

Chapter 7: Homework

It is desired to fill a plate made of glass fiber perform using epoxy resin. The dimension of the plate is 1m x 1m. The injection pressure at the gate is kept constant at 500 kPa. The viscosity of the resin is 800 cP. The permeability of the fiber perform is $1 \times 10^{-10} \text{ m}^2$. Fiber volume fraction 0.50.

Determine the estimated time to fill the mold using the different techniques as follows:

- a) *Point injection with a 3 cm diameter of the injection port. Assume that the equation is valid over the whole domain of the plate.*
- b) *Edge injection*
- c) *Peripheral injection*

Solution:

a. Point injection:

$$t_{ff} = \frac{\phi\mu}{2K_r P_o} \left[r_{ff}^2 \ln \frac{r_{ff}}{r_o} - \frac{1}{2} (r_{ff}^2 - r_o^2) \right]$$

The maximum radius for this case is taken to be half the diagonal of the rectangle, since it is assumed that the equation is valid for the whole domain of the plate. This is a conservative estimate for the fill time. As such:

$$r_{ff} = (0.5^2 + 0.5^2)^{0.5} = 0.707m$$

Substituting the values into the equation gives (make sure to write the units along to avoid confusion):

$$t_{ff} = \frac{(0.5)(800cP) \left(\frac{Pa - sec}{1000cP} \right)}{2(1 \times 10^{-10} \text{ m}^2)(500000Pa)} \left[(0.707m)^2 \ln \frac{0.707m}{0.015m} - \frac{1}{2} (0.707^2 - 0.0015^2) \right]$$

$$t_{ff} = 400 \frac{sec}{m^2} [1.926m^2 - \frac{1}{2} (0.5 - 0.0000023)m^2] = 670sec$$

b. Edge injection:

$$t_{ff} = \frac{\phi\mu}{2K_{xx} P_o} x_{ff}^2$$

The long edge is used. $x_{ff} = 0.5 \text{ m}$.

$$t_{ff} = \frac{(0.5)(800cP) \left(\frac{Pa - sec}{1000cP} \right)}{2(1 \times 10^{-10} \text{ m}^2)(500000Pa)} (0.5m)^2 = 100sec$$

C. Peripheral injection:

For peripheral injection, the distance is half that of the edge injection. As such the time is $\frac{1}{4}$ that of edge injection:

$t_{ff} = 25$ seconds.