Problem Set 2

We would like to distribute our favorite solution for each problem to the class as the official solution so please strive for clarity and elegance. If you would like to type your problem set, the raw LaTeX version of this problem set is available on the 2.008 Web site.

Problem 1-1. Injection Molding

The gate and runner system that you use to move plastic into an injection molding cavity are critical design parameters. Suppose the polymer material that you are using has a viscosity μ of $950 Ns/m^2$ under your processing conditions. Suppose your initial gate and round runner system is 3.5 mm in diameter and approximately 25 mm long. Your part has a volume of approximately 20000 mm^3 and a projected area of approximately 1800 mm^2. Your Engel machine claims that it can melt and deliver material at a rate of 165 cm^3/sec. Assume that there is no pressure loss bewteen the mold cavity and the runner system, and none of the clamping force is lost in deforming the molds when they come together.

(a) What is shortest injection time for the part?

(b) Recall that the equation for Newtonian flow through a round channel is:

$$Q = \frac{\pi P r^4}{8 \mu L}$$

where Q is the flow (m^3/s), P is the pressure change (Pa), r is the radius of the channel (m), μ is viscosity (Ns/m^2), and L is the length of the channel (m).

What is the pressure required to inject your part if you use the smallest injection time?

(c) What happens if you change the injection time to 1 second instead? What is the pressure required? What is the required clamping force? What happens to the clamping force if you make your channel radius 10 percent larger?

(d) Why is it ok to increase the injection time to 1 second? What prevents you from using a 10 second injection time? What are the disadvantages of making a 10mm radius runner channel?

Problem 1-2. Geometry

The top part in Figure 1 is used as the battery cover in a cellphone. How would you modify the design to make it easier to manufacture?

Plastic bottle caps [the kind that screw on to a bottle] illustrate one major injection molding hurdle. What is it? How can you get around it?

Problem 1-3. The elements What happens to a plastic part that is left outside in the sun for several years? The absorption spectrum for carbon black is presented below (Figure 2). Why might you want to add carbon black to a plastic part that is meant for outdoor use?

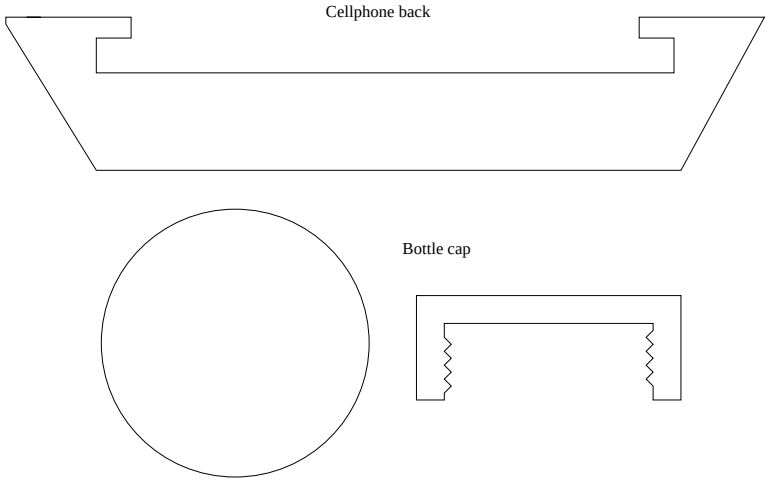

Figure 1: Geometry problem

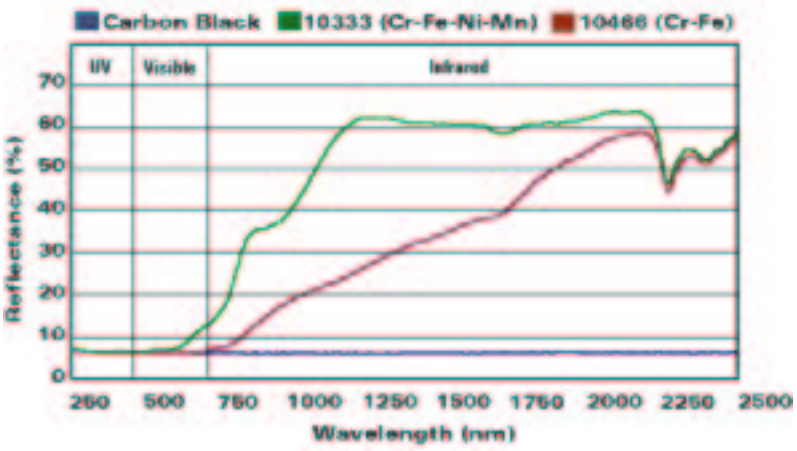

Figure 2: Spectrum of carbon black