Problem 1

A pump slowly introduces mercury into the bottom of the closed tank shown in the figure below. At the instant shown, the air pressure $p_a = 75$ kPa. The pump stops when the air pressure rises to 120 kPa and an engineer closes a valve at the exit of the pump at that time. All fluids remain at 20°C. At that temperature, the density of water and mercury are 998 and 13,550 kg/m³, respectively.

a) What is the manometer reading $h$ when the air pressure reaches 120 kPa, if it is connected to standard sea-level ambient air $p_{am} = 101.35$ kPa?

b) Sketch a profile of the pressure distribution in the tank.

c) What is the pressure at the bottom of the tank initially (when $p_a = 75$ kPa)? What is it at the end of the process (when $p_a = 120$ kPa)?

With the valve still closed, a hole forms at the top of the tank so that the air becomes in contact with the ambient air.

d) If the cross-sectional areas of the tank and manometer are 0.1 m² and 0.001 m² respectively, what is the new manometer reading $h$?