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Impact of non-Newtonian droplet on a liquid surface

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Abstract

Each year more Canadians are added to the heart transplant waiting list. The prevalence of heart failure is estimated at 10% of Canadians and is the second leading cause of death in the country, after cancer. Expanding the available donor pool of hearts is thus a priority. A team of medicine, surgery and engineering researchers at the University of Alberta have been developing a transplant assist device for continuous ex-vivo heart perfusion (EVHP), which may increase the potential organ supply by monitoring and rehabilitating donor hearts. A present concern in this system is a leakage leading to blood drip which may be resulting in damage to the blood cells, known as hemolysis. Despite decades of hemolysis-related research, seminal questions remain about how different types of fluid stresses result in red blood cell (RBC) membrane disruption and at what level this contributes to oxidative stress and inflammatory responses. To address this hypothesis, the present work aims to investigate the dynamics of impact force and stress distributions over the entire time domain of drop impact on a liquid surface under a comprehensive range of Froude and Weber numbers. For such, an experimental setup was designed to allow flow measurements with Particle Image Velocimetry (PIV). Particularly, as blood is a shear-thinning fluid, a blood-like, optically transparent, non-Newtonian solution must be used in order to account for the non-linear rheological effects on the flow domain. From a fluid mechanics point of view, while the study of drop impact kinematics has been well explored over the last few decades thanks to high-speed imaging techniques and numerical analysis, research on drop impact dynamics has only gained momentum in the last 10 years and is still requiring further efforts. Quantitative measurements of the stress distributions underneath impacting drops are highly demanded and are important not only for verifying the key assumptions made here, but mainly to understand the phenomenon as a whole. All in all, as it is known that extensional flow causes deformation of a fluid particle, and consequently deforms the RBC membrane *a priori*, the present study will focus on measuring the spatiotemporal features of the shear-stress distributions from early- to late-impact regimes. The presentation will discuss the experimental setup and review preliminary results.