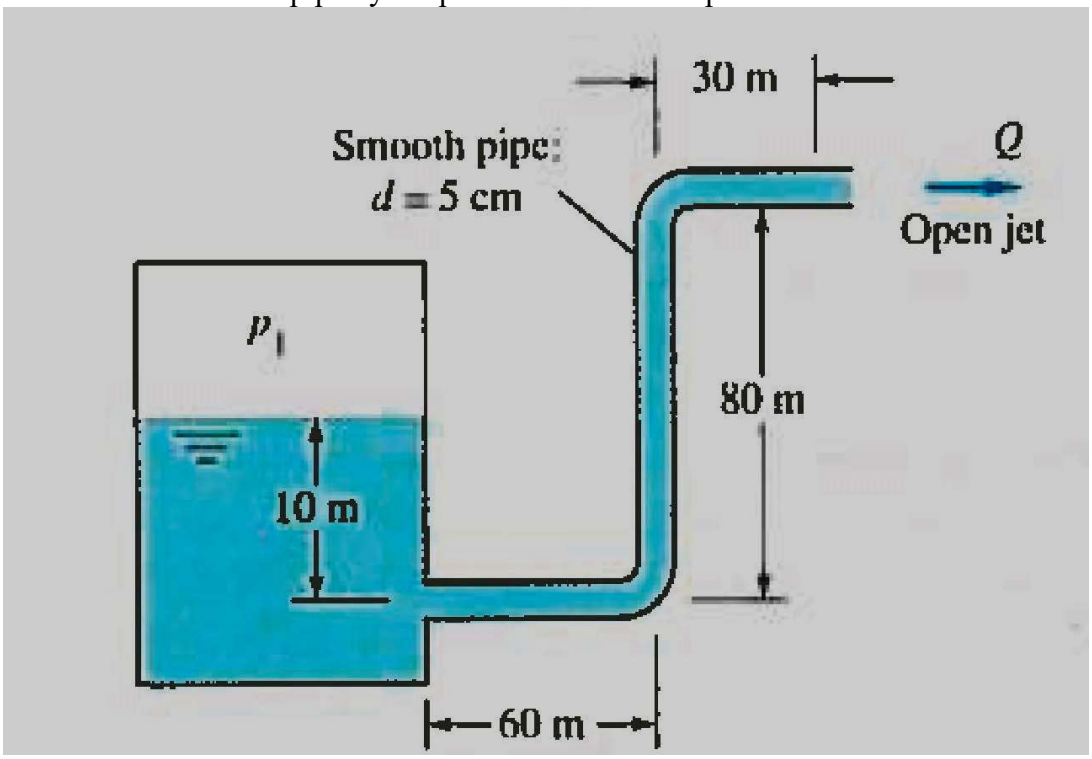
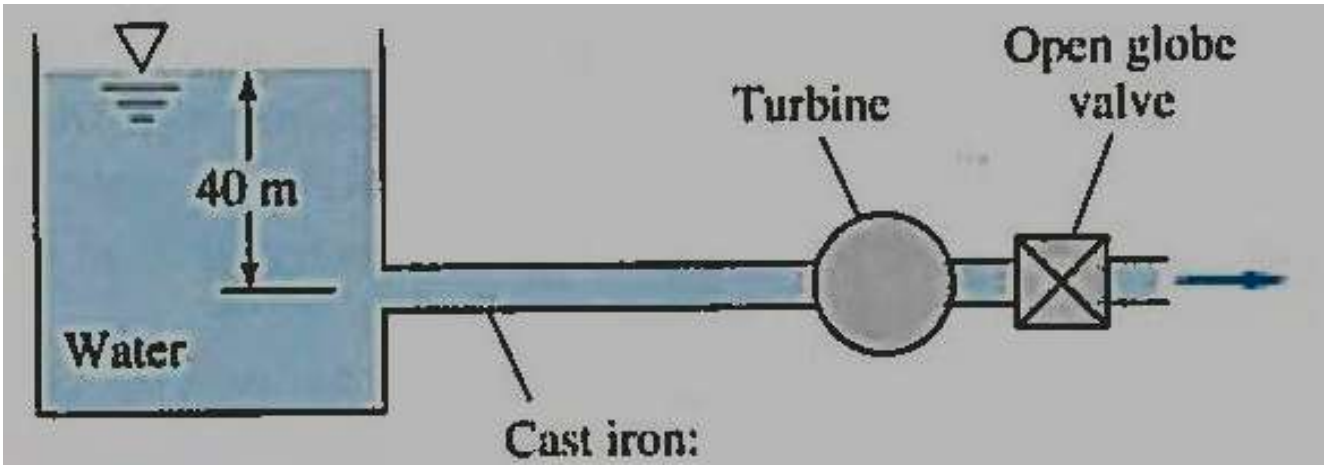
Problem 6.3 Unknown Discharge

Given**:** Standard atmospheric conditions hold outside the tank, and the headspace inside the tank is filled with nitrogen gas at a density of 13.2 kg/m^3. The elbow loss coefficients are 0.65 each and water is forced from the pipe by the pressure in the headspace.



Required: (a) What is the discharge? (b) What is the shear stress 1 cm from the pipe wall? (c) What is the velocity at the edge of the boundary layer?

Problem 6.4 Turbine and Pipeline Economics and Design

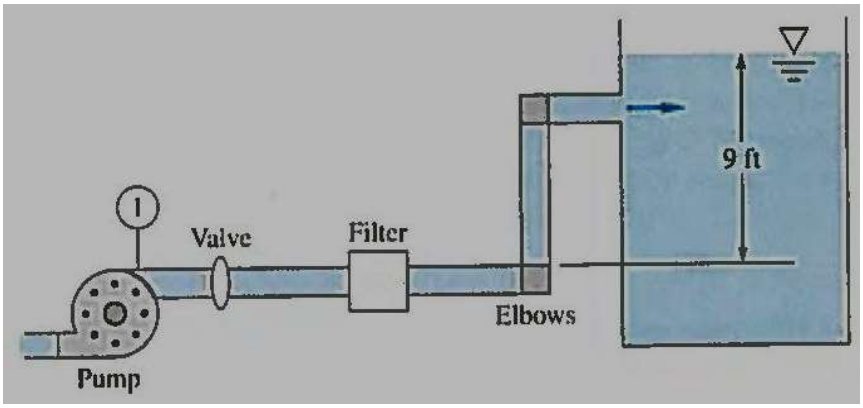


L=210 m, D=20 cm

Given: Water (20 deg C) flows at 0.080 m^3/s through the system, and exits as a free jet. The turbine efficiency is 80% and power costs $0.28 per kilowatt hour. Take the flanged globe valve loss coefficient from the text. The design life is 20 years.

Required: (a) How much revenue is earned by this system over its design life? (b) What is the cost of pipe friction? (c) Suppose the pressure at the turbine inlet can not exceed 300 kPa gage. How close to the reservoir can we locate the turbine? (d) We can replace the turbine with a new one with an efficiency of 87% at a cost of $25,000. How long before the replacement pays for itself?

Problem 6.5 Unknown Pipe Size and Energy Grade Line



Given: The pipeline sketched is reinforced concrete (2 mm ε), and the pressure head leaving the pump is 75 feet. The system delivers 8 cfs of 20 deg C water to the reservoir. The coordinates of the fittings are:

Fitting	*Pump*	*Valve*	*Filter*	*Elbow*	*Elbow*	*exit*
Number	*1*	*2*	*3*	*4*	*5*	*6*
x, ft	*0*	*40*	*90*	*130*	*136*	*180*
z, ft	*24.0*	*24.0*	*24.0*	*24.0*	*30.0*	*30.0*
Coefficient		*6.0*	*8.0*	*1.9*	*1.9*	*1.0*

Required: (a) Size the pipe. (b) Prepare a scaled energy gradeline, hydraulic gradeline, and potential energy gradeline. (c) How much of the organized energy just upgradient of fitting number 4 is pressure head?

Program Six.xls Circulating Water System Curve

Given: The circulating water system sketched delivers waste heat from a turbine condenser to a hyperbolic cooling tower of a power plant. The system routes cooling water from the forebay pump entrance (at the site grade) through the condenser and up to the top of the cooling tower fill section. The flow exits to a free surface reservoir above the fill section at elevation z_F of 12 m above the site grade, which we treat as the datum plane. We note the following pipe fittings, with their associated minor loss coefficients K: