



Hydraulic Engineering and Infrastructures

Civil Engineering Department

Pressurized pipe flow

1 Pressure drop ††

Water $\nu = 1.12 \times 10^{-6} \text{ m}^2/\text{s}$ flows from the basement to the second floor through the 1.9 cm diameter copper pipe (a drawn tubing with threaded elbows $K_L = 1.5$) at a rate of $Q = 0.76 \text{ L/s}$, flows through a globe valve (with $K_L = 10$) and exits through a faucet of diameter 1.27 cm as shown in Figure 1.

Determine the pressure at point (1) if

1. all losses are neglected,
2. the only losses included are major losses, or
3. all losses are included.

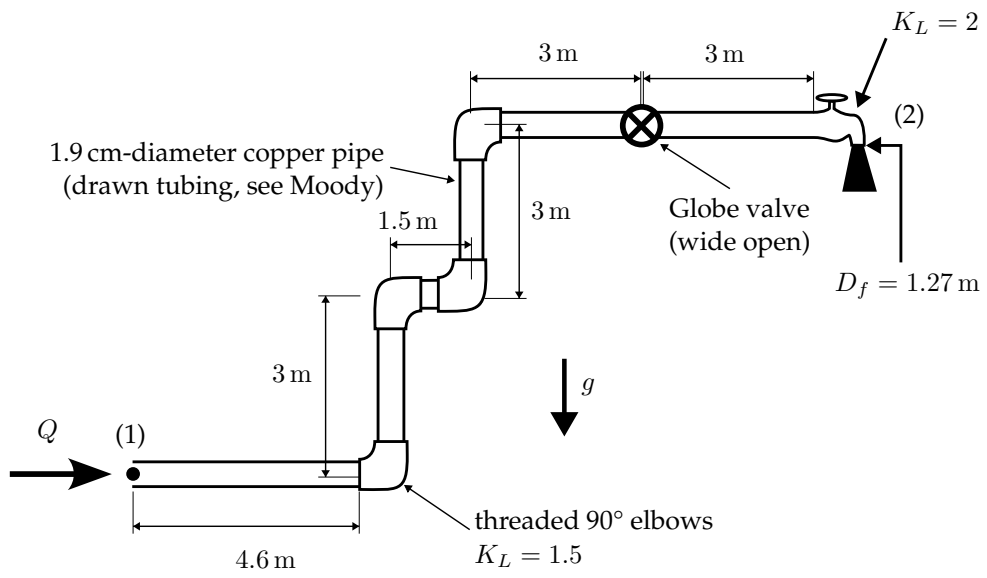


Figure 1: Pressure drop through a pipe.

2 No minor losses †

Air at standard temperature and pressure flows through a horizontal, galvanised iron pipe ($\varepsilon = 0.000152$ m) at a rate of 0.0566 m³/s. The pressure drop is to be no more than 3.45 kPa per 30.5 m of pipe. Assume the flow is incompressible with $\rho = 1.2266$ kg/m³ and $\mu = 1.7907 \times 10^{-5}$ Pa·s.

Determine the minimum pipe diameter.

3 Minor losses †

Water at 15°C ($\nu = 1.21 \times 10^{-6} \text{ m}^2/\text{s}$) flows from reservoir A to reservoir B through a pipe of length $L = 518 \text{ m}$ and roughness $\varepsilon = 0.000152 \text{ m}$ at a rate of $Q = 0.737 \text{ m}^3/\text{s}$. The system contains a square-edged entrance, four regular 45° elbows and a submerged exit.

Determine the pipe diameter needed.

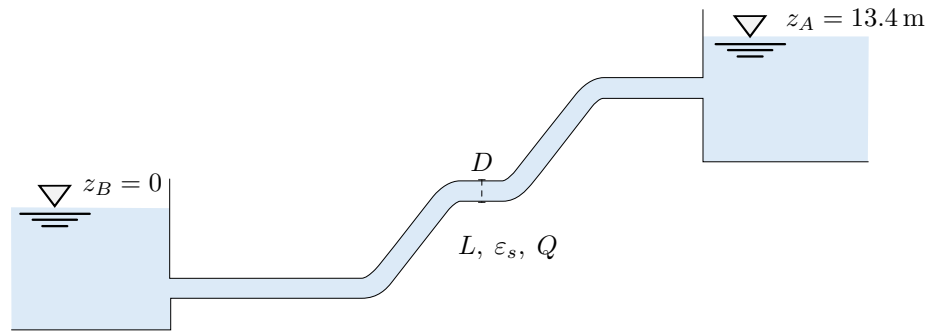


Figure 2: Illustration of the problem.

4 Cavitation in siphon †

Siphons are pipes that allow to connect two or more reservoirs winding around obstacles. When they go higher than the highest surface, the siphon will experience low pressures $p = H - z_{\max}$ and might cavitate¹.

Consider a pipe with a diameter $D = 20$ cm, a rugosity $\varepsilon = 0.5$ mm and the kinematic viscosity of the water $\nu = 1.16 \times 10^{-6}$ m²/s. What's the maximum head difference ΔH between the reservoirs for which $p/\gamma \geq -10.25$ m throughout the pipe? What's the corresponding discharge?

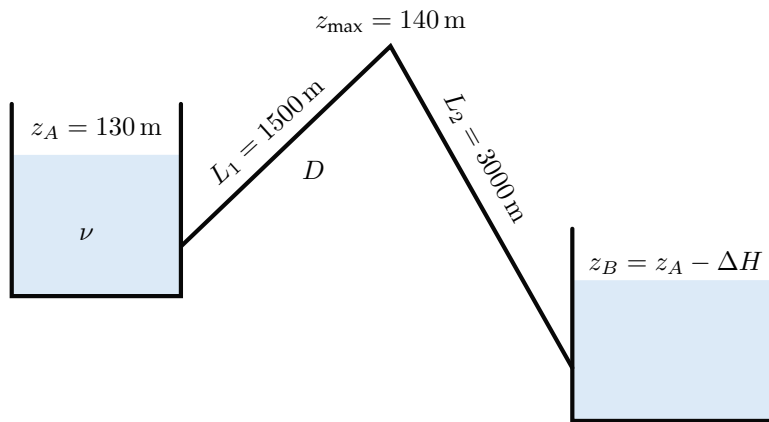


Figure 3: Two reservoirs connected by a siphon.

¹Cavitation is when the the pressure is low enough for the water to vaporize. Here's a cool video introducing the topic: [Cavitation - Physics girl](#).