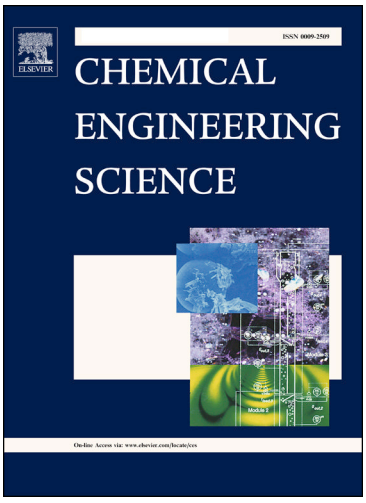

Drop-on-demand satellite-free drop formation for precision fluid delivery

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Drop-on-demand satellite-free drop formation for precision fluid delivery

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Abstract

A drop-on-demand liquid dispensing system, based on a rotary piston pump, for delivering microlitre droplets at ~ 10 Hz is analysed. Five types of drop formation are observed under different pump operation schemes, characterised by the breakup behaviour of the thin liquid ligament that develops between the forming drop and the liquid remaining at the dispensing nozzle. A range of control parameters and fluids (Newtonian and non-Newtonian) have been explored in order to identify key system parameters for precise satellite-free drop formation and hence to establish an operating window. Under a conventional 'one-step-ejection' pump operation cycle, the window for satellite-free drop production is found to be small and impractical due to the long ligament and large pendant drop at the nozzle. The satellite-free operating window can be expanded dramatically with the ligament and pendant drop size under control with a novel 'two-step-ejection' process, in which the drop is first partly grown, then allowed to settle, and then ejected via a second pulse of liquid from the pump. Rapid deceleration of the pump near the maximum flow rate at the end of the second pulse is essential for satellite-free drop production.

Key words: Drop-on-demand, satellite, flow rate, Newtonian and Non-Newtonian fluid, digital printing