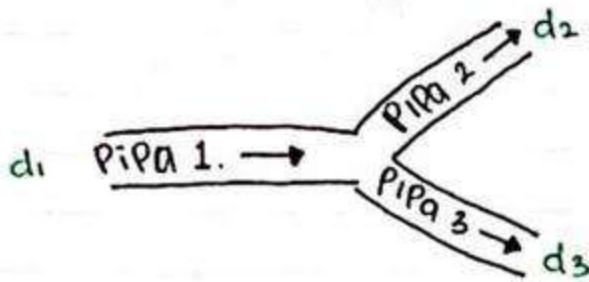


Naura Noor Ufaira
201464568/SV/18687

X	Y	Z
6	8	7

Tugas 1 Hidrolika

1.

Diketahui: $r_1 = 7,86 \text{ cm}$

$$d_1 = 15,72 \text{ cm} = 0,1572 \text{ m}$$

$$d_2 = 0,38 \cdot 0,1572 = 0,059736 \text{ m}$$

$$d_3 = 0,5 \cdot 0,1572 = 0,0786 \text{ m}$$

$$V_2 = 0,47 \cdot V_1$$

$$V_{\max} = 5,87 \text{ m/s}$$

$$\heartsuit Q_1 = Q_2 + Q_3$$

$$A_1 \cdot V_1 = A_2 \cdot V_2 + A_3 \cdot V_3$$

$$\frac{1}{4} \cdot \pi \cdot d_1^2 \cdot V_1 = \frac{1}{4} \cdot \pi \cdot d_2^2 \cdot V_2 + \frac{1}{4} \cdot \pi \cdot d_3^2 \cdot V_3$$

$$\frac{1}{4} \pi \cdot d_1^2 \cdot V_1 = \frac{1}{4} \pi (d_2^2 \cdot V_2 + d_3^2 \cdot V_3)$$

$$d_1^2 \cdot V_1 = d_2^2 \cdot V_2 + d_3^2 \cdot V_3$$

$$0,1572^2 \cdot V_1 = 0,059736^2 \cdot V_2 + 0,0786^2 \cdot V_3$$

$$0,02471 \cdot V_1 = 0,00357 \cdot 0,47 \cdot V_1 + 0,00618 V_3$$

$$0,02471 V_1 = 0,00168 V_1 + 0,00618 V_3$$

$$0,02303 V_1 = 0,00618 V_3$$

$$V_3 = \frac{0,02303 \cdot V_1}{0,00618} = 3,73 V_1$$

$$\heartsuit V_{\max} = V_1 + V_2 + V_3$$

$$5,87 = V_1 + 0,47 V_1 + 3,73 V_1$$

$$5,87 = 5,2 V_1$$

$$V_1 = \frac{5,87}{5,2} = 1,129 \text{ m/s}$$

$$\heartsuit V_1 = 1,129 \text{ m/s}$$

$$V_2 = 0,47 \cdot 1,129$$

$$= 0,53063 \text{ m/s}$$

$$V_3 = 3,73 \cdot 1,129$$

$$= 4,2117 \text{ m/s}$$

cek

$$V_{\max} = V_1 + V_2 + V_3$$

$$5,87 = 1,129 + 0,53063 + 4,2117$$

$$5,87 = 5,87 \text{ (OK)}$$

$$\heartsuit Q_1 = A_1 \cdot V_1$$

$$= \frac{1}{4} \pi \cdot d_1^2 \cdot V_1$$

$$= \frac{1}{4} \cdot 3,14 \cdot (0,1572)^2 \cdot 1,129$$

$$= 0,02190 \text{ m}^3/\text{s}$$

$$Q_2 = A_2 \cdot V_2$$

$$= \frac{1}{4} \cdot \pi \cdot d_2^2 \cdot V_2$$

$$= \frac{1}{4} \cdot 3,14 \cdot (0,059736)^2 \cdot 0,53063$$

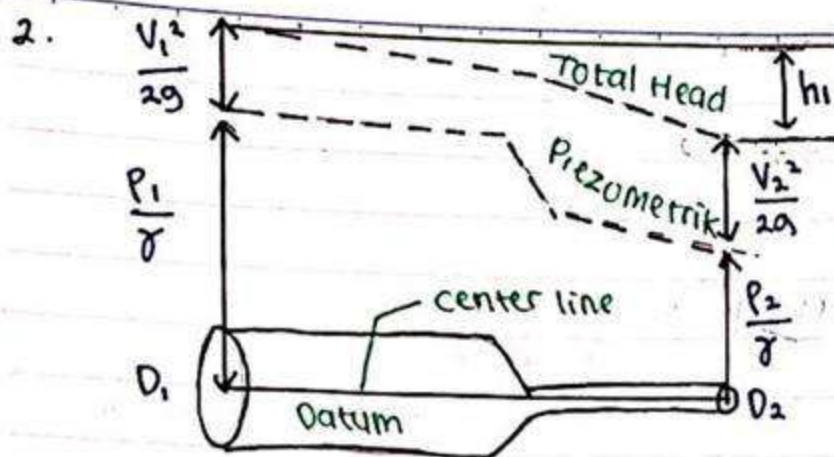
$$= 0,00149 \text{ m}^3/\text{s}$$

$$Q_3 = A_3 \cdot V_3$$

$$= \frac{1}{4} \cdot \pi \cdot d_3^2 \cdot V_3$$

$$= \frac{1}{4} \cdot 3,14 \cdot (0,0786)^2 \cdot 4,2117$$

$$= 0,02042$$



Diketahui : Panjang Pipa = 169 m

$$D_1 = 24,78 \text{ cm} = 0,2478 \text{ m}$$

$$D_2 = 0,5 \cdot 0,2478 = 0,1239 \text{ m}$$

$$\Delta P = 2,8 \text{ kgf/cm}^2$$

$$= 28 \text{ ton/m}^2$$

$$\heartsuit \text{ Tinggi tekanan}_1 = \frac{P_1}{\gamma} = \frac{P_1}{1000}$$

$$\text{Tinggi tekanan}_2 = \frac{P_2}{\gamma} = \frac{P_1 - 28}{1000}$$

\heartsuit Pers. kontinuitas

$$Q_1 = Q_2$$

$$A_1 \cdot V_1 = A_2 \cdot V_2$$

$$\frac{1}{4} \cdot \pi \cdot d_1^2 \cdot V_1 = \frac{1}{4} \cdot \pi \cdot d_2^2 \cdot V_2$$

$$(0,2478)^2 \cdot V_1 = (0,1239)^2 \cdot V_2$$

$$V_1 = \frac{0,01535 V_2}{0,06140} = 0,25 V_2$$

$$\heartsuit Q_1 = A_1 \cdot V_1$$

$$= \frac{1}{4} \cdot \pi \cdot d_1^2 \cdot V_1$$

$$= \frac{1}{4} \cdot 3,14 \cdot (0,2478)^2 \cdot 0,325$$

$$= 0,01567 \text{ m}^3/\text{s}$$

$$Q_2 = A_2 \cdot V_2$$

$$= \frac{1}{4} \cdot \pi \cdot d_2^2 \cdot V_2$$

$$= \frac{1}{4} \cdot 3,14 \cdot (0,1239)^2 \cdot 1,3$$

$$= 0,01567 \text{ m}^3/\text{s}$$

\heartsuit Pers. Bernoulli (horizontal)

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$$

$$\frac{P_1 - P_2}{\gamma} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$$

$$\frac{28}{1000} = \frac{V_2^2 - (0,25 V_2)^2}{2 \cdot 9,81}$$

$$0,028 = \frac{V_2^2 - 0,0625 V_2^2}{19,62}$$

$$0,54936 = 0,9375 V_2^2$$

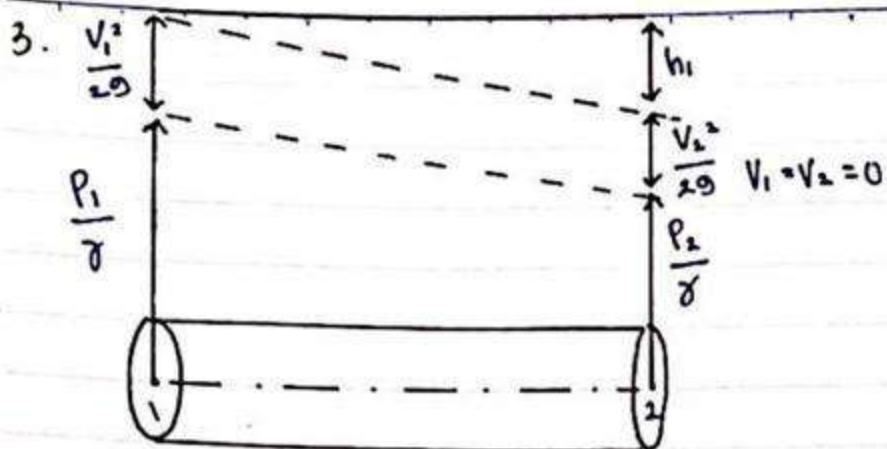
$$V_2 = \sqrt{\frac{0,54936}{0,9375}}$$

$$V_2 = 1,3 \text{ m/s}$$

$$\heartsuit V_1 = 0,25 V_2$$

$$= 0,25 \cdot 1,3$$

$$= 0,325 \text{ m/s}$$



$$f = \frac{0,316}{Re^{0,25}}$$

$$0,0367 = \frac{0,316}{Re^{0,25}}$$

$$Re^{0,25} = 8,61035$$

$$Re = 74,13012712$$

$$\frac{1}{\sqrt{f}} = -2 \log \left(\frac{K}{3,70} + \frac{2,51}{Re \sqrt{f}} \right)$$

$$\frac{1}{\sqrt{0,0367}} = -2 \log \left(\frac{K}{3,7 \cdot 0,2478} + \frac{2,51}{74,14 \sqrt{0,0367}} \right)$$

$$5,219 = -2 \log \left(\frac{K}{0,91686} + \frac{2,51}{14,2} \right) \text{ misal } x$$

$$5,219 = -2 \log x$$

$$x = 10^{(5,219/2)}$$

$$= 406,91$$

$$\left(\frac{K}{0,91686} + \frac{2,51}{14,2} \right) = 406,91$$

$$\left(\frac{14,2 K + 2,3013186}{13,019} \right) = 406,91$$

$$14,2 K + 2,3013186 = 5297,56129$$

$$14,2 K = 5295,259971$$

$$K = 372,9$$

$$= 3,729 \text{ m}$$

♥ Kehilangan tenaga primer

$$K = f \cdot \frac{L}{D}$$

$$= 0,0367 \cdot \frac{169}{0,2478} = 25,02$$

♥ Kecepatan

$$Q_1 = Q_2$$

$$A_1 \cdot V_1 = A_2 \cdot V_2$$

$$V_2 = \left(\frac{D_1}{D_2} \right)^2 \cdot V_1$$

♥ Substitusi

$$K = \frac{V_2^2}{2g} \cdot \frac{L}{D} \cdot f$$

$$25,02 = \frac{V_2^2}{2 \cdot 9,81} \cdot \frac{169}{0,2478} \cdot 0,0367$$

$$V_2 = \sqrt{19,61}$$

$$= 4,42 \text{ m/s}$$

♥ $Q_1 = Q_2$

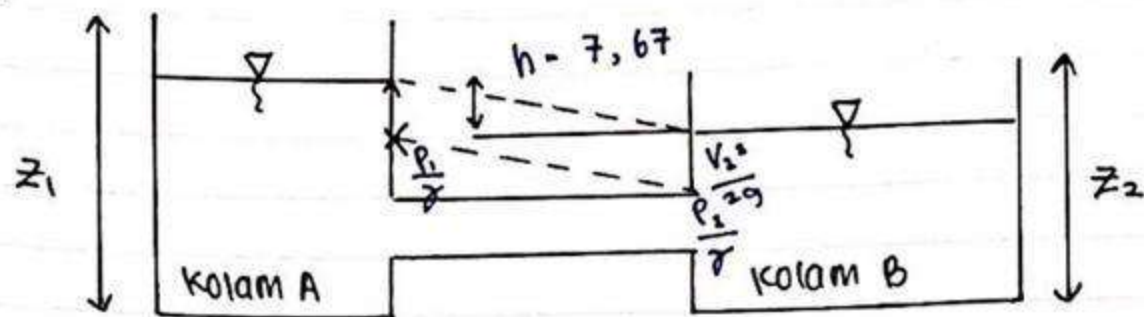
$$Q_2 = A_2 \cdot V_2$$

$$= \frac{1}{4} \cdot 3,14 \cdot D_2^2 \cdot V_2$$

$$= \frac{1}{4} \cdot 3,14 \cdot (0,1239)^2 \cdot 4,42$$

$$= 0,0576 \text{ m}^3/\text{s}$$

4.



$$\heartsuit \frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + \sum hf$$

$$h + hf = \left(z_1 + \frac{p_1}{\gamma} + \frac{V_1^2}{2g} \right) - \left(z_2 + \frac{p_2}{\gamma} + \frac{V_2^2}{2g} \right)$$

$$V_1 = V_2 = 0$$

$$\sum h + \sum hf = \left(z_1 + \frac{p_1}{\gamma} \right) - \left(z_2 + \frac{p_2}{\gamma} \right)$$

$$h_{ab} + hf_1 = H$$

$$K_a \cdot \frac{V_1^2}{2g} + K_b \cdot \frac{V_2^2}{2g} + f_1 \cdot \frac{L_1}{D_1} \cdot \frac{V_1^2}{2g} = H \dots (1)$$

♥ Pers. Kontinuitas

$$A_1 \cdot V_1 = A_2 \cdot V_2$$

$$V_2 = \frac{A_1}{A_2} \cdot V_1$$

$$= \frac{\frac{1}{4} \pi D_1^2}{\frac{1}{4} \pi D_2^2} \cdot V_1$$

$$V_2 = \left(\frac{D_1}{D_2} \right)^2 V_1 \dots (2)$$

♥ substitusi (2) ke (1)

$$K_a \cdot \frac{V_1^2}{2g} + K_b \cdot \left(\frac{D_1}{D_2} \right)^4 \frac{V_1^2}{2g} + f_1 \cdot \frac{L_1}{D_1} \cdot \frac{V_1^2}{2g} = H$$

$$\left(K_a + K_b \left(\frac{D_1}{D_2} \right)^4 + f_1 \cdot \frac{L_1}{D_1} \right) \frac{V_1^2}{2g} = 7,67$$

$$\left(0,77 + 1,36 \cdot \left(\frac{0,2478}{0,1239} \right)^4 + 0,0367 \cdot \frac{169}{0,2478} \right) \cdot \frac{V_1^2}{2 \cdot 9,81} = 7,67$$

$$(0,77 + 1,36 \cdot 16 + 25,029) \cdot \frac{V_1^2}{19,62} = 7,67$$

$$47,559 V_1^2 = 150,4854$$

$$V_1 = \sqrt{\frac{150,4854}{47,559}} = 1,7708 \text{ m/s}$$

♥ Jika f_2 diperhitungkan maka :

$$K_a \cdot \frac{V_1^2}{2g} + K_b \frac{V_2^2}{2g} + f_1 \cdot \frac{L_1}{D_1} \cdot \frac{V_1^2}{2g} + f_2 \cdot \frac{L_2}{D_2} \cdot \frac{V_2^2}{2g} = H$$

$$K_a \cdot \frac{V_1^2}{2g} + K_b \left(\frac{D_1}{D_2} \right)^4 \cdot \frac{V_1^2}{2g} + f_1 \cdot \frac{L_1}{D_1} \cdot \frac{V_1^2}{2g} + f_2 \cdot \frac{L_2}{D_2} \left(\frac{D_1}{D_2} \right)^4 \cdot \frac{V_1^2}{2g} = H$$

$$\left(K_a + K_b \left(\frac{D_1}{D_2} \right)^4 + f_1 \cdot \frac{L_1}{D_1} + f_2 \cdot \frac{L_2}{D_2} \left(\frac{D_1}{D_2} \right)^4 \right) \frac{V_1^2}{2g} = H$$

$$\left(0,77 + 1,36 \left(\frac{0,2478}{0,1239} \right)^4 + 0,0367 \frac{16g}{0,1239} + 0,0367 \cdot \frac{16g}{0,1239} \cdot \left(\frac{0,2478}{0,1239} \right)^4 \right) \frac{V_1^2}{2 \cdot 9,81} = 7,67$$

$$(0,77 + 21,76 + 50,0509 + 800,9424) \frac{V_1^2}{2g} = 150,4854$$

$$V_1 = \sqrt{\frac{150,4854}{873,5313}} = 0,415 \text{ m/s}$$

$$♥ V_2 = \left(\frac{D_1}{D_2} \right)^2 \cdot V_1$$

$$= \left(\frac{0,2478}{0,1239} \right)^2 \cdot 0,415$$

$$= 6,64 \text{ m/s}$$

$$V_2 = 6,64 \rightarrow V_1 = V_2$$

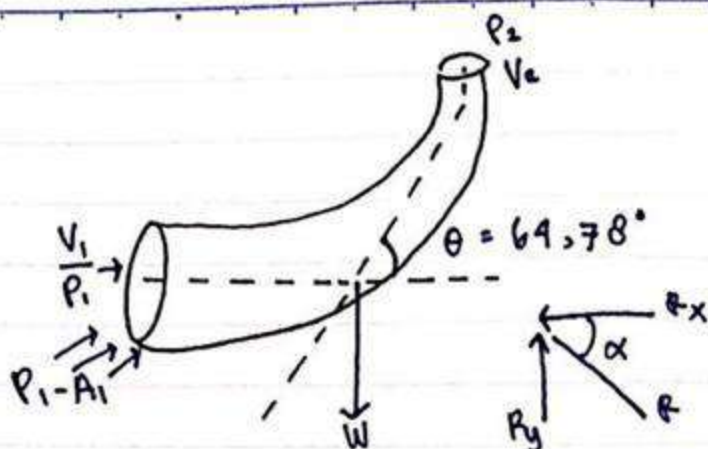
♥ Debit

$$Q_1 = A_1 \cdot V_1$$

$$= \frac{1}{4} \cdot 3,14 \cdot 0,2478^2 \cdot 6,64$$

$$= 0,320 \text{ m}^3/\text{s}$$

5.



$$P_1 \cdot A_1 - P_2 \cdot A_2 \cos \theta - R_x = \rho Q (V_2 \cos \theta - V_1)$$

$$\text{arah } x \rightarrow R_x = P_1 \cdot A_1 - P_2 \cdot A_2 \cos \theta - \rho Q (V_2 \cos \theta - V_1)$$

$$\text{arah } y \rightarrow R_y = W - P_2 \cdot A_2 \sin \theta = \rho Q V_2 \sin \theta$$

$$R_y = W + P_2 \cdot A_2 \sin \theta + \rho Q V_2 \sin \theta$$

$$\heartsuit A_1 \cdot V_1 = A_2 \cdot V_2$$

$$V_2 = \frac{A_1 \cdot V_1}{A_2} = \frac{0,0482 \cdot 0,325}{0,01205}$$

$$= 4 \cdot 0,325 = 1,3 \text{ m/s}$$

$$\heartsuit Q_1 = A_1 \cdot V_1$$

$$= 0,0482 \cdot 0,325$$

$$= 0,01567 \text{ m}^3/\text{s}$$

$$\heartsuit z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$$

$$\frac{P_1}{1000} + \frac{0,325^2}{2 \cdot 9,81} = \frac{P_2}{1000} + \frac{1,3^2}{2 \cdot 9,81}$$

$$\frac{P_1 - P_2}{1000} = \frac{1,3^2 - 0,325^2}{19,62}$$

$$\frac{P_1 - P_2}{1000} = \frac{1,69 - 0,105625}{19,62}$$

$$P_1 - P_2 = 80,75 \text{ N/m}^2$$

$$\heartsuit P_1 = P_1 + 14,87 \% \cdot P_1$$

$$P_2 = P_1 + 14,87 \% \cdot P_1$$

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} = 0$$

$$\frac{P_1}{1000} + \frac{(0,325)^2}{2 \cdot 9,81} = 0$$

$$\frac{P_1}{1000} + \frac{0,1056}{19,62} = 0$$

$$P_1 = 3,3022 \text{ N/m}^2$$

$$\heartsuit P_1 = 3,3022 + 3,3022 \cdot 14,87 \%$$

$$\cdot P_2 = P_2 + 14,87 \% \cdot P_2$$

$$R = \sqrt{R_x^2 + R_y^2}$$

$$\operatorname{tg} \alpha = \frac{R_y}{R_x}$$

$$\begin{aligned} A_1 &= \frac{1}{4} \cdot \pi \cdot D_1^2 \\ &= \frac{1}{4} \cdot 3,14 \cdot 0,2478^2 \\ &= 0,0194523 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} A_2 &= \frac{1}{4} \cdot \pi \cdot D_2^2 \\ &= \frac{1}{4} \cdot 3,14 \cdot (0,1239)^2 \\ &= 0,01207 \text{ m}^2 \end{aligned}$$

$$V_1 = 0,525 \text{ m/s}$$

$$\begin{aligned} P_2 &= 5,3822 + 5,3822 \cdot 14,87\% \\ &= 6,1825 \text{ N/m}^2 \end{aligned}$$

$$\begin{aligned} R_x &= P_1 A_1 - P_2 A_2 \cos \theta - P \cdot Q (V_2 \cos \theta - V_1) \\ &= 5,3822 \cdot 0,0194523 - 6,1825 \cdot 0,01207 \cdot \cos 64,78 - \frac{1000}{9,81} \cdot 0,05167 (1,3 \cos 64,78 - 0,525) \end{aligned}$$

$$\begin{aligned} &= 0,1047 - 0,031789 - 0,35389 \\ &= 0,2809 \end{aligned}$$

$$\begin{aligned} R_z &= W + P_2 \cdot A_2 \sin \theta + P Q V_2 \sin \theta \\ &= 6,1825 + 0,07462 \sin 64,78 + \frac{1000}{9,81} \cdot 1,3 \sin 64,78 \end{aligned}$$

$$\begin{aligned} &= 6,1825 + 0,0674 + 110,87 \\ &= 245,99 \end{aligned}$$

$$\begin{aligned} R &= \sqrt{R_x^2 + R_z^2} \\ &= \sqrt{0,2809^2 + 110,87^2} \\ &= 110,95 \text{ N} \end{aligned}$$