

**BAE 103**  
**Energy in Biological Systems**

**Problem Set No. 2**  
**Concepts of Volumes, Surface Areas Related Rates**  
**Due Date: Monday, January 22**

- 2.1 A storage tank, used in a fermentation process, is to be rotationally molded from polyethylene plastic. This tank will have a conical section at the bottom, right circular cylindrical mid-section, and a hemispherical dome to cover the top. The radius of the tank is 1.5 m, the cylindrical side-walls will be 4.0 m in height, and the apex of the conic section at the bottom has an included angle of  $60^\circ$ . If the tank is filled to the top of the cylindrical side-walls, what is the tank capacity in liters?
- 2.2 The tank in problem 2.1 above has a wall thickness of 15 mm. Assume the plastic (polyethylene) used in the molding process has a mass density of  $1890 \text{ kg/m}^3$ . How many kg of plastic should be order to produce 10 tanks?
- 2.3 Cellulose, the feedstock for the fermentation process, will be added to the tank in problem 2.1 to fill the complete volume (including hemispherical dome). The feedstock has a mass density of  $410 \text{ kg/m}^3$ . What is the total mass (kg) of cellulose added to the tank in problem 2.1?
- 2.4 A 15.0 cm diameter (ID) screw conveyor is used to load the cellulose into the top of the tank in problem 2.3. The screw conveyor rotates at 200 rev/min, and has a flighting pitch of 25 cm. How long (s) will it take to fill the tank with cellulose?