# CM 4655 Polymer Rheology Lab

Rhe-

ρει – flow in Greek

Rheology Study of

Rheometry Measurement of

*For complex fluids in motion, we want to measure,*

- Viscous properties
- Elastic Properties

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There are many types of measurements to be done on Non-Newtonian fluids.

**We will look at three classes of tests:**

- Steady shear in a capillary rheometer
- Estimation of elongational viscosity from entrance flow
- Shear in torsional flow (steady and small amplitude oscillatory shear SAOS)

## *Triblock copolymer rheology*

Both capillary and cone-and-plate are used to cover the range of shear rate desired.

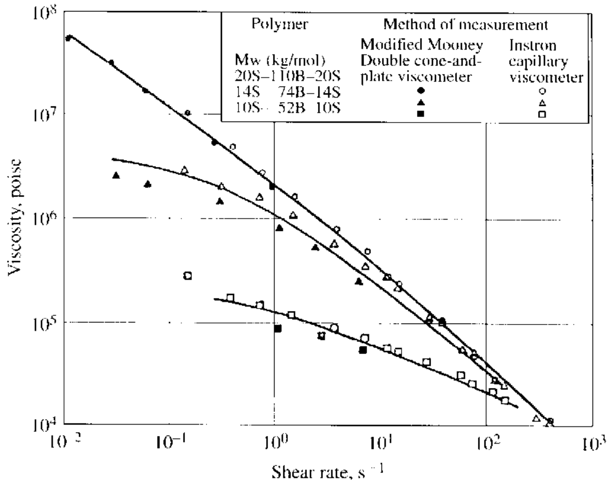

*Figure 6.25 p. 187*
*Holden et al.; SBS*

For more on block copolymers, see Larson

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## Cox-Merz Rule

$$\eta(\dot{\gamma}) = \left|\eta^*(\omega)\right|_{\dot{\gamma}=\omega}$$

*An empirical way to infer steady shear data from SAOS data.*

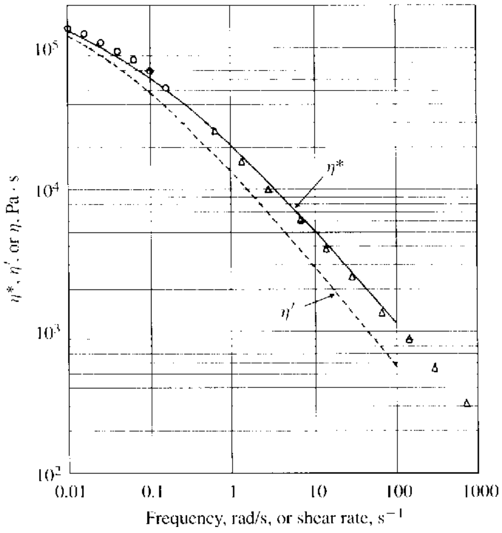


*Figure 6.32, p. 193*
*Venkataraman et al.; LDPE*

## Summary of Course

1. Each three-person student group gets a polymer
2. Measure pressure drop versus flow rate in a capillary rheometer (Goettfert) for various capillary sizes and at various temperatures.

viscous

3. Calculate steady shear viscosity from data; apply time-temperature superposition (REPORT 1)

viscous elastic

4. Estimate steady elongational viscosity from data; compare to Trouton's rule (REPORT 2)

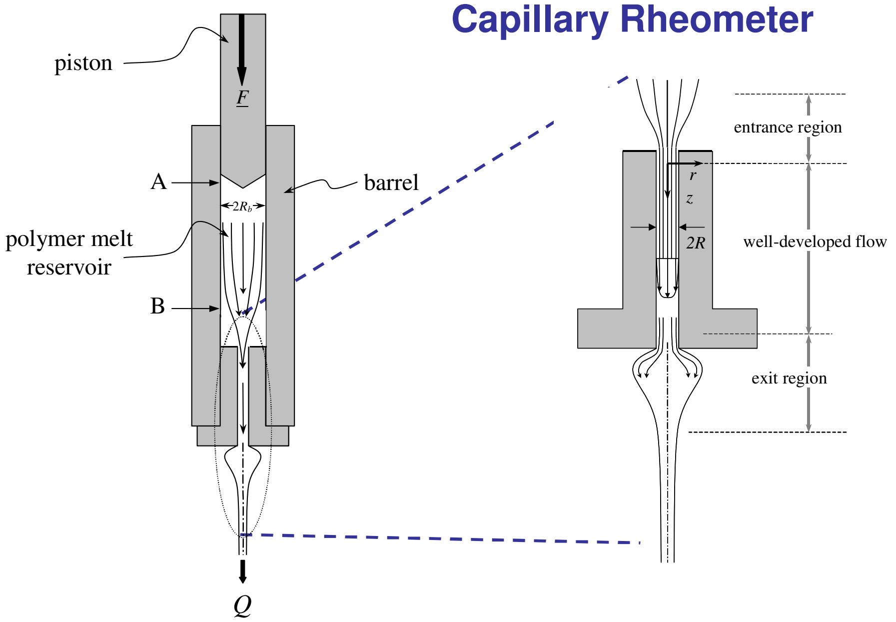
viscous elastic

5. Measure steady shear viscosity and complex viscosity on PDMS at various temperatures; apply time-temperature superposition and check Cox-Merz rule (REPORT 3)

## Summary of Course (con't)

6. Fit the Generalized Maxwell Linear-viscoelastic Model to PDMS small-amplitude oscillatory shear data and thereby calculate the relaxation spectrum (REPORT 4)

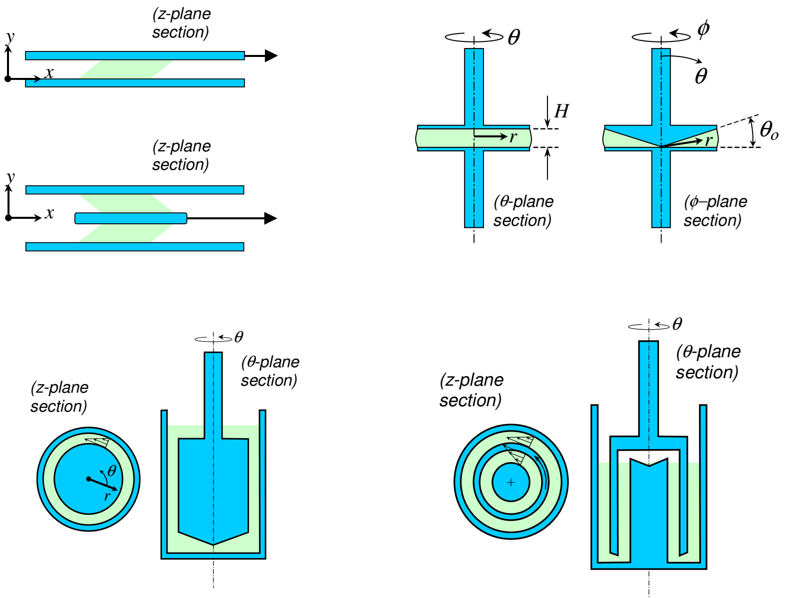
# Capillary Rheometer



# Capillary Rheometry

1. Take data of pressure-drop (related to shear stress at the wall) versus flow rate (related to shear rate at the wall), at various D, L, and T
2. Apply Weissenberg-Rabinowitsch correction for non parabolic velocity profile – calculate correct shear rate at the wall
3. Correct the stress measurements for entrance and exit effects (Bagley Correction)
4. Look for slip effects (Mooney Plot); correct data
5. Calculate and plot steady shear viscosity versus shear rate.

## Experimental Shear Geometries



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## Torsional Rheometry – Steady

1. Take data of steady state torque and normal thrust in parallel-plate and cone-and-plate geometries at various temperatures
2. Apply correction for non-constant shear rate (parallel plate only)
3. Calculate and plot steady shear viscosity versus shear rate for various temperatures.
4. Apply time-temperature superposition; calculate shift factors versus 1/T

## Torsional Rheometry – SAOS

1. Take data of G', G'' in the cone-and-plate geometry at various temperatures
2. Calculate and plot complex shear viscosity versus frequency for various temperatures.
3. Apply time-temperature superposition; calculate shift factors versus 1/T; compare to steady shear shift factors

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## Lab rules – CM4655

1. Follow the rules in the lab and departmental safety manuals at all time.
2. Safety glasses with side shields, closed shoes, long trousers must be worn in lab at all times.
3. Each lab member must have a bound laboratory notebook.
4. You must use the log books that are provided for each instrument.