Problem 1. ***Determine the capillary depression*** *of mercury in a 4 mm ID glass*

Tube. Assume surface tension as 0.45 N/m and β *=115°?.*

The specific weight of mercury = 13550 × 9.81 N/m3, Equating the surface force and the

pressure force, $[h \times \gamma \times \pi D2/4] = [\pi \times D \times \sigma \times \cos \beta]$, Solving for *h,*

$h = \{4 \times \sigma \times \cos \beta\}/\{\gamma \times D\} = [4 \times 0.45 \times \cos 115]/[13550 \times 9.81 \times 0.004]$

= **– 1.431 × 10–3 m or – 1.431 mm, (depression)**

Problem 2. *A glass tube of 8 mm ID is immersed in a liquid at 20°C. The specific weight of the liquid is 20601 N/m*^{3}*. The contact angle is 60°. Surface tension is 0.15 N/m.* ***Calculate the capillary rise*** *and* ***also the radius of curvature of the meniscus****.*

Capillary rise, $h = \{4 \times \sigma \times \cos \beta\}/\{\gamma \times D\} = \{4 \times 0.15 \times \cos 60\}/\{20601 \times 0.008\}$

$= \mathbf{1.82 \times 10^{-3}}$ **m or 1.82 mm.**

The meniscus is a doubly curved surface with **equal radius** as the section is circular

$P_i - P_o) = \sigma \times \{(1/R\ 1) + (1/R\ 2)\} = 2\ \sigma/R$

$R = 2\sigma/(P_i - P_o)$, $(P_i - P_o)$ = **specific weight ×** h

So, $R = [2 \times 0.15]/[1.82 \times 10^{-3} \times 2060] = 8 \times 10^{-3}$ **m or 8 mm.**

Problem 3. *A mercury column is used to measure the atmospheric pressure. The height of column above the mercury well surface is 762 mm. The tube is 3 mm in dia. The contact angle is 140°.* ***Determine the true pressure in mm*** *of mercury if surface tension is 0.51 N/m. The space above the column may be considered as vacuum.* In this case capillary depression is involved and so the true pressure = mercury column + capillary depression.

The specific weight of mercury = 13550 × 9.81 N/m^3, equating forces,

$[h \times \gamma \times \pi D^2/4] = [\pi \times D \times \sigma \times \cos \beta]$.

So

$h = \{4 \times \sigma \times \cos \beta\}/\{\gamma \times D\}$

$h = (4 \times 0.51) \times \cos 140]/[13550 \times 9.81 \times 0.003]$

$= \mathbf{-3.92 \times 10^{-3}}$ **m or - 3.92 mm, (depression)**

Hence actual pressure indicated = 762 + 3.92 = **765.92 mm** of mercury.

Problem 4. *A hollow cylinder of 150 mm OD with its weight equal to the buoyant forces is to be kept floating vertically in a liquid with a surface tension of 0.45 N/m ^{2}. The contact angle is 60°. Determine the additional force required due to surface tension.*

In this case a capillary rise will occur and this requires an additional force to keep the cylinder floating.

Capillary rise, $h = \{4 \times \sigma \times \cos \beta\}/\{\gamma \times D\}$.

As

$(P_i - P_o) = h \times$ specific weight, $(P_i - P_o) = \{4 \times \sigma \times \cos \beta\}/D$

$(P_i - P_o) = \{4 \times 0.45 \times \cos 60\}/\{0.15\} = 6.0$ N/m^2

Force = Area $\times (P_i - P_o) = \{\pi \times 0.015^2/4\} \times 6 = 0.106$ N

As the immersion leads to additional buoyant force the force required to kept the cylinder floating will be double this value.

So the additional force = 2 × 0.106 = **0.212 N.**