ABE 457
Homework 2
Spring 2018

Due: 1/19/18

1. An extrusion type tube viscometer is used to measure the flow properties of batter. The batter is placed in a cylindrical reservoir which is fitted with a piston at the top and a capillary is attached to the bottom. The piston radius is 2 cm and the capillary radius is 2 mm. In order to subtract the entrance and exit losses for the flow through the capillary, two sets of experiments are performed. In the first, the batter is forced through a short capillary that is 15 mm long. In the second, the batter is forced through a long capillary at the same flow rate. The length of the long capillary is 100 mm. The flow rate of batter is varied by varying the velocity of the piston. The pressure drop for flow through the capillary is inferred from the force required to move the piston at a specified velocity. Following is the data

Piston velocity (mm/min)	**Long tube force (N)**	**Short tube force (N)**
0.5	35.9	7.18
2	54.4	10.88
5	71.62	14.33
20	108.56	21.71
50	142.91	28.58
100	175.94	35.19
200	216.6	43.32

   (a) Convert piston velocity to volumetric flow rate of batter
   (b) Calculate the effective force for a capillary of effective length. Explain why you need to do this\
   (c) Convert tube force to pressure drop
   (d) Convert pressure drop to wall shear stress
   (e) Convert flow rate to pseudo wall shear rate
   (f) Calculate the correction factor at each flow rate
   (g) Calculate the wall shear rate at each flow rate
   (h) Estimate the rheological properties of the batter
2. Following is the pressure drop data in a capillary viscometer at different flow rates of tomato ketchup. The radius of the capillary is 2 mm and the capillary length is 50 mm. Neglecting the expansion and contraction losses, determine the consistency index and the flow behavior index of the ketchup.

Flow rate (m^3/s)	Pressure drop (Pa)
1×10^{-6}	2.85×10^{5}
5×10^{-6}	5.89×10^{5}
1×10^{-5}	8.04×10^{5}
5×10^{-5}	1.66×10^{6}
1×10^{-4}	2.27×10^{6}
5×10^{-4}	4.68×10^{6}