**Center for Fluid Mechanics, Division of Applied Mathematics**
**Fluids, Thermal and Chemical Processes Group, School of Engineering**
**Joint Seminar Series**

**Dr. Etienne Lac**
**Schlumberger Doll Research**

# Motion of a Drop in a Pressure-driven Flow along a Capillary

We revisit the classic problem of a single deformable drop flowing in low Reynolds number pressure-driven flow within a cylindrical tube. The drop shape and surrounding flow field are determined numerically by means of boundary integral computations. If gravity is neglected, the drop motion is determined by three independent parameters: the size a of the undeformed drop relative to the radius R of the capillary, the viscosity ratio l between the drop phase and the wetting phase, and the capillary number Ca, which measures the relative importance of viscous and capillary forces.

We investigate the drop behaviour in the parameter space ($a/R$, $\lambda$, Ca) over a large range of capillary numbers, Ca=O(0.01) to Ca=O(1). If the fluid flow rate is maintained, the presence of the drop causes a change in the pressure difference between the ends of the capillary, and this too is investigated. A simple model based on annular flow leads to asymptotic predictions for the drop cylindrical radius as well as for the additional pressure drop at high capillary numbers. The model agrees well with full numerical results if $\lambda > 1/2$, in which case the drop elongation increases without limit as Ca increases. If $\lambda < 1/2$, we find the drop elongates towards a limiting non-zero cylindrical radius. Two breakup modes are identified: Low viscosity drops ($\lambda < 1$) break up owing to a re-entrant jet at the rear, whereas a travelling capillary wave instability eventually develops on more viscous drops ($\lambda > 1$).

**TUESDAY – DECEMBER 7, 2010**

**BARUS & HOLLEY, ROOM 190**

**3:00pm**