Stretching filaments of polymeric fluids

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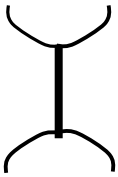
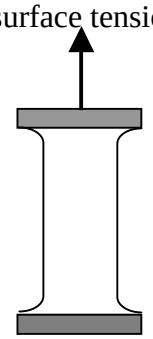
Fluids containing a small amount of polymer (long chain molecules) behave very differently to ordinary Newtonian fluids such as water. One important property of polymeric fluids is that they have a high resistance to extension that allows them to be drawn into thin filaments or threads. A simple demonstration of this phenomenon is to stretch a filament of saliva between your thumb and index finger. The saliva forms a thin liquid bridge thumb and finger that can last for several seconds, whereas if you try this experiment with pure water the filament breaks instantly.



Polymer molecules are highly flexible and can become stretched out by the flow. However, this stretching resisted by random thermal fluctuations in the fluid, so that the polymer molecules behave like elastic bands. In the liquid bridge it is this elastic stress from the stretched polymer molecules that stabilises the filament.

In this project we will use a simplified model for polymer solution based on this "elastic band" idea where we consider the polymers as two beads connected by a spring. Using this model we will study two experiments based on the liquid bridge. In the first, fluid between two plates is stretched by moving the plates apart exponentially. In the second, a cylinder filament of fluid between two blobs thins due to surface tension.



Co-requisites: Polymeric Fluids MATH5450M

References:

Phan-Thien N, "Understanding Viscoelasticity", Springer (Mathematics H-2 PHA)
McKinley GH and Sridhar T "Filament-Stretching Rheometry of Complex Fluids", Annual reviews of Fluid Mechanics (2002), vol 34, p375-415.