Experimental investigation of liquid ligament fragmentation

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Abstract

Fragmentation of liquid ligaments is a phenomenon which is observable in different industrial applications. For example in roll coating or printing, when paint films split between rollers, ligaments are formed and produce unwanted droplets [1]. Also, it is one of the fundamental processes in spray generation since atomization of a liquid surface most often implies the formation of liquid ligaments which are stretched out of the surface, elongate and break-up into single droplets [2]. The dynamics and fragmentation mechanisms of those stretched ligaments are investigated experimentally in this work. The experiments are performed with pure Newtonian liquids and suspensions of spherical glass particles (3-20 μm) in water with mass fractions up to 0.8.

Methodologies

Single liquid ligaments were produced and stretched using the experimental setup shown in Fig. 1. It consists of two parallel glass plates, from which one is mounted at a fixed position while the other one, movable, is connected with a linear driving system. The motion of the movable plate is accurately controlled. By using a displacement pipette a defined amount of liquid is deposited onto the movable plate which then drives towards the fixed plate until a liquid bridge is formed in the gap between the plates. After this a ligament is created stretching the bridge uniaxially by driving the movable plate apart from the other. Two high-speed camera systems allow observation of stretching and break-up processes from a top-view and side-view.
The main advantage of using a controllable linear motor for stretching the liquid bridge is the accuracy and reproducibility of the experiments. Furthermore it is possible to investigate the influence of velocity and acceleration of the movable plate on ligament stretching and break-up in detail.

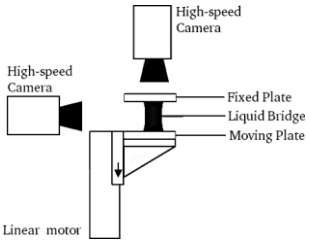

FIG. 1 Experimental setup.

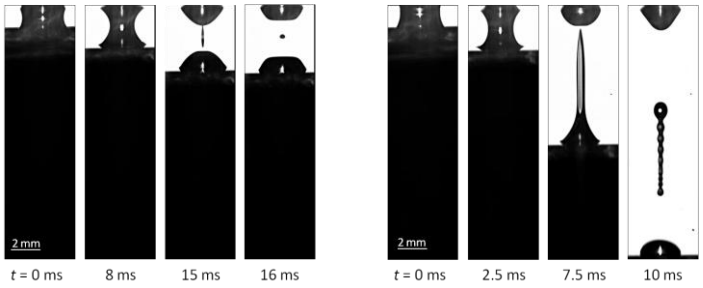

FIG. 2 Side view on ligament stretching and breakup at two different magnitudes of the plate acceleration: a = 10 m/s^2 (left) and 150 m/s^2 (right).

Sample results

In series of experiments the acceleration was varied from a = 10 to 150 m/s^2. Some examples of ligament breakups at various accelerations are shown in Fig. 2. These images are used for estimation of the kinematics of the ligament stretching (variation of its diameter and length), measurements of the typical breakup time and evaluation of the distribution of the fragment size.
The influence of accelerations of the movable plate as well as liquid properties and particle concentration on the kinematics of ligament stretching and breakup were investigated in this work.

References

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