Numerical Study for Drop Transfer between Two Plates

A. Criscione*, C. Chang, I.V. Roisman, C. Tropea, S. Jakirlić, A. Amirfazli†
Institute for Fluid Mechanics and Aerodynamics, Technische Universität Darmstadt, Germany
† Department of Mechanical Engineering, University of Alberta, Edmonton, Canada

Abstract

The central process in off-set printing is transfer of ink from roller to roller, or from a roller onto paper, essentially a drop transfer from one surface to another. Most of the studies to date have examined the phenomenon of drop transfer under quasi-static conditions or within a limited range of influencing parameters, such as plate contact angle, squeeze ratio, approach and departure velocities, drop volume, or liquid properties. Developing a numerical code to allow the full range of parameters to be probed will be a very useful tool to understand the drop transfer phenomenon. In this study a volume of fluid (VOF) code is developed to study the drop transfer from one surface to another under dynamic as well as near quasi-static conditions. The phenomenon is modeled by holding one surface stationary with a drop placed on it (see Fig. 1), while an upper surface is moved towards the drop to make contact. Movement of the upper surface if arbitrary, allowing all stages of printing to be simulated. Initial results show interesting phenomenon not seen in the past. For example, for surfaces of similar hydrophobicity under slow or quasi-static conditions, it was shown that the initial drop, after contact with upper surface and subsequent pulling away, will result in a drop transfer ratio of 50% wt. However, under very high approach and departure velocities of 0.2 m/s, the transfer ratio fall significantly below 50% (see Fig. 2). The appearance of satellite drops is also of note at high departure velocities, which has not been reported before. The effect of other parameters mentioned above will also be discussed in this presentation.

Figure 1. Initial stage of simulation, where a drop is placed on the lower surface with the upper surface beginning the approach.

[a] [b]

Figure 2. [a] The initial squeezing of the drop after contact. [b] Rapid departure of the upper surface at high velocities (0.2m/s).

*Corresponding author: a.criscione@sla.tu-darmstadt.de