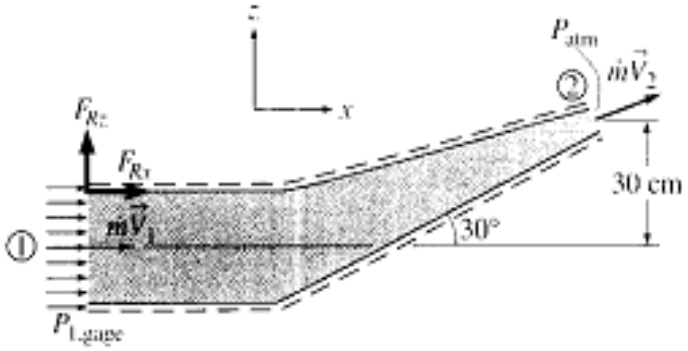
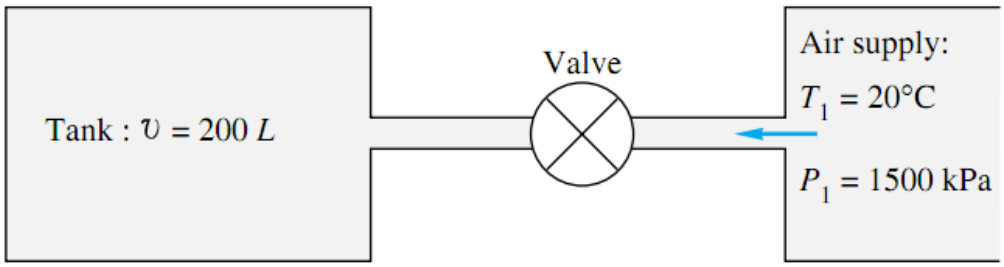
Sahand University of Technology **Advanced Fluid Mechanics HW1**
Chemical Engineering Faculty **Return date: With Midterm Exam**
Instructor: Dr. Alizadeh Fall Semester

1. A reducing elbow is used to deflect water flow at a rate of 14 kg/s in a horizontal pipe upward 30º while accelerating it (figure). The elbow discharge water into the atmosphere. The cross sectional area of the elbow is 113 cm^2 at the inlet and 7 cm^2 at the outlet. The elevation difference between the centers of the outlet and the inlet is 30 cm. the weight of the elbow and the water in it is considered to be negligible. Determine (a) the gage pressure at the center of the inlet of the elbow and (b) the anchoring force needed to hold the elbow in place.

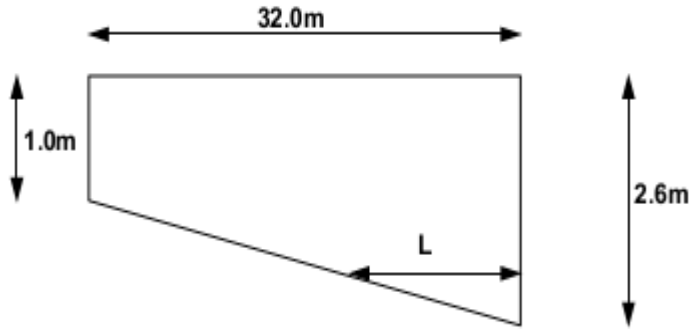
1. 

2. Consider a steady, two-dimensional, incompressible flow of a Newtonian fluid in which the velocity field is known, i.e. u= -2xy, v= y^2-x^2, w=0. (a) Does this flow satisfy conservation of mass? (b) Find the pressure this field, p(x,y) if the pressure at the point (x=0, y=0) is equal p_a.

3. The insulated tank in figure below is to be filled from a high-pressure air supply. Initial conditions in the tank are T=20℃ and p=200 kPa. When the valve is opened, the initial mass flow rate into the tank is 0.013 kg/s. assuming an ideal gas, estimate the initial rate of temperature rise of the air in the tank.



4. A rectangular swimming pool is 1 m deep at one end and increases in depth to 2.6 at the other end. The pool is 8m wide and 32m long and is emptied through an orifice of area $0.224m^2$, at the lowest point in the side of the deep end. Taking C_d for the orifice as 0.6, find, from first principles,

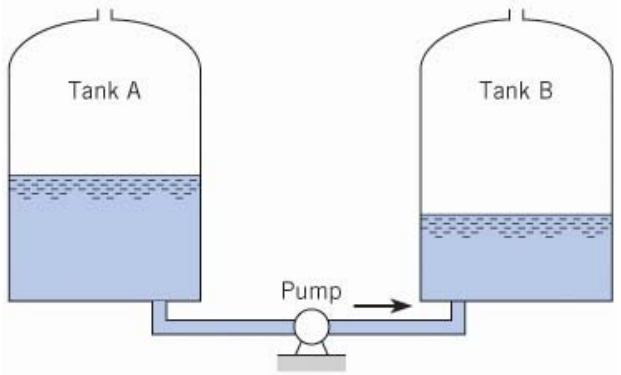


   a) The time for the depth to fall by 1m
   b) The time to empty the pool completely

5. A pump takes water from the bottom of a large tank where the pressure is 50 psig and delivers it through a hose to a nozzle that is 50 ft above the bottom of the tank at a rate of 100 lb_m/s. The water exits the nozzle into the atmosphere at a velocity of 70 ft/s. If a 10 hp motor is required to drive the pump, which is 75% efficient, find:
   (a) The friction loss in the pump
   (b) The friction loss in the rest of the system

   Express your answer in units of ft lb_f/lb_m.

6. A pump is used to transfer liquid from tank A to tank B as shown. The tanks have a diameter of 12 m. the initial depth of the liquid in tank A is 20 m, and in tank B the depth is 1 m. the pump delivers a constant head of 60 m. The connecting pipe has a diameter of 20 cm, and the head loss due to the friction in pipe is $\frac{20V^2}{2g}$. Find the time required to transfer the liquid from tank A to B, that is, the time required to fill tank B to 20 m depth.



7. The water tank show in figure has the form of the frustum of a cone. The diameter of the top of the tank is 12 ft, while that at the bottom is 8 ft. the bottom of the tank contains a round, sharp-edge orifice, while has a diameter of 4 in. the discharge coefficient of the orifice is 0.6. if the tank is full at a depth of 10 ft, as shown in figure, how long will is take to empty the tank.