

Drop in drop diameter from a vibrating capillary tube

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Whereas the impact of longitudinal vibrations on membrane emulsification (ME) is well documented, the effect of transversal vibrations (*i.e.* perpendicular to the membrane surface) has been less discussed. In this case, Arnaud (EP 1 551 540 B1) found that smaller drops with a narrower size distribution were generated. In order to understand the effect of transversal vibrations on emulsification, we focused on a simplified configuration where a single drop is formed from a vibrating capillary tube immersed in a stationary surrounding liquid. The effects of various parameters were investigated including the frequency and amplitude of vibration, the dispersed phase flow rate, the capillary inside diameter, the surface tension and both phase viscosities.

At set forcing frequencies, significantly smaller drops (up to 76% lower in diameter) are generated once a threshold amplitude is reached.

A drop grows and resonates in first mode as soon as its resonance frequency and the forcing frequency coincide. During resonance, the drop detaches prematurely in stretching mode if its elongation ratio reaches a critical value function of the drop to pore diameter ratio.

Otherwise, the drop grows further, leaves the first mode resonance range and detaches at a larger size in dripping mode.

The effects of the various parameters on drop size and amplitude threshold are well described by a harmonic oscillator model where the bound drop eigenfrequency is given by Strani & Sabetta's calculations and the damping term is modified to account for additional friction.