

Trickling filters are packed bed reactors that biologically treat wastewater. Trickling filters are commonly used in the United States and the world because of their low energy and material requirements as well as relatively lower operation and maintenance costs as compared to other processes. You have been hired at Corvallis wastewater treatment utility to design a trickling filter reactor in order to expand their current treatment design.

Your initial design is demonstrated below. The reactor is a cylindrical tank with a conical bottom. Bed sand particles are held by a mesh screen at just above the conical bottom of the tank. The volumetric flow rate entering the tank is equal to the volumetric flow rate exiting the conical bottom's opening ($F_{in} = F_{out}$, steady state). The inlet and outlet flows are exposed to the atmosphere.

- 1) In the graph on next page, sketch a line to show the change of pressure in the tank along the height of wastewater (between point [1] to [4]). Illustrate points [1], [2], [3], and [4] on the graph with their associated pressures. Make sure that pressure is indicated in the graph (connect the points) at any location between the points. List the assumptions. Show your calculations.
- 2) What is the height of water (H) above the packed bed?

Data:

$$\rho = 1000 \text{ [kg/m}^3\text{]}$$

$$\varepsilon = 0.45$$

$$\mu = 0.001 \text{ [Pa}\cdot\text{s]}$$

$$d_{part} = 313 \text{ [}\mu\text{m]}$$

$$P_{atm} = 101325 \text{ [Pa]}$$

$$D_{tank} = 20 \text{ [m]}$$

$$F = 2.07 \text{ [m}^3\text{/s]}$$

$$D_{conical\ bottom\ opening} = 0.5 \text{ [m]}$$



