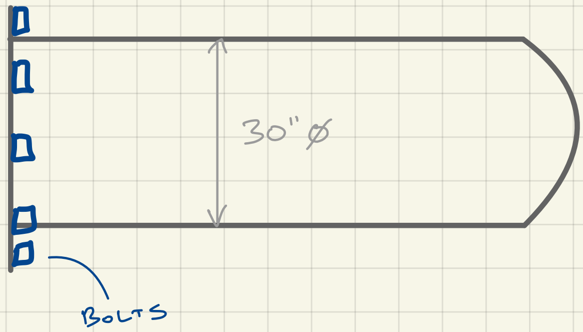
4-2 **GIVEN:**

A FLAT END OF A TANK IS HELD TOGETHER W/ A BOLTED FLANGE.

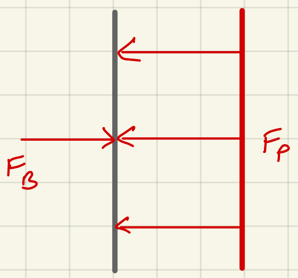


$P = 14.4$ psig

REQUIRED:

CALCULATE THE FORCE RESISTED BY THE BOLTS

SOLUTION:



$F = pA$

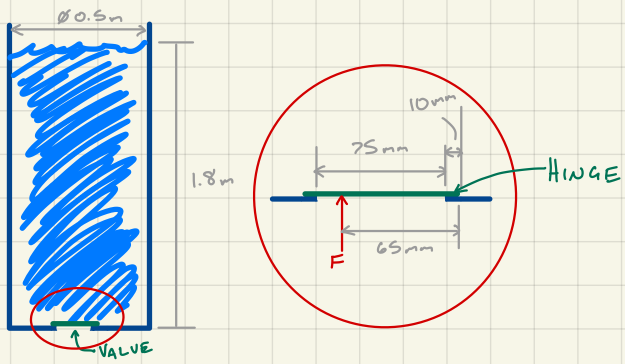
$A_T = \frac{\pi D^2}{4} = \frac{\pi (30")^2}{4} = \boxed{706.9 \text{ in}^2}$

$F_P = F_B = p A_T = (14.4 \text{ psig})(706.9 \text{ in}^2)$

$\boxed{= 10179 \text{ psi}}$

4-10 **GIVEN:**

A SHOWER CONSISTS OF A CYLINDRICAL TANK W/ A FLAPPER VALVE AT THE BASE WHICH OPENS INWARD

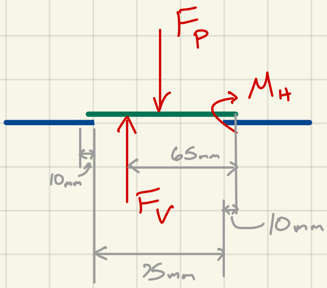


REQUIRED:

HOW MUCH FORCE IS REQURED TO OPEN THE VALVE?

4-10 cont

SOLUTION:



$F_V > F_p$

$\Sigma M = 0$

$F_P = pA$

$A = \frac{\pi D^2}{4} = \frac{\pi (0.095m)^2}{4} = \boxed{0.00709 \ m^2}$

• This area assumes the flapper overlaps both sides of the value equally, making $D = 75mm + 10mm + 10mm = 95mm$

$P = \gamma_{H_2O} h = (9.81 \ kN/m^3)(1.8m) = \boxed{17.66 \ kN/m^2}$

$F_p = (17.66 \ kN/m^2)(0.00709 \ m^2) = \boxed{0.1252 \ kN}$

$\circlearrowleft \Sigma M_H = F_V (0.065m) - F_p \left(\frac{0.075m}{2} + 0.01m \right) = 0$

$\therefore$

$F_V = \frac{F_p (0.0475m)}{(0.065m)} = \frac{(0.1252 kN)(0.0475m)}{(0.065m)}$

$= 0.915 \ kN = \boxed{91.5 N}$

5-8 **GIVEN:**

A PUMP IS PARTIALLY SUBMERGED IN OIL, AND RESTS ON SPRINGS.

VOLUME SUBMERGED = V_s = 40 in^3

WEIGHT OF PUMP = W_p = 14.6 lbs

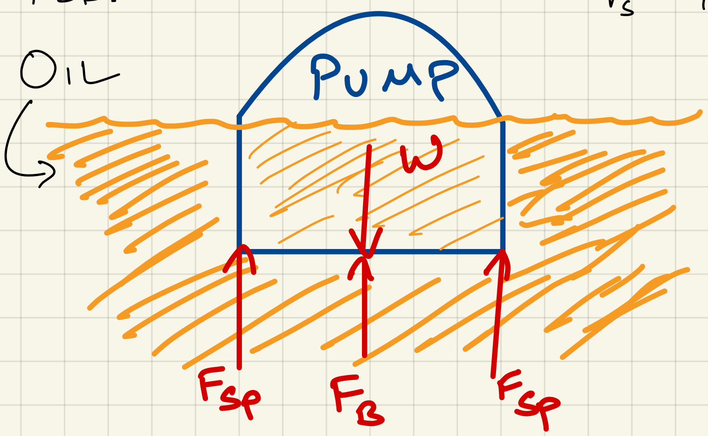
Sg_{OIL} = 0.90

REQUIRED:

FIND SUPPORTING FORCE EXERTED BY SPRINGS

SOLUTION:

FBD:



$$V_s = 40 \, in^3 \left(\frac{1 \, ft^3}{1728 \, in^3} \right) = \boxed{0.0231 \, ft^3}$$

$F_B = W_D$

- F_B = BUOYANT FORCE
- W_D = WEIGHT DISPLACED

$W_D = \gamma_{OIL} V_D \;\therefore\; F_B = \gamma_{OIL} V_D$

$\gamma_{OIL} = Sg_{OIL} \gamma_{WATER} = (0.90)(62.4 \, lb/ft^3)$ • γ_{WATER} IN TABLE A.2

$= \boxed{56.16 \, lb/ft^3}$

$F_B = (56.16 \, lb/ft^3)(0.0231 \, ft^3) = \boxed{1.2973 \, lb}$

$\uparrow \Sigma F_y = 0$ • SUM OF THE FORCES IN y IS 0 AS PUMP IS STATIONARY. SOLVE FOR F_{SP}

$F_B + F_{SP} - W_p = 0 \;\therefore\; F_{SP} = W_p - F_B$

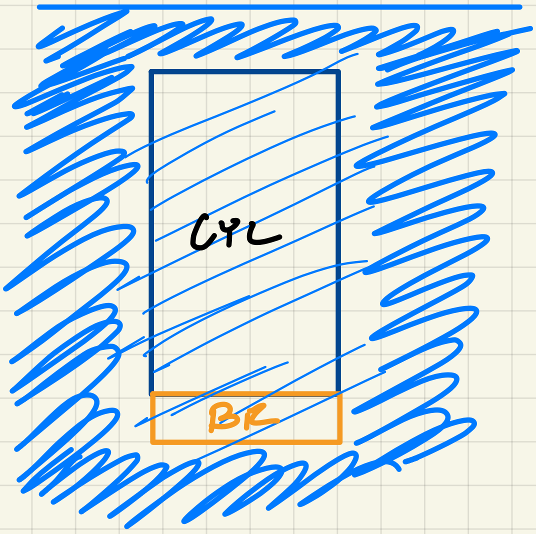
$F_{SP} = (14.6 \, lbs) - (1.2973 \, lbs)$

$= \boxed{13.3 \, lbs}$

S-24

GIVEN:

A BRASS WEIGHT IS TO BE ATTACHED TO THE BOTTOM OF A UNIFORM CYLINDER SO AS TO MAKE THE SYSTEM NEUTRALLY BUOYANT BELOW THE SURFACE OF WATER. THE BRASS IS A DISK W/ THE SAME DIAMETER AS THE CYLINDER.



$D_{cyl} = D_{BR} = 0.45\,m$

$L_{cyl} = 0.75\,m$

$\gamma_{water @ 95^\circ C} = 9.4\,kN/m^3$ • TABLE A.1

$\gamma_{cyl} = 6.456\,kN/m^3$ • SOLVED IN LECTURE, PROB S.22

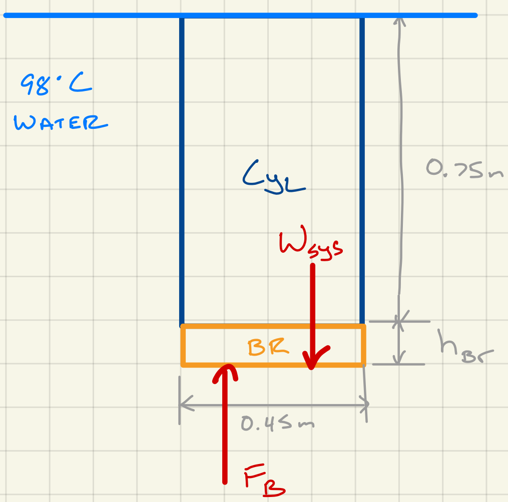
$\gamma_{Br} = 84.0\,kN/m^3$ • GIVEN IN PROB FIGURE

REQUIRED:

CALCULATE THE THICKNESS OF THE BRASS DISK REQUIRED TO MAKE THE SYSTEM NEUTRALLY BUOYANT.

SOLUTION:

FBD:



$F_B = W_{sys}$

$W_{sys} = \gamma_{cyl} \cdot V_{cyl} + \gamma_{Br} \cdot V_{Br}$

$V_{Br} = \frac{\pi D^2}{2} \cdot h_{Br}$

$F_B = \gamma_w \cdot V_D = \gamma_w \cdot \left(V_{cyl} + \frac{\pi D^2}{2} \cdot h_{Br}\right)$

$\therefore$

$$\gamma_w \cdot \left(V_{cyl} + \frac{\pi D^2}{2} \cdot h_{Br}\right) = \gamma_{cyl} \cdot V_{cyl} + \gamma_{Br} \cdot \frac{\pi D^2}{2} \cdot h_{Br}$$

$\therefore$

$$\gamma_w V_{cyl} + \gamma_w \frac{\pi D^2}{2} \cdot h_{Br} = \gamma_{cyl} \cdot V_{cyl} + \gamma_{Br} \cdot \frac{\pi D^2}{2} \cdot h_{Br}$$

S-24 cont

$$\gamma_w \frac{\pi D^2}{2} \cdot h_{Br} - \gamma_{Br} \cdot \frac{\pi D^2}{2} \cdot h_{Br} = \gamma_{cyl} \cdot V_{cyl} - \gamma_w \cdot V_{cyl}$$

- Solve for known terms to simplify problem.

$$\gamma_w \frac{\pi D^2}{2} = (9.4\ kN/m^3)\frac{\pi (0.45m)^2}{2} = 2.99\ kN/m$$

$$\gamma_{Br} \frac{\pi D^2}{2} = (84.0\ kN/m^3 \frac{\pi (0.45m)^2}{2} = 26.72\ kN/m$$

$$V_{cyl} = \frac{\pi D^2}{2} \cdot h_{cyl} = \frac{\pi (0.45m)^2}{2} \cdot (0.75m) = 0.239\ m^3$$

$$\gamma_{cyl} V_{cyl} - \gamma_w V_{cyl} = (6.456\ kN/m^3)(0.239m^3) - (9.4\ kN/m^3)(0.239m^3)$$

$$= -0.704\ kN$$

- Solve equation for h_{Br}:

$$2.99\ kN/m\ h_{Br} - 26.72\ kN/m\ h_{Br} = -0.704\ kN$$

$$\therefore$$

$$h_{Br} = \frac{(-0.704\ kN)}{(-23.73\ kN/m)} = 0.0297\ m = \boxed{29.7\ mm}$$