Homework 3
Polymer Processing

1) a) For a Newtonian fluid and a fluid that follows time temperature superposition using the WLF equation plot viscosity versus temperature in the vicinity of T_g/T_0, i.e. from T_g-50 to T_g+200°K. (Equation 6.4-11 pp. 163 and Equation 6.1-1 pp. 147)

b) Discuss the importance of this to processing water (e. g. for a power plant) versus polymers (e. g. extrusion).

c) If you wanted to calculate the flow of a glassy part over 100,000 years could you use the WLF approach?

d) In the WLF equation a temperature 10 to 20°K less than the glass transition is often used in place of T_g in equation 6.4-11. What effect will this have on the calculated viscosity in the vicinity of the glass transition. What about at T_g + 100? Discuss why a temperature lower than the glass transition might be used.

e) You are extruding high density polyethylene and have a problem that the actual extruder output exceeds by an order of magnitude the calculated output. In your calculation you have used the temperature of the wall of the extruder and the WLF equation. Explain what the problem might be.

2) One method of determining the radius of a capillary tube is to measure the rate of flow of a viscous fluid through the tube. Find the radius of a capillary from the following flow data:

Length of Capillary = 50.02 cm

Kinematic viscosity of fluid = 4.03×10^{-5} m^2sec^{-1}

Density of fluid = 0.9552×10^3 kgm^{-3}

Pressure drop across (horizontal) Capillary tube = 4.829×10^5 newtons m^{-2}
= 4.766 atm

Mass rate of flow through tube = 2.997×10^{-3} $kgsec^{-1}$

What is a major drawback to this method? Suggest some other means for determining the radii of capillary tubes.

(Answer: 0.7512 mm)

Bird Stewart Lightfoot "Transport Phenomena" Wiley 1960 pp. 61

3) Tadmor Problem 6.1 pp. 192.

Homework 3
Answers