Dynamics of drops-on-a-string for viscoelastic solutions

Hrishikesh Pingulkar[1], Jorge Peixinho[1,2] & Olivier Crumeyrolle[1]

[1] Laboratoire Ondes et Milieux Complexes, CNRS and Université Le Havre Normandie, 76600 Le Havre, France
[2] Laboratoire PIMM, CNRS, Arts et Metiers, CNAM, HESAM Université, 75013 Paris, France
hrishikesh.pingulkar@etu.univ-lehavre.fr

The thinning of filaments, formed by viscoelastic polymer solutions, is slower than that of Newtonian fluids. When the concentration of the polymers is right, these filaments form drops-on-a-string, as shown in Fig. 1(a). The viscoelastic solutions are formed using the high molecular weight poly-ethylene oxide (PEO) and poly-ethylene glycol (PEG) polymers. By stretching the liquid bridge formed in-between the plates of capillary breakup extensional rheometer (CaBER), the less-understood phenomena such as formation of the filaments and the drops-on-a-filament are investigated using high-speed digital video microscopy. Then, a diameter-space-time diagram, as shown in Fig. 1(b), is developed in order to monitor the spacial and temporal evolution of viscoelastic threads, its filament thinning, and then the migration, coalescence of drops. In addition, the position of the minimum diameter on filament is determined, along with quantification of the number of drops, their positions, the diameters of drops (D) and the filament breakup time. The calculated extensional viscosity, obtained from minimum diameter, indicates the effect of polymer concentration and direction of filament thinning. The present study is the extension of the previous work carried out by Oliviera *et al.* [1] and, in addition, gives the accurate measurements of the drop diameters and their positions. Further analysis of drops indicates that the maximum number of drops on the filament can be predicted using Deborah number, which is a dimensionless number indicating the viscoelastic behaviour of the solution. The effect of plate diameter, the stretching height and the stretching speed of capillary bridge on the number of drops and size of the drops will be discussed.

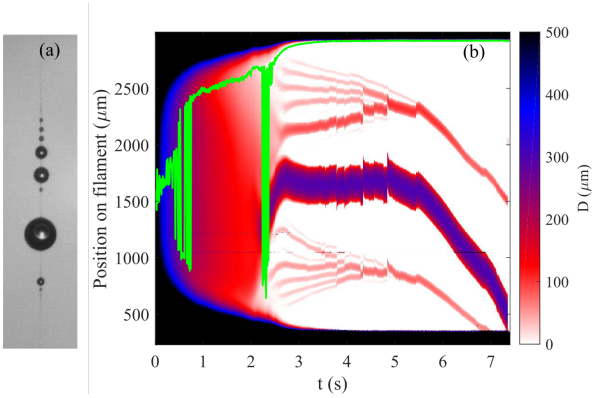

Figure 1. (a) The drops-on-a-string phenomenon for PEO1000 solution (1000 ppm of PEO in degassed water). (b) Diameter-space-time diagram for PEO1000 solution. $t = 0$ is when the separation of the plates of CaBER starts. The green line represents the position of the minimum diameter on the filament (Pingulkar *et al.* [2])

Références

1. M. S. N. Oliveira, R. Yeh, and G. H. McKinley, Iterated stretching, extensional rheology and formation of beads-on-a-string structures in polymer solutions, *J. Non-Newt. Fluid Mech.*, **137**, 137 (2006).
2. H. Pingulkar, J. Peixinho, and O. Crumeyrolle, Drop dynamics of viscoelastic filaments, *Phys.Rev. Fluids*, **5**, 011301(2020).