	61.97	1.69	61.7	60.47	61.09	7.32	0.84	58.96	59.72	59.34	0.84	58.33	59.35	58.84
1.75	62.03	62.45	62.24	1.75	62.27	62.47	62.37	1.75	61.44	60.03	60.73	7.17	0.87	59.01	59.51	59.26	0.87	58.46	59.44	58.95
1.81	61.94	62.37	62.16	1.81	62.1	62.14	62.12	1.81	61.16	59.86	60.51	7.13	0.9	59.17	59.68	59.43	0.9	58.56	59.82	59.19
1.87	62.09	62.35	62.22	1.87	61.82	62	61.91	1.87	61.37	59.95	60.66	7.13	0.93	58.87	59.37	59.12	0.93	58.76	59.48	59.12
1.93	62.17	62.63	62.4	1.93	62.27	62.48	62.37	1.93	61.22	60	60.61	7.26	0.96	58.96	59.52	59.24	0.96	58.33	59.48	58.9
1.99	62.11	62.54	62.32	1.99	62.21	62.3	62.25	1.99	61.4	60.34	60.87	7.35	0.99	58.9	59.47	59.18	0.99	58.46	59.3	58.88
2.05	61.9	62.34	62.12	2.05	62.06	62.16	62.11	2.05	61.26	60.29	60.77	7.36	1.02	59.01	59.58	59.29	1.02	58.47	59.52	59
2.11	61.95	62.31	62.13	2.11	61.91	61.99	61.95	2.11	61.27	59.94	60.6	7.18	1.06	58.88	59.64	59.26	1.06	58.51	59.41	58.96
2.17	62.2	62.57	62.39	2.17	61.95	62.08	62.02	2.17	61.39	60.01	60.7	7.08	1.09	58.97	59.44	59.2	1.09	58.48	59.77	59.12
2.23	61.91	62.46	62.19	2.23	62.31	62.31	62.31	2.23	61.49	60.13	60.81	7.26	1.12	58.97	59.34	59.15	1.12	58.29	59.24	58.77
2.29	62.1	62.71	62.4	2.29	62.12	62.09	62.1	2.29	61.61	60.34	60.98	7.27	1.15	58.83	59.62	59.22	1.15	58.5	59.53	59.01
2.35	62.15	62.57	62.36	2.35	62.16	62	62.08	2.35	61.42	60.43	60.92	7.38	1.18	58.81	59.31	59.06	1.18	58.47	59.37	58.92
2.41	62.02	62.35	62.18	2.41	61.82	62.03	61.93	2.41	61.3	59.96	60.63	7.21	1.21	58.51	59.2	58.85	1.21	58.49	59.51	59
2.47	62.02	62.22	62.12	2.47	62.34	62.42	62.38	2.47	61.59	60.47	61.03	7.37	1.24	58.93	59.43	59.18	1.24	58.56	59.35	58.96
2.53	61.76	62.03	61.89	2.53	62.22	62.29	62.25	2.53	61.72	60.59	61.16	7.33	1.27	59.08	59.62	59.35	1.27	58.52	59.63	59.07
2.59	62.18	62.39	62.29	2.59	62.02	61.84	61.93	2.59	61.45	60.09	60.77	7.21	1.3	58.77	59.55	59.16	1.3	58.84	59.76	59.3
2.65	62.15	62.36	62.25	2.65	61.9	62.09	62	2.65	61.41	60.41	60.91	7.34	1.33	59.11	59.37	59.24	1.33	58.4	59.56	58.98
2.71	62.06	62.28	62.17	2.71	62.04	61.99	62.02	2.71	61.27	60.09	60.68	7.27	1.36	59.19	59.76	59.48	1.36	58.71	59.66	59.18
2.77	62.05	62.32	62.19	2.77	62.27	62.27	62.27	2.77	61.63	60.43	61.03	7.39	1.39	58.87	59.63	59.25	1.39	58.35	59.49	58.92
2.83	62.17	62.41	62.29	2.83	62.05	62	62.03	2.83	61.58	60.21	60.9	7.2	1.42	58.88	59.31	59.1	1.42	58.43	59.53	58.98
2.89	62	62.31	62.15	2.89	61.82	61.99	61.91	2.89	61.1	60	60.55	7.13	1.45	58.96	59.48	59.22	1.45	58.59	59.4	59
2.95	61.74	62.09	61.91	2.95	61.87	62.15	62.01	2.95	61.83	60.58	61.2	7.45	1.48	59.05	59.58	59.31	1.48	58.39	59.6	58.99
3.01	62.23	62.6	62.41	3.01	62.19	62.4	62.29	3.01	61.35	60.53	60.94	7.54	1.51	58.79	59.37	59.08	1.51	58.71	59.57	59.14
3.08	61.72	62.44	62.08	3.07	62	62.16	62.08	3.07	61.34	60.64	60.99	7.64	1.54	59.09	59.59	59.34	1.54	58.48	59.59	59.04
3.14	61.97	62.51	62.24	3.14	61.95	61.86	61.9	3.13	61.64	60.25	60.95	7.27	1.57	58.8	59.57	59.19	1.57	58.56	59.51	59.04
3.2	61.94	62.53	62.24	3.2	62.07	62.38	62.22	3.2	61.39	59.75	60.57	6.93	1.6	59.03	59.51	59.27	1.6	58.5	59.27	58.89
3.26	61.9	62.35	62.13	3.26	62.22	62.37	62.29	3.26	61.42	59.9	60.66	7.06	1.63	59	59.52	59.26	1.63	58.4	59.6	59

3.32	61.67	62.28	61.98	3.32	62.45	62.44	62.45	3.32	61.52	60.13	60.82	7.14	1.66	58.9	59.56	59.23	1.66	58.5	59.69	59.1
3.38	62.03	62.39	62.21	3.38	61.45	61.67	61.56	3.38	61.41	59.92	60.66	7.14	1.69	58.94	59.51	59.22	1.69	58.74	59.61	59.18
3.44	61.59	62.1	61.84	3.44	62.12	62.29	62.21	3.44	61.23	59.98	60.61	7.21	1.72	58.88	59.41	59.15	1.72	58.51	59.57	59.04
3.5	62.3	62.67	62.48	3.5	61.92	62.09	62.01	3.5	61.23	60.11	60.67	7.29	1.75	58.93	59.4	59.16	1.75	58.43	59.26	58.85
3.56	61.82	62.28	62.05	3.56	62.12	62.2	62.16	3.56	61.38	60.24	60.81	7.28	1.78	58.89	59.51	59.2	1.78	58.48	59.58	59.03
3.62	62.04	62.51	62.27	3.62	62	62.02	62.01	3.62	61.85	60.52	61.19	7.49	1.81	58.7	59.47	59.08	1.81	58.48	59.37	58.93
3.68	61.7	62.16	61.93	3.68	62.28	62.24	62.26	3.68	61.64	60.53	61.09	7.36	1.84	59	59.42	59.21	1.84	58.37	59.39	58.88
3.74	62.07	62.54	62.31	3.74	62.07	61.96	62.02	3.74	61.44	60.09	60.77	7.24	1.87	58.75	59.46	59.1	1.87	58.43	59.5	58.96
3.8	61.95	62.3	62.13	3.8	62.36	62.5	62.43	3.8	61.7	60.39	61.05	7.36	1.9	58.8	59.39	59.09	1.9	58.53	59.53	59.03
3.86	62.11	62.48	62.29	3.86	62.27	62.19	62.23	3.86	61.24	60.01	60.62	7.15	1.93	58.91	59.4	59.15	1.93	58.73	59.6	59.17
3.92	61.49	61.99	61.74	3.92	61.96	61.84	61.9	3.92	61.53	60.31	60.92	7.27	1.96	58.97	59.81	59.39	1.96	58.55	59.45	59
3.98	62.17	62.54	62.36	3.98	62.1	61.85	61.97	3.98	61.27	59.89	60.58	7.21	1.99	58.85	59.3	59.08	1.99	58.56	59.51	59.04
4.04	62.1	62.43	62.26	4.04	62.43	62.38	62.4	4.04	61.82	60.58	61.2	7.4	2.02	59.01	59.52	59.27	2.02	58.61	59.6	59.1
4.1	62.15	62.25	62.2	4.1	61.88	61.82	61.85	4.1	61.41	60.37	60.89	7.37	2.05	58.81	59.37	59.09	2.05	58.56	59.42	58.99
4.16	61.88	62.18	62.03	4.16	62.16	62.22	62.19	4.16	61.67	60.32	60.99	7.34	2.08	58.87	59.41	59.14	2.08	58.44	59.46	58.95
4.22	62.07	62.33	62.2	4.22	62.17	62.12	62.14	4.22	61.28	60.08	60.68	7.25	2.11	58.85	59.5	59.17	2.11	58.61	59.5	59.06
4.28	62.06	62.47	62.27	4.28	62.08	62.17	62.12	4.28	61.57	60.38	60.98	7.25	2.14	58.89	59.49	59.19	2.14	58.71	59.58	59.15
4.34	61.66	62.24	61.95	4.34	62.36	62.6	62.48	4.34	61.62	60.34	60.98	7.27	2.17	59.11	59.52	59.32	2.17	58.33	59.39	58.86
4.4	62	62.36	62.18	4.4	61.79	61.85	61.82	4.4	61.64	60.39	61.02	7.35	2.2	58.62	59.36	58.99	2.2	58.39	59.52	58.96
4.46	61.95	62.43	62.19	4.46	62.29	62.48	62.39	4.46	61.18	59.97	60.58	7.24	2.23	59.12	59.64	59.38	2.23	58.55	59.59	59.07
4.52	62.17	62.41	62.29	4.52	62.41	62.38	62.4	4.52	61.94	60.47	61.21	7.3	2.26	59.06	59.74	59.4	2.26	58.42	59.43	58.93
4.58	62.24	62.51	62.38	4.58	61.98	62.19	62.08	4.58	61.09	59.57	60.33	7.03	2.29	58.95	59.48	59.21	2.29	58.59	59.54	59.07
4.64	61.95	62.34	62.15	4.64	62.02	62.23	62.13	4.64	61.24	59.94	60.59	7.22	2.32	58.99	59.54	59.26	2.32	58.39	59.37	58.88
4.7	62.21	62.54	62.38	4.7	62.04	62.17	62.11	4.7	61.38	60.31	60.85	7.34	2.35	58.95	59.51	59.23	2.35	58.6	59.72	59.16
4.76	62.24	62.63	62.44	4.76	62.2	62.39	62.29	4.76	61.33	60.3	60.81	7.33	2.38	58.74	59.31	59.02	2.38	58.62	59.46	59.04
4.82	61.9	62.34	62.12	4.82	61.98	62.17	62.08	4.82	61.27	60.26	60.76	7.26	2.41	58.81	59.49	59.15	2.41	58.68	59.49	59.08
4.88	61.94	62.46	62.2	4.88	62.13	62.29	62.21	4.88	61.36	60.27	60.82	7.33	2.44	58.85	59.44	59.14	2.44	58.61	59.5	59.05
4.94	62.16	62.54	62.35	4.94	61.98	62.04	62.01	4.94	61.33	59.95	60.64	7.18	2.47	58.79	59.4	59.09	2.47	58.4	59.55	58.97
5	61.98	62.45	62.21	5	62.21	62.31	62.26	5	61.34	60.25	60.8	7.36	2.5	58.89	59.45	59.17	2.5	58.5	59.6	59.05
5.06	62.24	62.71	62.48	5.06	61.93	62.18	62.05	5.06	61.24	60.03	60.64	7.22	2.53	59.03	59.49	59.26	2.53	58.69	59.61	59.15

5.12	61.91	62.45	62.18	5.12	62.29	62.46	62.37	5.12	61.28	60.03	60.66	7.24	2.56	58.91	59.44	59.17	2.56	58.45	59.49	58.97
5.19	61.77	62.29	62.03	5.19	61.92	61.83	61.87	5.18	61.34	60.13	60.74	7.27	2.59	59.05	59.64	59.35	2.59	58.68	59.67	59.17
5.25	61.8	62.36	62.08	5.25	62.07	62.04	62.05	5.25	61.17	60.17	60.67	7.35	2.62	58.89	59.29	59.09	2.62	58.46	59.61	59.04
5.31	61.98	62.44	62.21	5.31	61.96	61.87	61.91	5.31	61.49	60.22	60.85	7.35	2.65	58.82	59.56	59.19	2.65	58.82	59.57	59.2
5.37	62.09	62.45	62.27	5.37	62.05	62	62.03	5.37	61.43	60.16	60.8	7.27	2.68	58.65	59.2	58.92	2.68	58.48	59.58	59.03
5.43	62.21	62.54	62.38	5.43	61.98	61.88	61.93	5.43	61.54	60.18	60.86	7.19	2.71	59.13	59.52	59.32	2.71	58.69	59.62	59.16
5.49	62	62.25	62.13	5.49	62.21	62.42	62.31	5.49	61.41	60.1	60.75	7.21	2.74	58.67	59.41	59.04	2.74	58.46	59.4	58.93
5.55	62.09	62.51	62.3	5.55	62.09	62.2	62.15	5.55	61.49	60.49	60.99	7.39	2.77	58.79	59.37	59.08	2.77	58.55	59.57	59.06
5.61	61.9	62.32	62.11	5.61	62.07	62.26	62.16	5.61	61.73	60.56	61.14	7.38	2.8	58.95	59.46	59.21	2.8	59.13	59.09	59.11
5.67	62	62.29	62.15	5.67	61.85	62.09	61.97	5.67	61.33	60.19	60.76	7.31	2.83	58.83	59.45	59.14	2.83	58.61	59.54	59.08
5.73	62.16	62.43	62.3	5.73	62.18	62.27	62.22	5.73	61.34	60.03	60.68	7.25	2.86	58.62	59.24	58.93	2.86	58.57	59.63	59.1
5.79	61.63	61.99	61.81	5.79	62.08	62.13	62.11	5.79	61.51	60.13	60.82	7.19	2.89	59.03	59.51	59.27	2.89	58.5	59.43	58.96
5.85	62.05	62.54	62.29	5.85	61.96	62.03	61.99	5.85	61.66	60.38	61.02	7.31	2.92	58.73	59.38	59.06	2.92	58.36	59.51	58.94
5.91	61.89	62.37	62.13	5.91	61.67	61.85	61.76	5.91	61.83	60.27	61.05	7.25	2.95	58.79	59.24	59.01	2.95	58.83	59.53	59.18
5.97	62.1	62.53	62.32	5.97	61.8	62.12	61.96	5.97	61.74	60.38	61.06	7.31	2.98	58.65	59.3	58.98	2.98	58.47	59.39	58.93
6.03	61.85	62.27	62.06	6.03	61.79	61.92	61.85	6.03	61.4	59.83	60.62	7.14	3.01	59.09	59.55	59.32	3.01	58.61	59.7	59.15
6.09	62.03	62.59	62.31	6.09	62.1	62.19	62.14	6.09	61.23	59.81	60.52	7.2	3.04	58.98	59.39	59.18	3.04	58.48	59.27	58.88
6.15	62.01	62.49	62.25	6.15	62.06	61.88	61.97	6.15	61.41	60.28	60.85	7.34	3.07	59.05	59.53	59.29	3.07	58.4	59.3	58.85
6.21	61.86	62.25	62.06	6.21	62.21	62.18	62.19	6.21	61.46	60.24	60.85	7.4	3.1	58.68	59.39	59.04	3.11	58.42	59.29	58.85
6.27	62.09	62.41	62.25	6.27	62.1	62.07	62.09	6.27	61.24	60.01	60.62	7.2	3.14	59.06	59.45	59.25	3.14	58.43	59.44	58.94
6.33	62.08	62.67	62.38	6.33	61.91	61.84	61.88	6.33	61.6	60.22	60.91	7.22	3.17	58.93	59.6	59.26	3.17	58.52	59.46	58.99
6.39	62.02	62.37	62.2	6.39	61.9	62.09	62	6.39	61.54	60.34	60.94	7.33	3.2	58.83	59.37	59.1	3.2	58.68	59.39	59.04
6.45	62.17	62.37	62.27	6.45	61.97	61.94	61.96	6.45	61.48	60.41	60.94	7.45	3.23	58.86	59.5	59.18	3.23	58.33	59.71	59.02
6.51	61.55	61.99	61.77	6.51	62.08	62.16	62.12	6.51	61.6	60.52	61.06	7.42	3.26	58.8	59.45	59.13	3.26	58.7	59.52	59.11
6.57	61.99	62.26	62.12	6.57	61.95	61.95	61.95	6.57	61.26	59.91	60.58	7.07	3.29	58.85	59.49	59.17	3.29	58.45	59.56	59.01
6.63	61.84	62.24	62.04	6.63	62.13	62.12	62.13	6.63	61.58	60.37	60.97	7.28	3.32	58.8	59.33	59.07	3.32	58.29	59.38	58.84
6.69	62.21	62.44	62.33	6.69	61.92	62.08	62	6.69	61.65	60.48	61.07	7.42	3.35	58.89	59.5	59.2	3.35	58.48	59.47	58.98
6.75	61.67	62.26	61.97	6.75	61.84	62.22	62.03	6.75	61.2	60.02	60.61	7.24	3.38	59.02	59.61	59.31	3.38	58.55	59.59	59.07
6.81	62.02	62.26	62.14	6.81	62.07	62.15	62.11	6.81	61.39	60.07	60.73	7.23	3.41	58.73	59.32	59.03	3.41	58.48	59.38	58.93
6.87	62.02	62.41	62.21	6.87	61.91	62.01	61.96	6.87	61.22	59.91	60.56	7.17	3.44	59.02	59.65	59.34	3.44	58.32	59.5	58.91

6.93	61.92	62.29	62.1	6.93	61.68	61.77	61.72	6.93	61.47	60.3	60.88	7.37	3.47	58.91	59.37	59.14	3.47	58.5	59.61	59.06
6.99	61.57	61.98	61.77	6.99	61.87	61.75	61.81	6.99	61.17	60.13	60.65	7.27	3.5	59.04	59.55	59.29	3.5	58.51	59.53	59.02
7.05	61.79	62.15	61.97	7.05	61.98	62.02	62	7.05	61.64	60.18	60.91	7.32	3.53	58.68	59.36	59.02	3.53	58.49	59.61	59.05
7.11	62.18	62.51	62.35	7.11	62.12	62.21	62.17	7.11	61.61	60.17	60.89	7.26	3.56	58.88	59.38	59.13	3.56	58.37	59.5	58.93
7.17	61.79	62.33	62.06	7.17	62.27	62.29	62.28	7.17	61.25	60.34	60.79	7.42	3.59	58.59	59.35	58.97	3.59	58.31	59.22	58.77
7.23	61.88	62.35	62.12	7.24	61.96	62.15	62.05	7.23	61.08	60.06	60.57	7.29	3.62	58.91	59.34	59.12	3.62	58.54	59.58	59.06
7.3	61.8	62.39	62.09	7.3	61.87	61.94	61.91	7.3	61.3	60.06	60.68	7.31	3.65	58.84	59.34	59.09	3.65	58.49	59.43	58.96
7.36	61.78	62.21	62	7.36	62.11	62.11	62.11	7.36	61.3	60.01	60.65	7.14	3.68	58.79	59.55	59.17	3.68	58.86	59.96	59.41
7.42	61.89	62.29	62.09	7.42	61.96	62.07	62.01	7.42	61.18	60.08	60.63	7.3	3.71	58.95	59.44	59.19	3.71	58.73	59.67	59.2
7.48	61.84	62.42	62.13	7.48	62.14	62.25	62.19	7.48	61.94	60.55	61.25	7.47	3.74	58.84	59.45	59.14	3.74	58.55	59.56	59.05
7.54	62.1	62.41	62.26	7.54	62.04	62.04	62.04	7.54	61.63	60.34	60.99	7.29	3.77	58.72	59.41	59.07	3.77	58.58	59.32	58.95
7.6	61.98	62.51	62.25	7.6	62.56	62.61	62.58	7.6	61.02	59.59	60.3	7.13	3.8	59.08	59.44	59.26	3.8	58.24	59.45	58.85
7.66	61.94	62.35	62.15	7.66	62.44	62.35	62.4	7.66	61.36	60.15	60.75	7.27	3.83	58.97	59.4	59.18	3.83	58.41	59.22	58.81
7.72	61.49	62.18	61.84	7.72	61.7	61.72	61.71	7.72	61.15	59.9	60.53	7.16	3.86	58.9	59.46	59.18	3.86	58.23	59.24	58.73
7.78	61.98	62.42	62.2	7.78	62.44	62.33	62.38	7.78	61.5	60.17	60.84	7.25	3.89	58.72	59.53	59.13	3.89	58.52	59.61	59.06
7.84	61.77	62.25	62.01	7.84	62.43	62.24	62.33	7.84	61.49	60.24	60.87	7.28	3.92	58.88	59.3	59.09	3.92	58.8	59.79	59.29
7.9	61.51	62.15	61.83	7.9	61.85	61.81	61.83	7.9	61.06	59.95	60.51	7.28	3.95	58.92	59.31	59.12	3.95	58.55	59.63	59.09
7.96	61.8	62.16	61.98	7.96	61.96	61.99	61.97	7.96	61.28	60.12	60.7	7.35	3.98	58.92	59.62	59.27	3.98	58.66	59.48	59.07
8.02	61.69	62.21	61.95	8.02	61.83	61.77	61.8	8.02	61.37	60.37	60.87	7.38	4.01	58.96	59.4	59.18	4.01	58.55	59.55	59.05
8.08	61.82	62.32	62.07	8.08	62.16	62.32	62.24	8.08	61.33	59.96	60.65	7.12	4.04	58.7	59.11	58.91	4.04	58.52	59.43	58.98
8.14	61.99	62.38	62.18	8.14	62.02	62.13	62.07	8.14	61.51	60.22	60.86	7.29	4.07	58.8	59.47	59.14	4.07	58.64	59.5	59.07
8.2	61.88	62.24	62.06	8.2	61.88	61.95	61.92	8.2	61.42	60.11	60.76	7.16	4.1	58.86	59.57	59.21	4.1	58.69	59.69	59.19
8.26	61.92	62.32	62.12	8.26	62.07	62.13	62.1	8.26	61.17	59.83	60.5	7.15	4.13	58.76	59.28	59.02	4.13	58.33	59.11	58.72
8.32	61.73	62.27	62	8.32	62.33	62.59	62.46	8.32	61.43	60.17	60.8	7.29	4.16	58.99	59.56	59.28	4.16	58.39	59.31	58.85
8.38	61.87	62.09	61.98	8.38	61.86	61.97	61.92	8.38	61.45	60.51	60.98	7.44	4.19	58.91	59.4	59.16	4.19	58.47	59.41	58.94
8.44	62.02	62.4	62.21	8.44	61.86	61.87	61.86	8.44	61.29	60.16	60.72	7.4	4.22	58.79	59.4	59.09	4.22	58.63	59.45	59.04
8.5	62	62.46	62.23	8.5	61.85	61.89	61.87	8.5	61.19	59.71	60.45	7.11	4.25	58.81	59.49	59.15	4.25	58.31	59.55	58.93
8.56	61.99	62.46	62.23	8.56	61.97	62.08	62.03	8.56	62.04	60.68	61.36	7.41	4.28	58.69	59.33	59.01	4.28	58.59	59.49	59.04
8.62	62.05	62.4	62.22	8.62	61.92	61.93	61.93	8.62	61.26	60.19	60.73	7.29	4.31	58.45	59.18	58.81	4.31	58.55	59.5	59.03
8.68	62	62.39	62.19	8.68	62.28	62.06	62.17	8.68	61.45	60.45	60.95	7.39	4.34	58.85	59.4	59.13	4.34	58.38	59.46	58.92

8.74	61.99	62.33	62.16	8.74	62.1	61.93	62.01	8.74	61.26	60.02	60.64	7.22	4.37	58.91	59.39	59.15	4.37	58.55	59.25	58.9
8.8	61.88	62.34	62.11	8.8	62.1	62.16	62.13	8.8	61.53	60.24	60.88	7.32	4.4	58.97	59.64	59.31	4.4	58.33	59.61	58.97
8.86	61.87	62.21	62.04	8.86	61.93	62.22	62.07	8.86	61.48	60.09	60.78	7.21	4.43	58.85	59.38	59.12	4.43	58.69	59.55	59.12
8.92	62.18	62.44	62.31	8.92	62.12	62.2	62.16	8.92	61.14	59.91	60.53	7.14	4.46	58.98	59.41	59.2	4.46	58.55	59.5	59.02
8.98	61.89	62.21	62.05	8.98	62.12	62.17	62.14	8.98	60.99	59.68	60.33	7.09	4.49	58.62	59.23	58.93	4.49	58.4	59.44	58.92
9.04	61.97	62.32	62.15	9.04	62.24	61.98	62.11	9.04	61.43	60.22	60.82	7.3	4.52	58.9	59.31	59.1	4.52	58.44	59.41	58.93
9.1	61.83	62.02	61.92	9.1	62.2	62.45	62.32	9.1	61.25	60.17	60.71	7.28	4.55	58.95	59.48	59.21	4.55	58.35	59.37	58.86
9.16	61.93	62.27	62.1	9.16	62.06	62.17	62.11	9.16	61.49	60.16	60.82	7.28	4.58	58.72	59.46	59.09	4.58	58.4	59.26	58.83
9.22	61.7	62.3	62	9.22	62.01	61.91	61.96	9.22	61.16	59.82	60.49	7.16	4.61	58.79	59.25	59.02	4.61	58.28	59.5	58.89
9.29	61.73	62.26	62	9.28	61.99	61.93	61.96	9.28	61.42	60.01	60.71	7.12	4.64	58.92	59.52	59.22	4.64	58.27	59.46	58.87
9.35	61.87	62.3	62.08	9.35	62.06	62.03	62.04	9.34	61.52	60.17	60.85	7.25	4.67	58.94	59.47	59.2	4.67	58.47	59.43	58.95
9.41	61.59	62.03	61.81	9.41	62.08	62.14	62.11	9.41	61.56	60.36	60.96	7.37	4.7	58.92	59.52	59.22	4.7	58.53	59.53	59.03
9.47	61.92	62.32	62.12	9.47	62.01	61.99	62	9.47	61.73	60.48	61.11	7.42	4.73	58.98	59.36	59.17	4.73	58.31	59.41	58.86
9.53	62.01	62.38	62.19	9.53	62	62.09	62.05	9.53	61.61	60.45	61.03	7.48	4.76	58.99	59.56	59.27	4.76	58.34	59.05	58.7
9.59	61.87	62.05	61.96	9.59	61.7	61.73	61.71	9.59	61.37	60.33	60.85	7.37	4.79	58.61	59.31	58.96	4.79	58.35	59.55	58.95
9.65	61.9	62.34	62.12	9.65	61.99	61.93	61.96	9.65	61.02	59.81	60.42	7.11	4.82	58.78	59.26	59.02	4.82	58.54	59.4	58.97
9.71	62.06	62.28	62.17	9.71	61.68	61.77	61.72	9.71	61.38	59.94	60.66	7.18	4.85	58.66	59.25	58.95	4.85	58.31	59.48	58.89
9.77	61.55	62.14	61.85	9.77	61.77	61.92	61.84	9.77	61.24	60.12	60.68	7.24	4.88	58.75	59.38	59.07	4.88	58.5	59.32	58.91
9.83	61.78	62.29	62.03	9.83	61.9	62.23	62.06	9.83	61.02	59.69	60.35	7.15	4.91	58.87	59.47	59.17	4.91	58.62	59.46	59.04
9.89	61.67	62.06	61.86	9.89	61.76	62.15	61.96	9.89	61.48	60.15	60.81	7.28	4.94	58.86	59.39	59.13	4.94	58.54	59.5	59.02
9.95	62	62.47	62.23	9.95	61.95	62.08	62.02	9.95	61.51	60.34	60.93	7.36	4.97	58.83	59.37	59.1	4.97	58.48	59.59	59.03
				10.01	61.99	62.16	62.08						5	58.67	59.13	58.9	5	58.6	59.59	59.1
			62.17				62.09				60.81					59.17				58.99

Table 7.15: Contact angle measurement for millerite electrode at pH 12 conditioned at 0.3 V potential under 0.01 M KEX

Trial 1				Trial 2				Trial 3				Trial 4				Trial 5			
Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]	Time [s]	CA left [°]	CA right [°]	CA mean [°]
0	68.54	66.14	67.34	0	74.74	73.5	74.12	0	78.14	78.13	78.14	0	72.86	71.7	72.28	0	66.78	66.39	66.58
0.06	68.25	65.94	67.09	0.06	74.6	73.39	74	0.06	78.25	78.14	78.19	0.06	72.65	71.51	72.08	0.06	66.64	66.17	66.4
0.12	68.35	65.97	67.16	0.12	74.65	73.38	74.01	0.12	78.14	78.13	78.14	0.12	72.53	71.4	71.97	0.12	67.04	66.37	66.71
0.18	68.4	66.04	67.22	0.18	74.61	73.41	74.01	0.18	78.12	78.11	78.11	0.18	72.67	71.46	72.07	0.18	67.12	66.3	66.71
0.24	68.49	65.87	67.18	0.24	74.44	73.6	74.02	0.24	78.03	78.02	78.03	0.24	72.67	71.56	72.11	0.24	67.04	66.25	66.64
0.3	68.55	66.01	67.28	0.3	74.72	73.27	73.99	0.3	78.13	78.12	78.13	0.3	72.8	71.64	72.22	0.3	67	66.26	66.63
0.36	68.51	65.91	67.21	0.36	74.4	73.48	73.94	0.36	78.12	78.07	78.09	0.36	72.78	71.56	72.17	0.36	67.12	66.31	66.72
0.42	68.56	65.96	67.26	0.42	74.44	73.33	73.89	0.42	78.02	78.14	78.08	0.42	72.83	71.55	72.19	0.42	67.14	66.28	66.71
0.48	68.6	65.9	67.25	0.48	74.78	73.48	74.13	0.48	78.21	77.97	78.09	0.48	72.66	71.5	72.08	0.48	66.92	66.11	66.52
0.54	68.57	65.87	67.22	0.54	74.83	73.68	74.25	0.54	77.99	78.34	78.17	0.54	72.67	71.34	72.01	0.54	67.11	66.15	66.63
0.6	68.47	66.12	67.3	0.6	74.74	73.42	74.08	0.6	77.86	78.07	77.97	0.6	72.83	71.74	72.28	0.6	66.82	66.22	66.52
0.66	68.61	66	67.31	0.66	74.64	73.74	74.19	0.66	77.89	78.05	77.97	0.66	72.84	71.6	72.22	0.66	67.12	66.35	66.73
0.72	68.54	65.88	67.21	0.72	74.61	73.27	73.94	0.72	78.1	77.88	77.99	0.72	72.9	71.72	72.31	0.72	67.07	66.43	66.75
0.78	68.57	65.87	67.22	0.78	74.37	73.34	73.86	0.78	77.78	78.05	77.92	0.78	72.94	71.69	72.31	0.78	66.89	66.21	66.55
0.84	68.45	65.9	67.18	0.84	74.58	73.46	74.02	0.84	77.96	77.94	77.95	0.84	72.74	71.56	72.15	0.84	66.66	66.2	66.43
0.9	68.58	65.82	67.2	0.9	74.4	73.48	73.94	0.9	77.97	78.1	78.04	0.9	72.62	71.2	71.91	0.9	66.98	66.34	66.66
0.96	68.64	65.9	67.27	0.96	74.23	73.4	73.82	0.96	78.13	77.94	78.03	0.96	72.81	71.45	72.13	0.96	67.24	66.33	66.78
1.02	68.63	65.97	67.3	1.02	74.7	73.43	74.06	1.02	77.96	78.04	78	1.02	73.06	71.79	72.42	1.02	67.03	66.01	66.52
1.09	68.33	66.07	67.2	1.09	74.76	73.47	74.11	1.09	77.81	78.1	77.95	1.09	72.7	71.56	72.13	1.09	67.13	66.24	66.68
1.15	68.42	66	67.21	1.15	74.69	73.26	73.97	1.15	78.21	77.67	77.94	1.15	72.78	71.41	72.1	1.15	66.97	66.01	66.49
1.21	68.26	66.15	67.2	1.21	74.36	73.37	73.87	1.21	77.97	78.14	78.05	1.21	72.8	71.25	72.02	1.21	67.22	66.27	66.75
1.27	68.38	66.19	67.28	1.27	74.54	73.34	73.94	1.27	78	77.78	77.89	1.27	72.79	71.51	72.15	1.27	66.92	66.19	66.56
1.33	68.33	66	67.17	1.33	74.37	73.42	73.9	1.33	77.9	77.96	77.93	1.33	72.84	71.5	72.17	1.33	67.04	66.17	66.6
1.39	68.29	65.99	67.14	1.39	74.61	73.42	74.02	1.39	77.91	78.06	77.98	1.39	72.96	71.74	72.35	1.39	66.89	66.39	66.64
1.45	68.46	66.05	67.26	1.45	74.78	73.41	74.1	1.45	78.02	78.01	78.01	1.45	72.69	71.56	72.13	1.45	66.85	66.36	66.6
1.51	68.45	66	67.22	1.51	74.63	73.55	74.09	1.51	77.81	78.05	77.93	1.51	72.68	71.67	72.17	1.51	66.79	66.39	66.59

1.57	68.4	65.91	67.15	1.57	74.78	73.48	74.13	1.57	78.01	77.93	77.97	1.57	72.69	71.6	72.15	1.57	66.81	66.11	66.46
1.63	68.35	65.92	67.14	1.63	74.52	73.56	74.04	1.63	78.05	77.92	77.99	1.63	72.78	71.69	72.24	1.63	67.09	66.31	66.7
1.69	68.62	65.94	67.28	1.69	74.48	73.19	73.83	1.69	77.89	77.99	77.94	1.69	72.86	71.63	72.24	1.69	66.87	66.06	66.47
1.75	68.58	66.04	67.31	1.75	74.64	73.32	73.98	1.75	77.82	78.03	77.93	1.75	72.51	71.48	72	1.75	67.03	66.31	66.67
1.81	68.54	65.87	67.21	1.81	74.6	73.36	73.98	1.81	77.75	78.13	77.94	1.81	72.72	71.64	72.18	1.81	67.03	66.34	66.68
1.87	68.46	65.93	67.19	1.87	74.64	73.53	74.09	1.87	78.19	77.77	77.98	1.87	72.61	71.39	72	1.87	66.94	66.23	66.58
1.93	68.35	65.9	67.13	1.93	74.44	73.61	74.03	1.93	77.81	77.99	77.9	1.93	72.79	71.76	72.27	1.93	67.09	66.37	66.73
1.99	68.35	65.98	67.16	1.99	74.51	73.46	73.98	1.99	77.73	77.94	77.84	1.99	72.67	71.44	72.05	1.99	66.88	66.23	66.56
2.05	68.57	66.04	67.3	2.05	74.6	73.63	74.12	2.05	77.76	77.84	77.8	2.05	72.88	71.64	72.26	2.05	66.85	66.35	66.6
2.11	68.37	65.77	67.07	2.11	74.65	73.49	74.07	2.11	78.01	77.85	77.93	2.11	72.94	71.52	72.23	2.11	66.95	66.15	66.55
2.17	68.46	65.97	67.21	2.17	74.75	73.55	74.15	2.17	77.75	77.87	77.81	2.17	72.64	71.19	71.91	2.17	67.01	66.31	66.66
2.23	68.36	65.92	67.14	2.23	74.82	73.43	74.13	2.23	77.85	77.85	77.85	2.23	72.96	71.5	72.23	2.23	66.97	66.41	66.69
2.29	68.55	65.88	67.21	2.29	74.54	73.43	73.99	2.29	77.59	77.96	77.78	2.29	72.55	71.34	71.94	2.29	66.95	66.4	66.68
2.35	68.45	66.05	67.25	2.35	74.46	73.43	73.94	2.35	78.02	77.87	77.95	2.35	72.61	71.33	71.97	2.35	67.06	66.24	66.65
2.41	68.42	65.87	67.15	2.41	74.52	73.27	73.9	2.41	77.75	77.74	77.74	2.41	72.6	71.51	72.06	2.41	67.11	66.14	66.63
2.47	68.45	66.01	67.23	2.47	74.59	73.45	74.02	2.47	78.16	77.67	77.92	2.47	72.55	71.38	71.96	2.47	66.97	66.14	66.55
2.53	68.37	66.02	67.2	2.53	74.63	73.52	74.08	2.53	77.67	77.83	77.75	2.53	73.03	71.6	72.31	2.53	67.02	66.05	66.53
2.59	68.35	66.03	67.19	2.59	74.68	73.61	74.15	2.59	77.82	77.71	77.76	2.59	72.52	71.32	71.92	2.59	67.02	66.27	66.65
2.65	68.28	65.89	67.08	2.65	74.48	73.39	73.94	2.65	78.01	77.65	77.83	2.65	72.65	71.41	72.03	2.65	67.13	66.29	66.71
2.71	68.45	65.85	67.15	2.71	74.29	73.39	73.84	2.71	77.69	78.09	77.89	2.71	72.85	71.57	72.21	2.71	67.13	66.21	66.67
2.77	68.5	66.08	67.29	2.77	74.61	73.35	73.98	2.77	77.97	77.69	77.83	2.77	72.75	71.57	72.16	2.77	67.08	66.27	66.67
2.83	68.43	65.82	67.13	2.83	74.49	73.4	73.95	2.83	77.75	77.84	77.79	2.83	72.62	71.34	71.98	2.83	66.71	66.25	66.48
2.89	68.39	65.86	67.13	2.89	74.73	73.46	74.09	2.89	77.95	77.71	77.83	2.89	72.98	71.68	72.33	2.89	66.96	66.2	66.58
2.95	68.49	65.7	67.09	2.95	74.36	73.44	73.9	2.95	77.66	77.92	77.79	2.95	72.84	71.77	72.31	2.95	66.89	66.22	66.56
3.01	68.48	65.95	67.22	3.01	74.45	73.27	73.86	3.01	77.85	77.86	77.85	3.01	72.58	71.54	72.06	3.01	66.84	66.26	66.55
3.07	68.53	65.81	67.17	3.07	74.48	73.32	73.9	3.07	78.06	77.55	77.81	3.07	72.83	71.68	72.26	3.07	67.09	66.23	66.66
3.14	68.41	65.95	67.18	3.14	74.3	73.37	73.84	3.14	77.73	77.7	77.72	3.14	72.58	71.43	72.01	3.13	66.65	66.14	66.39
3.2	68.46	65.96	67.21	3.2	74.63	73.38	74	3.2	78.04	77.73	77.88	3.2	72.75	71.46	72.1	3.2	66.9	66.21	66.55
3.26	68.49	65.9	67.2	3.26	74.53	73.54	74.04	3.26	77.82	77.76	77.79	3.26	72.67	71.39	72.03	3.26	66.99	66.22	66.6
3.32	68.51	65.87	67.19	3.32	74.36	73.31	73.83	3.32	77.69	77.66	77.67	3.32	72.66	71.52	72.09	3.32	66.95	66.04	66.49

3.38	68.48	66.01	67.25	3.38	74.52	73.59	74.06	3.38	77.6	77.64	77.62	3.38	72.77	71.68	72.22	3.38	66.98	66.28	66.63
3.44	68.45	65.92	67.18	3.44	74.71	73.38	74.05	3.44	77.71	77.72	77.72	3.44	72.64	71.5	72.07	3.44	67.09	66.35	66.72
3.5	68.38	65.96	67.17	3.5	74.58	73.17	73.87	3.5	77.74	77.68	77.71	3.5	72.68	71.46	72.07	3.5	66.74	66.11	66.43
3.56	68.36	66.01	67.18	3.56	74.61	73.32	73.97	3.56	77.67	77.84	77.76	3.56	72.59	71.49	72.04	3.56	66.96	66.42	66.69
3.62	68.35	65.81	67.08	3.62	74.46	73.52	73.99	3.62	77.74	77.41	77.58	3.62	72.79	71.67	72.23	3.62	67.02	66.27	66.64
3.68	68.42	65.95	67.19	3.68	74.47	73.63	74.05	3.68	77.84	77.75	77.79	3.68	72.73	71.68	72.2	3.68	66.72	66.08	66.4
3.74	68.47	65.78	67.13	3.74	74.72	73.37	74.04	3.74	77.68	77.77	77.73	3.74	72.98	71.65	72.32	3.74	66.97	66.17	66.57
3.8	68.41	65.84	67.12	3.8	74.44	73.37	73.91	3.8	77.69	77.7	77.69	3.8	72.77	71.53	72.15	3.8	66.87	66.05	66.46
3.86	68.32	65.85	67.08	3.86	74.5	73.3	73.9	3.86	77.72	77.84	77.78	3.86	72.75	71.51	72.13	3.86	67.2	66.3	66.75
3.92	68.46	65.87	67.16	3.92	74.34	73.37	73.86	3.92	77.76	77.58	77.67	3.92	72.78	71.47	72.12	3.92	67.01	66.16	66.58
3.98	68.46	65.91	67.18	3.98	74.47	73.25	73.86	3.98	77.62	77.77	77.7	3.98	72.56	71.41	71.98	3.98	66.9	66.13	66.51
4.04	68.42	65.89	67.15	4.04	74.46	73.5	73.98	4.04	77.71	77.53	77.62	4.04	72.61	71.44	72.03	4.04	67.01	66.19	66.6
4.1	68.49	65.87	67.18	4.1	74.28	73.2	73.74	4.1	77.59	77.59	77.59	4.1	72.64	71.45	72.04	4.1	66.76	66.08	66.42
4.16	68.54	65.86	67.2	4.16	74.71	73.26	73.99	4.16	77.63	77.65	77.64	4.16	72.64	71.29	71.96	4.16	67.07	66.19	66.63
4.22	68.57	66.03	67.3	4.22	74.49	73.23	73.86	4.22	77.61	77.68	77.65	4.22	72.74	71.49	72.12	4.22	66.82	65.96	66.39
4.28	68.4	65.99	67.19	4.28	74.52	73.54	74.03	4.28	77.65	77.58	77.62	4.28	72.64	71.23	71.93	4.28	66.91	65.99	66.45
4.34	68.39	65.86	67.13	4.34	74.75	73.59	74.17	4.34	77.64	77.69	77.67	4.34	72.47	71.4	71.94	4.34	67.08	66.17	66.63
4.4	68.44	65.81	67.12	4.4	74.46	73.42	73.94	4.4	77.69	77.48	77.58	4.4	72.75	71.65	72.2	4.4	66.77	66	66.38
4.46	68.59	65.63	67.11	4.46	74.67	73.39	74.03	4.46	77.54	77.74	77.64	4.46	72.52	71.49	72.01	4.46	66.92	66.17	66.55
4.52	68.46	65.73	67.09	4.52	74.67	73.57	74.12	4.52	77.59	77.46	77.53	4.52	72.52	71.54	72.03	4.52	66.87	66.14	66.5
4.58	68.53	65.88	67.2	4.58	74.78	73.41	74.1	4.58	77.58	77.77	77.68	4.58	72.32	71.35	71.84	4.58	66.5	66.21	66.35
4.64	68.37	65.93	67.15	4.64	74.17	73.4	73.79	4.64	77.63	77.73	77.68	4.64	72.64	71.44	72.04	4.64	66.58	66.64	66.61
4.7	68.47	65.86	67.16	4.7	74.4	73.14	73.77	4.7	77.65	77.59	77.62	4.7	72.65	71.54	72.09	4.7	66.67	66.42	66.54
4.76	68.23	65.89	67.06	4.76	74.27	73.37	73.82	4.76	77.69	77.71	77.7	4.76	72.75	71.58	72.17	4.76	66.89	66.08	66.49
4.82	68.41	66.05	67.23	4.82	74.57	73.39	73.98	4.82	77.87	77.35	77.61	4.82	72.94	71.66	72.3	4.82	67.26	65.91	66.58
4.88	68.45	66.1	67.27	4.88	74.13	73.2	73.67	4.88	77.53	77.58	77.56	4.88	72.73	71.51	72.12	4.88	67.29	66.07	66.68
4.94	68.27	65.9	67.09	4.94	74.48	73.19	73.84	4.94	77.61	77.58	77.6	4.94	72.58	71.59	72.09	4.94	67.22	66.18	66.7
5	68.26	65.9	67.08	5	74.51	73.45	73.98	5	77.56	77.56	77.56	5	72.44	71.49	71.97	5	66.71	66.1	66.4
5.06	68.25	66.02	67.14	5.06	74.51	73.26	73.89	5.06	77.67	77.61	77.64	5.06	72.75	71.52	72.14	5.06	66.82	66.17	66.49
5.12	68.2	65.86	67.03	5.12	74.43	73.31	73.87	5.12	77.74	77.39	77.57	5.12	72.79	71.47	72.13	5.12	66.93	66.24	66.59

5.19	68.39	65.91	67.15	5.19	74.45	73.41	73.93	5.18	77.43	77.69	77.56	5.19	72.82	71.51	72.16	5.18	66.88	66.18	66.53
5.25	68.27	66	67.13	5.25	74.34	73.4	73.87	5.25	77.7	77.52	77.61	5.25	72.65	71.48	72.07	5.25	66.99	66.28	66.64
5.31	68.33	65.85	67.09	5.31	74.34	73.32	73.83	5.31	77.39	77.56	77.48	5.31	72.79	71.58	72.18	5.31	66.87	66.14	66.5
5.37	68.34	66	67.17	5.37	74.49	73.49	73.99	5.37	77.59	77.35	77.47	5.37	72.69	71.58	72.14	5.37	67.07	66.27	66.67
5.43	68.29	65.94	67.12	5.43	74.5	73.3	73.9	5.43	77.67	77.66	77.67	5.43	72.76	71.5	72.13	5.43	66.96	66.18	66.57
5.49	68.29	66.08	67.18	5.49	74.37	73.18	73.77	5.49	77.34	77.41	77.37	5.49	72.68	71.51	72.09	5.49	66.94	66.16	66.55
5.55	68.44	65.81	67.13	5.55	74.42	73.42	73.92	5.55	77.7	77.38	77.54	5.55	72.57	71.51	72.04	5.55	67.02	66.22	66.62
5.61	68.34	65.82	67.08	5.61	74.2	73.71	73.95	5.61	77.5	77.55	77.53	5.61	72.6	71.28	71.94	5.61	66.98	66.16	66.57
5.67	68.54	65.88	67.21	5.67	74.43	73.31	73.87	5.67	77.54	77.4	77.47	5.67	72.66	71.32	71.99	5.67	66.95	66.23	66.59
5.73	68.35	65.73	67.04	5.73	74.23	73.35	73.79	5.73	77.6	77.44	77.52	5.73	72.83	71.39	72.11	5.73	66.89	66.27	66.58
5.79	68.38	65.85	67.11	5.79	74.36	73.21	73.78	5.79	77.36	77.68	77.52	5.79	72.88	71.47	72.17	5.79	66.83	66.27	66.55
5.85	68.5	65.88	67.19	5.85	74.44	73.19	73.81	5.85	77.66	77.55	77.61	5.85	72.68	71.35	72.02	5.85	66.89	66.03	66.46
5.91	68.49	65.88	67.18	5.91	74.6	73.32	73.96	5.91	77.45	77.63	77.54	5.91	72.71	71.52	72.11	5.91	67.04	66.11	66.57
5.97	68.52	65.74	67.13	5.97	74.63	73.5	74.06	5.97	77.59	77.42	77.51	5.97	72.73	71.52	72.12	5.97	66.78	65.96	66.37
6.03	68.42	65.99	67.2	6.03	74.4	73.44	73.92	6.03	77.5	77.55	77.53	6.03	72.54	71.36	71.95	6.03	67.07	66.36	66.71
6.09	68.37	65.9	67.14	6.09	74.45	73.24	73.84	6.09	77.65	77.63	77.64	6.09	72.65	71.47	72.06	6.09	66.84	66	66.42
6.15	68.27	65.99	67.13	6.15	74.35	73.43	73.89	6.15	77.46	77.5	77.48	6.15	72.33	71.33	71.83	6.15	66.96	66.23	66.59
6.21	68.33	66.01	67.17	6.21	74.52	73.29	73.9	6.21	77.4	77.58	77.49	6.21	72.53	71.41	71.97	6.21	67.01	66.15	66.58
6.27	68.37	65.83	67.1	6.27	74.3	73.36	73.83	6.27	77.38	77.47	77.43	6.27	72.58	71.5	72.04	6.27	66.87	66.03	66.45
6.33	68.31	65.87	67.09	6.33	74.3	73.26	73.78	6.33	77.45	77.43	77.44	6.33	72.78	71.66	72.22	6.33	66.92	66.02	66.47
6.39	68.21	65.77	66.99	6.39	74.37	73.33	73.85	6.39	77.5	77.43	77.46	6.39	72.61	71.58	72.09	6.39	67.18	66.11	66.65
6.45	68.23	65.78	67.01	6.45	74.38	73.47	73.93	6.45	77.38	77.5	77.44	6.45	72.59	71.35	71.97	6.45	67.01	66.04	66.53
6.51	68.41	65.91	67.16	6.51	74.5	73.22	73.86	6.51	77.55	77.29	77.42	6.51	72.53	71.37	71.95	6.51	67.16	66.13	66.64
6.57	68.39	65.85	67.12	6.57	74.35	73.41	73.88	6.57	77.32	77.53	77.43	6.57	72.56	71.36	71.96	6.57	67.13	66.31	66.72
6.63	68.39	65.99	67.19	6.63	74.57	73.33	73.95	6.63	77.44	77.32	77.38	6.63	72.53	71.34	71.94	6.63	66.87	66.18	66.52
6.69	68.27	65.97	67.12	6.69	74.47	73.43	73.95	6.69	77.47	77.38	77.42	6.69	72.7	71.59	72.14	6.69	66.74	66.14	66.44
6.75	68.17	65.86	67.02	6.75	74.62	73.26	73.94	6.75	77.42	77.42	77.42	6.75	72.49	71.42	71.95	6.75	66.84	66.26	66.55
6.81	68.41	65.88	67.15	6.81	74.32	73.1	73.71	6.81	77.4	77.46	77.43	6.81	72.52	71.44	71.98	6.81	67	66.23	66.61
6.87	68.33	65.94	67.13	6.87	74.3	73.24	73.77	6.87	77.53	77.42	77.48	6.87	72.46	71.34	71.9	6.87	66.95	66.07	66.51
6.93	68.59	65.95	67.27	6.93	74.43	73.38	73.9	6.93	77.29	77.36	77.32	6.93	72.75	71.46	72.1	6.93	66.65	65.91	66.28

6.99	68.3	65.76	67.03	6.99	74.43	73.4	73.92	6.99	77.6	77.31	77.46	6.99	72.72	71.29	72	6.99	66.67	66.04	66.36
7.05	68.31	65.58	66.94	7.05	74.23	73.21	73.72	7.05	77.43	77.56	77.5	7.05	72.79	71.09	71.94	7.05	66.65	65.96	66.31
7.11	68.37	65.87	67.12	7.11	74.44	73.42	73.93	7.11	77.38	77.5	77.44	7.11	72.65	71.32	71.98	7.11	66.8	66.18	66.49
7.17	68.46	65.79	67.13	7.17	74.38	73.22	73.8	7.17	77.32	77.38	77.35	7.17	72.64	71.29	71.97	7.17	66.79	66.12	66.46
7.23	68.38	65.79	67.08	7.23	74.34	73.23	73.79	7.23	77.56	77.3	77.43	7.23	72.62	71.38	72	7.23	66.94	66.06	66.5
7.3	68.44	65.96	67.2	7.3	74.31	73.24	73.77	7.3	77.35	77.34	77.35	7.3	72.5	71.42	71.96	7.3	66.89	66.18	66.54
7.36	68.28	65.9	67.09	7.36	74.13	73.21	73.67	7.36	77.21	77.22	77.21	7.36	72.29	70.96	71.63	7.36	66.83	65.96	66.4
7.42	68.37	66.03	67.2	7.42	74.44	73.25	73.84	7.42	77.35	77.29	77.32	7.42	72.32	71.15	71.73	7.42	66.91	65.92	66.42
7.48	68.21	65.87	67.04	7.48	74.26	73.27	73.77	7.48	77.43	77.4	77.41	7.48	72.66	71.63	72.15	7.48	66.88	65.98	66.43
7.54	68.4	65.91	67.16	7.54	74.49	73.36	73.93	7.54	77.37	77.53	77.45	7.54	72.37	71.11	71.74	7.54	66.7	66.2	66.45
7.6	68.28	65.74	67.01	7.6	74.45	73.25	73.85	7.6	77.36	77.21	77.28	7.6	72.57	71.36	71.96	7.6	66.7	66.11	66.41
7.66	68.32	65.85	67.09	7.66	74.55	73.33	73.94	7.66	77.43	77.36	77.39	7.66	72.35	71.27	71.81	7.66	66.71	66.1	66.41
7.72	68.35	65.73	67.04	7.72	74.27	73.31	73.79	7.72	77.26	77.35	77.3	7.72	72.52	71.31	71.91	7.72	67.04	65.92	66.48
7.78	68.28	65.89	67.09	7.78	74.48	73.15	73.82	7.78	77.27	77.72	77.5	7.78	72.39	71.1	71.75	7.78	67.09	65.89	66.49
7.84	68.41	65.82	67.11	7.84	74.47	73.15	73.81	7.84	77.49	77.2	77.34	7.84	72.95	71.46	72.2	7.84	67.05	66.09	66.57
7.9	68.37	65.8	67.08	7.9	74.21	73.13	73.67	7.9	77.28	77.36	77.32	7.9	72.61	71.36	71.99	7.9	67.01	66.14	66.57
7.96	68.38	65.87	67.13	7.96	74.3	73.25	73.78	7.96	77.47	77.19	77.33	7.96	72.64	71.1	71.87	7.96	66.8	66.29	66.55
8.02	68.52	65.73	67.12	8.02	74.25	73.2	73.73	8.02	77.15	77.42	77.29	8.02	72.39	71.07	71.73	8.02	66.75	66.1	66.42
8.08	68.27	65.77	67.02	8.08	74.19	73.17	73.68	8.08	77.44	77.23	77.34	8.08	72.69	71.29	71.99	8.08	66.95	66.12	66.53
8.14	68.22	65.91	67.07	8.14	74.39	73.24	73.81	8.14	77.36	77.32	77.34	8.14	72.64	71.14	71.89	8.14	66.89	66.1	66.49
8.2	68.25	65.95	67.1	8.2	74.42	73.43	73.92	8.2	77.37	77.2	77.28	8.2	72.56	71.19	71.87	8.2	67.18	65.83	66.51
8.26	68.25	65.93	67.09	8.26	74.46	73.37	73.91	8.26	77.38	77.32	77.35	8.26	72.63	71.15	71.89	8.26	67.02	66.17	66.59
8.32	68.34	65.82	67.08	8.32	74.12	73.16	73.64	8.32	77.13	77.26	77.19	8.32	72.37	71.11	71.74	8.32	66.72	66.34	66.53
8.38	68.2	66.08	67.14	8.38	74.36	73.15	73.76	8.38	77.25	77.35	77.3	8.38	72.49	71.29	71.89	8.38	66.67	66.21	66.44
8.44	68.28	65.79	67.03	8.44	74.24	73.16	73.7	8.44	77.04	77.36	77.2	8.44	72.71	71.42	72.06	8.44	66.9	66.08	66.49
8.5	68.28	65.95	67.12	8.5	74.44	73.34	73.89	8.5	77.26	77.23	77.25	8.5	72.58	71.46	72.02	8.5	66.98	65.96	66.47
8.56	68.38	65.79	67.08	8.56	74.15	73.22	73.69	8.56	77.34	77.28	77.31	8.56	72.18	72.09	72.13	8.56	66.97	65.88	66.42
8.62	68.37	65.71	67.04	8.62	74.38	73.25	73.82	8.62	77.35	77.25	77.3	8.62	72.45	71.36	71.9	8.62	66.72	65.9	66.31
8.68	68.18	65.8	66.99	8.68	74.39	73.2	73.8	8.68	77.21	77.25	77.23	8.68	72.58	71.41	71.99	8.68	66.94	66.13	66.54
8.74	68.17	65.78	66.97	8.74	74.34	73.13	73.73	8.74	77.12	77.49	77.31	8.74	72.44	71.33	71.88	8.74	66.89	66.21	66.55

8.8	68.28	65.84	67.06	8.8	74.42	73.13	73.77	8.8	77.24	77.21	77.23	8.8	72.49	71.45	71.97	8.8	66.7	66.21	66.46
8.86	68.4	65.66	67.03	8.86	74.31	73.16	73.74	8.86	77.26	77.24	77.25	8.86	72.65	71.55	72.1	8.86	66.5	66.14	66.32
8.92	68.43	65.79	67.11	8.92	74.37	73.27	73.82	8.92	77.19	77.14	77.17	8.92	72.4	71.21	71.81	8.92	66.78	66.01	66.39
8.98	68.44	65.73	67.09	8.98	74.39	73.35	73.87	8.98	77.3	77.07	77.18	8.98	72.57	71.32	71.94	8.98	66.88	66.06	66.47
9.04	68.31	65.68	67	9.04	74.13	73.15	73.64	9.04	77.28	77.27	77.28	9.04	72.28	71	71.64	9.04	66.8	65.98	66.39
9.1	68.31	65.9	67.11	9.1	74.19	73.13	73.66	9.1	77.32	77.14	77.23	9.1	72.37	71.01	71.69	9.1	67.01	66.04	66.52
9.16	68.46	65.71	67.08	9.16	74.28	73.22	73.75	9.16	77.15	77.4	77.27	9.16	72.32	70.94	71.63	9.16	67.05	66.14	66.6
9.22	68.33	65.84	67.08	9.22	74.31	73.05	73.68	9.22	77.37	77.16	77.26	9.22	72.57	71.3	71.94	9.22	66.63	65.97	66.3
9.28	68.29	65.77	67.03	9.28	74.18	73.11	73.65	9.28	77.04	77.35	77.19	9.28	72.42	71.43	71.92	9.28	66.82	66.21	66.51
9.35	68.28	65.91	67.09	9.35	74.12	73.1	73.61	9.35	77.59	77.07	77.33	9.35	72.48	71.31	71.9	9.34	66.89	66.08	66.48
9.41	68.26	65.78	67.02	9.41	74.27	73.1	73.69	9.41	77.06	77.15	77.1	9.41	72.49	71.21	71.85	9.41	66.66	66.23	66.44
9.47	68.21	65.74	66.98	9.47	74.42	73.32	73.87	9.47	77.25	77.14	77.2	9.47	72.62	71.13	71.88	9.47	66.72	66.26	66.49
9.53	68	65.78	66.89	9.53	74.39	73.1	73.74	9.53	77.07	77.37	77.22	9.53	72.39	71.07	71.73	9.53	66.63	66	66.32
9.59	68.25	65.71	66.98	9.59	74.31	73.24	73.78	9.59	77.3	77.31	77.3	9.59	72.58	71.49	72.04	9.59	66.95	66.1	66.53
9.65	68.24	65.84	67.04	9.65	74.21	73.18	73.7	9.65	77.16	77.36	77.26	9.65	72.54	71.04	71.79	9.65	66.77	66.12	66.44
9.71	68.3	65.79	67.05	9.71	74.38	73.43	73.9	9.71	77.16	77.29	77.22	9.71	72.52	71.34	71.93	9.71	66.86	66.07	66.47
9.77	68.34	65.89	67.11	9.77	74.36	73.25	73.81	9.77	77.23	77.17	77.2	9.77	72.4	70.98	71.69	9.77	66.61	65.86	66.24
9.83	68.29	65.81	67.05	9.83	74.2	73.21	73.7	9.83	76.96	77.36	77.16	9.83	72.29	71.15	71.72	9.83	66.72	66.15	66.44
9.89	68.22	65.82	67.02	9.89	74.11	73.23	73.67	9.89	77.36	77.15	77.25	9.89	72.78	71.39	72.09	9.89	66.62	65.96	66.29
9.95	68.28	65.95	67.11	9.95	74.19	73.21	73.7	9.95	77.04	77.36	77.2	9.95	72.46	71.18	71.82	9.95	66.46	65.96	66.21
10.01	68.29	65.81	67.05					10.01	77.21	77.25	77.23					10.01	66.7	65.86	66.28
			67.14				73.9				77.59				72.04				66.53

The selected original data for millerite flotation are summarized in tables below:

Table 7.16: Flotation data summary for millerite in pH 9.2 buffer solution with 1.4 x 10-4 M KEX

NiS pH 9.2 Buffer Solution with 1.4 x 10^{-4} M KEX								
Actual OCPT (V vs SHE)	-0.223	-0.139	-0.012	0.051	0.101	0.178	0.227	0.281
Filter Blank	1.341	1.348	1.341	1.300	1.341	1.348	1.348	1.341
Filter Conc	1.365	1.327	1.326	1.280	1.368	1.336	1.329	1.343
Filter Tails	1.278	1.356	1.281	1.289	1.360	1.349	1.319	1.328
Final Blank	1.340	1.318	1.340	1.290	1.340	1.318	1.318	1.340
Final Conc	1.452	1.415	1.648	1.682	1.846	1.884	1.967	2.257
Final Tails	2.278	2.256	1.903	1.917	2.011	1.805	1.700	1.463
Difference Blank	-0.001	-0.030	-0.001	-0.011	-0.001	-0.030	-0.030	-0.001
Difference Conc	0.086	0.058	0.321	0.392	0.477	0.519	0.609	0.914
Difference Tails	0.999	0.870	0.621	0.618	0.651	0.426	0.351	0.134
Recovery=	7.927	6.269	34.055	38.826	42.287	54.922	63.438	87.217

Table 7.17: Flotation data summary for millerite in pH 12 buffer solution with 1.4 x 10-4 M KEX

NiS pH 12 Buffer Solution with 1.4×10^{-4} M KEX						
Actual OCPT (V vs SHE)	-0.159	-0.039	0.121	0.190	0.223	0.362
Filter Blank	1.348	1.313	1.313	1.348	1.348	1.313
Filter Conc	1.364	1.290	1.294	1.362	1.354	1.292
Filter Tails	1.356	1.302	1.257	1.358	1.351	1.268
Final Blank	1.318	1.295	1.295	1.318	1.318	1.295
Final Conc	1.444	1.832	1.777	1.660	1.551	1.427
Final Tails	2.221	1.683	1.804	2.067	2.014	2.211
Difference Blank	-0.030	-0.018	-0.018	-0.030	-0.030	-0.018
Difference Conc	0.051	0.524	0.465	0.269	0.168	0.118
Difference Tails	0.836	0.364	0.529	0.679	0.633	0.925
Recovery=	5.698	59.006	46.777	28.354	20.940	11.297

Table 7.18: XRF calculation summary for mixed feed containing (0.8 g millerite + 0.8 g chalcopyrite) at different pulp potentials at pH 12 with 1.4 x 10^{-4} M KEX

OCPT conc	0.92631	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	33.717	1.052	0.506	16.231	0.545	17.486
Fe	55.845	17.077	0.306	0.306	17.077		
Ni	58.693	29.710	0.506			0.506	29.710
Cu	63.546	19.500	0.307	0.306	19.432		
				Total Chalco=	52.739	Total NiS=	47.196
				Recovery (wt%)=	48.853		43.718
OCPT tails	0.07369	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	36.527	1.139	0.308	9.890	0.561	17.981
Fe	55.845	12.083	0.216	0.154	8.612		
Ni	58.693	32.913	0.561			0.561	32.913
Cu	63.546	9.800	0.154	0.154	9.800		
				Total Chalco=	28.302	Total NiS=	50.894
				Recovery (wt%)=	2.085523		3.750263
0.2V conc	0.6579	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	33.080	1.032	0.832	26.665	0.200	6.415
Fe	55.845	23.220	0.416	0.416	23.220		0.000

Ni	58.693	16.493	0.281			0.281	16.493
Cu	63.546	27.207	0.428	0.416	26.422		0.000
				Total Chalco=	76.307	Total NiS=	22.908
				Recovery (wt%)=	50.199		15.070
0.2V tails	0.3421	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	32.600	1.017	0.127	4.077	0.890	28.523
Fe	55.845	5.260	0.094	0.064	3.550		0.000
Ni	58.693	55.090	0.939			0.939	55.090
Cu	63.546	4.040	0.064	0.064	4.040		0.000
				Total Chalco=	11.668	Total NiS=	83.613
				Recovery (wt%)=	3.992		28.608
0.3V conc	0.5720	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	33.800	1.054	0.860	27.572	0.194	6.228
Fe	55.845	24.010	0.430	0.430	24.010		0.000
Ni	58.693	14.470	0.247			0.247	14.470
Cu	63.546	27.720	0.436	0.430	27.321		0.000
				Total Chalco=	78.903	Total NiS=	20.698
				Recovery (wt%)=	45.131		11.839
0.3V tails	0.4280	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%

S	32.065	30.940	0.965	0.192	6.159	0.773	24.781
Fe	55.845	6.853	0.123	0.096	5.364		0.000
Ni	58.693	53.257	0.907			0.907	53.257
Cu	63.546	6.103	0.096	0.096	6.103		0.000
				Total Chalco=	17.626	Total NiS=	78.037
				Recovery (wt%)=	7.545		33.402

Table 7.19: XRF calculation summary for mixed feed containing (0.4 g millerite + 1.2 g chalcopyrite) at different pulp potentials at pH 12 with 1.4 x 10^{-4} M KEX

OCPT conc	0.92912	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	35.830	1.117	0.817	26.186	0.263	8.442
Fe	55.845	22.803	0.408	0.408	22.803		
Ni	58.693	15.453	0.263			0.263	15.453
Cu	63.546	25.913	0.408	0.408	25.948		
				Total Chalco=	74.938	Total NiS=	23.896
				Recovery (wt%)=	69.626		22.202
OCPT tails	0.07088	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	34.167	1.066	0.692	22.202	0.373	11.965
Fe	55.845	19.333	0.346	0.346	19.333		
Ni	58.693	21.957	0.374			0.374	21.957
Cu	63.546	22.527	0.354	0.346	21.999		

				Total Chalco=	63.534	Total NiS=	33.922
				Recovery (wt%)=	4.503		2.404
0.2V conc	0.8708	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	35.947	1.121	0.923	29.593	0.150	4.797
Fe	55.845	25.770	0.461	0.461	25.770		0.000
Ni	58.693	8.780	0.150			0.150	8.780
Cu	63.546	29.507	0.464	0.461	29.324		0.000
				Total Chalco=	84.687	Total NiS=	13.577
				Recovery (wt%)=	73.744		11.822
0.2V tails	0.1292	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	33.433	1.043	0.296	9.489	0.747	23.944
Fe	55.845	8.263	0.148	0.148	8.263		0.000
Ni	58.693	45.780	0.780			0.780	45.780
Cu	63.546	12.523	0.197	0.148	9.403		0.000
				Total Chalco=	27.155	Total NiS=	69.724
				Recovery (wt%)=	3.509		9.010
0.3V conc	0.7786	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	35.907	1.120	1.014	32.502	0.056	1.803
Fe	55.845	28.303	0.507	0.507	28.303		0.000
Ni	58.693	3.300	0.056			0.056	3.300
Cu	63.546	32.490	0.511	0.507	32.206		0.000

				Total Chalco=	93.012	Total NiS=	5.103
				Recovery (wt%)=	72.421		3.973
0.3V tails	0.2214	% recovery					
	Atomic Mass	Wt%	Atomic proportion	For Cu:Fe:S2	wt%	For Ni:S	wt%
S	32.065	33.747	1.052	0.200	6.404	0.853	27.343
Fe	55.845	5.577	0.100	0.100	5.577		0.000
Ni	58.693	52.277	0.891			0.891	52.277
Cu	63.546	7.323	0.115	0.100	6.346		0.000
				Total Chalco=	18.326	Total NiS=	79.619
				Recovery (wt%)=	4.057		17.626