

# Break up of droplets in time-dependent flow

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# Break up of droplets in time-dependent flow



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# Introduction

Properties of blends depend largely on the microstructure, which is the result of break up and coalescence during processing. The objective of the present study is to determine the effect of timedependent flow conditions and visco-elastic behavior on the deformation and break up of droplets.

# **Experimental Methods**

A single Newtonian or visco-elastic droplet is subjected to a Newtonian hyperbolic flow, using an opposed jets device, as shown in figure 1.



fig. 1 Experimental setup and strain rate profiles applied

In quasi steady flow, the critical capillary number is determined, which defines the critical elongation rate  $\dot{\epsilon}_c$  at which a stable drop shape no longer exists. To study the droplet behavior in a more realistic flow, a triangular strain rate - time profile is applied, varying the rheological properties of the phases as well as the parameters  $\Delta T$  and  $\Delta \dot{\epsilon}$  (see figure 1).

# **Results**

Experiments have been performed using a viscoelastic drop (R=1.23 mm, 1.65 wt% PEO 5e6 in H<sub>2</sub>O) dispersed in silicon oil ( $\eta_c =$ 10 Pa·s), which has a critical deformation  $D_c \approx 0.35$  (figure 2).







**fig. 3** Droplet deformation, applying a triangular strain rate profile with  $\Delta \dot{\varepsilon} = 0.25 \dot{\varepsilon}_c$  and  $\Delta T$ =2.7, 5.6, 11, 17, 22, 28, 33, 39, 44, 50, and 56 s.

Applying triangular strain rate - time profiles with  $\Delta \dot{\varepsilon} = 0.25 \ \dot{\varepsilon}_c$  and various  $\Delta T$ , it is found that at small  $\Delta T$ , the droplet can not respond fast enough to reach this deformation  $D_c$ , see figure 3. As  $\Delta T$  is increased, the droplet reaches more elongated shapes with  $D > D_c$ , though break up does not occur. As is shown in figure 4, the drop will break up if  $\Delta T$  exceeds a critical value.



**fig. 4** Droplet response to the triangular strain rate - time profiles A (left,  $\Delta T = 50 \text{ s}$ ) and B(right,  $\Delta T = 56 \text{ s}$ ) of figure 3

# **Future Work**

- Experimental examination of:
  - \* the influence of visco-elasticity
  - $\star$  the critical values of parameters  $\Delta T$ ,  $\Delta \dot{\varepsilon}$
- Numerical analysis of the response of a droplet to time-dependent strain rate profiles

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