Municipal Engineering – Engi. 8713
Assignment #6

1) One module in a membrane filtration system is composed of 10,000 hollow fibers. Each hollow fiber has an internal diameter of 0.9 mm and a length of 1.2 m. Each hollow fiber has a cross flow configuration with flow going from the inside to the outside of the hollow fiber and the cross flow velocity is 1.0 m/s.
    a) What feed flow through the module (in units of m^3/d) is necessary in order to achieve the cross flow velocity of 1.0 m/s?
    b) If the system maintains a permeate flux of 70 $L/m^2 \cdot h$, what is the permeate flow rate for the module (in units of m^3/d)?
    c) What is the cross-flow velocity at the exit to the module (in units of m/s)?

2) At a temperature of 1°C the clean water flux for a microfiltration membrane is 50 L/m^2 hr and the MF membrane is operating at a pressure of 0.65 bar.
    a) Calculate the specific flux at 20°C using the equation with the two viscosity terms.
    b) Calculate the specific flux at 20°C using the empirical equation.
    c) What is the percentage error obtained in using the empirical equation?
    d) Calculate the membrane resistance coefficient (at 20°C)

3) A new membrane treatment plant is being designed for a city where the summer peak day demand is 190,000 m^3/d and the winter peak day demand is 136,000 m^3/d. The source water has a temperature of 17°C in the summer and 1°C in winter. The membrane plant that is being considered is to have a summer operating flux of 65 L/m^2 hr.
    a) What membrane area (in m^2) will be required in the summer?
    b) Will this membrane area be sufficient to meet the peak winter demand if it is operated at the same differential pressure across the membrane as in the summer?

4) A 5790 mm diameter pipe with a slope of 0.0001 is flowing 70% full ($A/A_f = 0.7$). Assuming n = 0.013. Find
    a) the depth of flow in mm.
    b) the volumetric flow rate in m^3/min,
    c) the flow velocity in m/s, and

5) An area that is planned for future development has an estimated population density of 95 persons per hectare and an area of 23 Ha. What is the average dry weather flow and what is the peak dry weather flow? Use the guidelines for the City of St John's. Give answers in units of L/s.

6) What are the average and peak dry weather flows for a light industrial area that has an area of 11 ha? Use the guidelines for the City of St. John's. Give answers in units of L/s.

7) Assume the area and population density you selected in problem 5 are for an already developed area. Calculate the peak dry weather flows using the guidelines for the City of St. John's and for the Government of Newfoundland and Labrador. Give answers in units of L/s.

8) Use the Rose equation to calculate the headloss through a dual media filter. The layer of crushed anthracite is 1.5 m deep, has a porosity of 0.5 and a particle diameter of 1.1 mm. The layer of rounded sand is 0.3 m deep, has a porosity of 0.4 and a particle diameter of 0.6 mm. The filtration rate is 15 m/h and the water temperature is 15 °C.