Fluid Rheology Laboratory

FABE 325 – Dr. Gönül Kaletunç
TA – Kelley Yosick
Winter 2003

Objective:

To become familiar with the principles and procedures involved in measurement of rheological properties of liquids using a coaxial cylinder viscometer

Procedure:

1) Use Contraves coaxial cylinder viscometer to record the % torque values of CMC solutions at various shear rates.

The rheometer has 15 speed steps, which correspond to 15 shear rates. The speed step is displayed on the LED display on the left side of the control unit. The LED display on the right of the control unit indicates the % torque that the bob is applying to the drive unit. Below is a table with the shear rate associated with each speed step, the % torque measured, and the shear stress calculated by multiplying the % torque by 1.141.

		UP		DOWN	
Speed step	Shear rate (1/s)	% Torque	Shear Stress (Pa)	% Torque	Shear Stress (Pa)
1	6.65				
2	9.51				
3	13.61				
4	19.48				
5	27.90				
6	39.9				
7	57.2				
8	81.8				
9	117.1				
10	167.6				
11	240				
12	343				
13	492				
14	704				
15	1008				

2) Use Contraves coaxial cylinder viscometer to record the % torque values of selected fluids at a constant shear rate as a function of time.
Set the viscometer speed at 14 with a corresponding shear rate of 704 s^{-1} and record the time-dependent data on the table given below.

Time	%Torque

Time	%Torque

Time	%Torque

Calculations:

Determine the viscosity of the CMC fluid, plots shear stress vs. shear rate; the slope of the resulting straight line, if the fluid is Newtonian, is the viscosity. For non-Newtonian fluids, the viscosity is not constant, but changes with shear rate. Use the power law equation to fit the shear stress-shear rate data collected for CMC solutions:

$$\sigma = K(\gamma)^n$$

where:

- σ = Shear stress (Pa)
- K = Consistency coefficient (Pa s^n)
- γ = Shear rate (s^{-1})
- n = Flow behavior index

Take the logarithm of the power law equation to put into linear form

$$\log(\sigma) = \log(K) + n \log \gamma$$

Determine "n" and "K" values.

1) Plot the shear stress (Pa) versus shear rate (s^{-1}) for both the up and down data.
2) Plot log(σ)versus log(γ)for both "up" and "down" data. For both sets of data (up and down), find the consistency coefficient "K" and flow behavior index "n".
3) Plot apparent viscosity at 704 s^{-1} shear rate versus time.

Questions:

1) Is the curve for the "up" data different from the "down" data? How? If it is, how do you describe the type of fluid used?

2) Could you use the information collected in the lab to predict pressure drop in pipes? How?

FABE 325 WI03
Lab Groups and Projects for Rheology Lab

9am –9:30am	**Group 1** 0.5% CMC solution, ketchup	Ryan Gierhart Hadi Gani Brian Henslee
9:30am –10:00am	**Group 2** 0.8% CMC solution, ketchup	Jacob Preston Eric Neer Chitra Kusnadi
10am –10:30am	**Group 3** 0.8% CMC solution	Issac Schroeder Susan Martin Cole Sanford
10:30am –11am	**Group 4** 0.5% CMC solution, ketchup	Brian Moeller Alex King Michael Podrosky
11am –11:30am	**Group 5** 0.8% CMC solution, ketchup	Erik Gracly Molly Heller Megan Clary Nicholas Bucurel
11:30am –12:00pm	**Group 6** 0.8% CMC solution	Clayton Bettin Ethan Schneider Scott Smith Julia Valigore

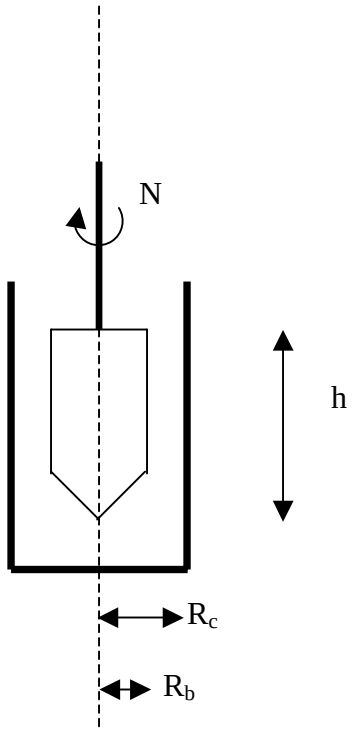
Fluid Rheology Laboratory

FABE 325 – Dr. Gönül Kaletunç
TA – Kelley Yosick
Winter 2003

Rotational Viscometer

The Couette Viscometer

Concentric cylinder viscometer. Sample is placed between the two cylinders. Inner cylinder is rotated.



Shear rate:

$$\gamma = r\frac{d\omega}{dr} \approx \frac{R_b\omega}{R_c - R_b}$$

where; $\omega = 2\pi N/60$

Shear stress:

$$\tau = \frac{M}{2\pi R_b{}^2 h}$$