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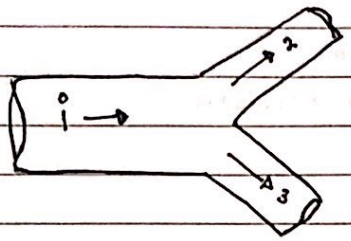
20/464378/SV/18697

"TUGAS 1 HIDROLOGI"

X	Y	Z
7	8	7

① Aliran air mengalir dalam pipa 1 yang memiliki jari-jari 7,87, kemudian bercabang menjadi pipa 2 dan pipa 3 dengan masing-xx diameternya 0,38 kali diameter pipa 1 dan 0,5 diameter pipa 1, secara berurutan. Kecepatan pipa 2 adalah 0,47 kali kecepatan pipa1. Hitung debit aliran bila kecepatan maksimum semua pipa tidak diperbolehkan melebihi 5,87 m/detik



- Pipa 1

$d_1 = 2 \times 7{,}87 = 15{,}74 \text{ cm} = 0{,}1574 \text{ m}$

$V_1 = V_1$

- Pipa 2

$d_2 = 0{,}38 \times 15{,}74 = 5{,}981 \text{ cm} = 0{,}05981 \text{ m}$

$V_2 = 0{,}47\ V_1$

- Pipa 3

$d_3 = 0{,}5\ d_1 = 0{,}5 \times 15{,}74 = 7{,}87 \text{ cm} = 0{,}0787 \text{ m}$

$V_3 = V_3$

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

a) $Q_1 = Q_2 + Q_3$

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

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

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

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

$0{,}1574^2 \cdot V_1 = 0{,}05981^2 \cdot 0{,}47 V_1 + 0{,}0787^2 \cdot V_3$

$0{,}02477 \cdot V_1 = 0{,}003577 \cdot 0{,}47 V_1 + 0{,}0061936 \cdot V_3$

$0{,}02477 \cdot V_1 = 0{,}001681 \cdot V_1 + 0{,}0061936\ V_3$

$V_3 = \frac{0{,}023089 \cdot V_1}{0{,}0061936} = 3{,}72\ V_1$

a) $V_{max} = V_1 + V_2 + V_3$

$5{,}87 = V_1 + 0{,}47 V_1 + 3{,}72 V_1$

$5{,}87 = 5{,}19 V_1$

$V_1 = \frac{5{,}87}{5{,}19} = 1{,}131 \text{ m/detik}$

a) $V_1 = 1{,}131 \text{ m/s}$

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

$= 0{,}47 \cdot 1{,}131 = 0{,}5315 \text{ m/s}$

$V_3 = 3{,}72\ V_1$

$= 3{,}72 \cdot 1{,}131 = 4{,}2073 \text{ m/s}$

cek

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

$5{,}87 = 1{,}131 + 0{,}5315 + 4{,}2073$

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

a) Debit Aliran

$Q_1 = A_1 \cdot V_1$

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

$= \frac{1}{4} \cdot 3{,}14 \cdot (0{,}1574)^2 \cdot 1{,}131$

$= 0{,}02199 \text{ m}^3/\text{s}$

$Q_2 = A_2 \cdot V_2$

$= \frac{1}{4} \cdot 3{,}14 \cdot (0{,}05981)^2 \cdot 0{,}5315$

$= 0{,}001492 \text{ m}^3/\text{s}$

$Q_3 = A_3 \cdot V_3$

$= \frac{1}{4} \cdot 3{,}14 \cdot (0{,}0787)^2 \cdot 4{,}2073$

$= 0{,}02045 \text{ m}^3/\text{s}$

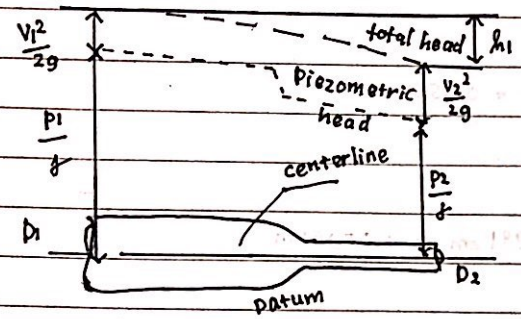
cek

$Q_1 = Q_2 + Q_3$

$0{,}02199 = 0{,}001492 + 0{,}02045$

$0{,}02199 = 0{,}02199$ (OK)

② Di sebuah desa di Yogyakarta, terdapat pipa yang mengalirkan air secara horizontal dengan panjang 179 meter. Pada daerah hulu, pipa tersebut memiliki bagian diameter yang besar sebesar 24,78 cm Di bagian hilir, pipa tersebut mengecil menjadi setengahnya. Pada daerah hulu hilir, tekanan masing-masing pipa memiliki perbedaan 2,8 kgf/cm². Estimasi debit aliran yang terjadi.



Panjang Pipa = 179 m

D_1 = 24,78 cm = 0,2478 m

D_2 = 0,5 . 24,78 = 12,39 cm = 0,1239 m

γ = 1000 kg/m³

$\Delta P = P_1 - P_2$

= 2,8 kgf/cm²

= 28 ton/m²

Q ... ?

a) Tinggi tekanan$_1$ = $\frac{P_1}{\gamma} = \frac{P_1}{1000}$

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

b) Persamaan Kontinuitas

$Q_1 = Q_2$

$A_1 . V_1 = A_2 . V_2$

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

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

$V_1 = \frac{0,01535}{0,0614} V_2$

$V_1 = 0,25\, V_2$

c) Persamaan Bernouli (Horizontal)

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

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

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

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

$0,028 = 0,04778 V_2^2$

$V_2 = \sqrt{\frac{0,04778}{0,028}} = 1,306$ m/s

a) $V_1 = 0,25\, V_2$

$= 0,25 . 1,306$

$= 0,3265$ m/s

b) $Q_1 = A_1 . V_1$

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

$= \frac{1}{4} \cdot 3,14 . (0,2478)^2 . 0,3265$

$= 0,01573$ m³/s

$Q_2 = A_2 . V_2$

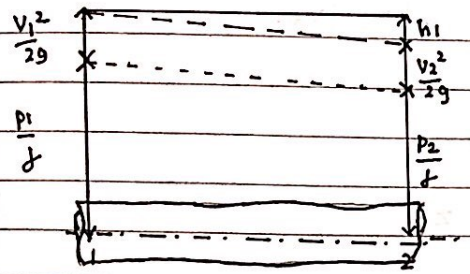
$= \frac{1}{4} . 3,14 . (1,306)^2 . (0,1239)^2$

$= 0,01573$

cek

$Q_1 = Q_2$ (OK)

③ Dengan kasus sama dengan nomor 2. Perbedaannya, di hilir tidak ada perubahan diameter pipa. sehingga, diameternya sama. Bila koefisien gesek aliran yang terjadi adalah F = 0,0377 tentukan debit Aliran



Q....

$V_1 = V_2 = 0$

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

$0{,}0377 = \frac{0{,}316}{Re^{0{,}25}}$

$Re^{0{,}25} = 8{,}3819$

$Re = 20954{,}175$ → Aliran transisi

a) $\frac{1}{\sqrt{f}} = -2\log\left(\frac{k}{3{,}7D} + \frac{2{,}51}{Re\sqrt{f}}\right)$

$\frac{1}{\sqrt{0{,}0377}} = -2\log\left(\frac{k}{3{,}7 \cdot 0{,}2478} + \frac{2{,}51}{20954{,}175 \cdot \sqrt{0{,}0377}}\right)$

$5{,}1502 = -2\log\left[\left(\frac{k}{0{,}91686} + \frac{2{,}51}{4068{,}6}\right)\right]$ misalx

$5{,}1502 = -2\log x$

$x = 10^{(5{,}1502/2)}$

$x = 375{,}92$

⇓

$x = 375{,}92$

$\left(\frac{k}{0{,}91686} + \frac{2{,}51}{4068{,}6}\right) = 375{,}92$

$\frac{4068{,}6k + 2{,}301}{3730{,}33} = 375{,}92$

$4068{,}6k + 2{,}301 = 1402305{,}6$

$4068{,}6k = 1402303{,}29$

$k = 344{,}6$

$k = 3{,}446$ m → beton (I)

a) Kehilangan tenaga Primer

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

$= \frac{0{,}0377 \cdot 179}{0{,}2478}$

$K = 27{,}232$ (II) → dipakai

a) kecepatan

$Q_1 = Q_2$

$A_1 V_1 = A_2 \cdot V_2$

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

a) Subtitusi

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

$3{,}446 = \frac{V_2^2}{2 \cdot 9{,}81} \cdot \frac{179}{0{,}2478} \cdot 0{,}0377$

$3{,}446 = \frac{V_2^2}{2 \cdot 9{,}81} \times 27{,}2328$

$V_2 = \sqrt{\frac{67{,}6105}{27{,}2328}}$

$V_2 = 1{,}57$ m/s

a) $Q_1 = Q_2$

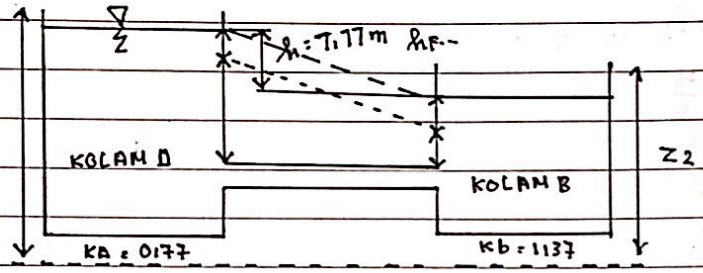
maka $Q_2 = A_2 \cdot V_2$

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

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

$= 0{,}048$ m³/s

④ Dengan kasus yang sama dengan nomor 3 - bedanya : pipa mengalir melalui kolam A dan kolam B dengan pipa tersebut, elevasi perbedaan kolam di hulu dan hilir adalah 7,77 m. Bila koef kehilangan tenaga akibat perubahan penampang pada sambungan antara pipa dan kolam A dan kolam B adalah $K_A = 0{,}77$ dan $K_b = 1{,}37$. Estimasi debit aliran



a) $\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + \Sigma h + \Sigma h_F$

$$h + h_F = \left(Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} \right) - \left(Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g} \right)$$

→ $V_1 = V_2 = 0$

$$\Sigma h + \Sigma h_F = \left(Z_1 + \frac{P_1}{\gamma} \right) - \left(Z_2 + \frac{P_2}{\gamma} \right)$$

→ $h_{ab} + h_{F1} = H$

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

o Persamaan kontinuitas

$$A_1 V_1 = A_2 \cdot V_2$$

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

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

$$V_2 = \frac{D_1^2}{D_2^2} \cdot V_1 \quad \ldots (2)$$

a) Substitusi (2) ke (1)

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

$$\left(K_a + K_b \left(\frac{D_1}{D_1} \right)^4 + f_1 \cdot \frac{L_1}{D_1} \right) \frac{V_1^2}{2g} = 7{,}77$$

$$0177 + 1{,}37 \left(\frac{01247\beta}{01247\beta} \right)^4 + \frac{010377 \cdot 179}{01247\beta} \cdot \frac{V_1^2}{2 \cdot 9{,}81} = 7{,}77$$

$$\left(0177 + 1{,}37 + 27{,}232 \right) \cdot V_1^2 / 19162 = 7{,}77$$

$(29{,}372)\ V_1^2 = 152{,}447$

$V_1 = 2{,}278\ m/s$

6) jika f_2 diperhitungkan maka

$$Ka \cdot \frac{V_1^2}{2g} + kb \cdot \frac{V_2^2}{2g} + f_1 \cdot \frac{L_1}{D_1} \cdot \frac{V_1^2}{2g} + f_2 \cdot \frac{L_1}{b_1} \cdot \frac{V_2^2}{2g} = H$$

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

$$Ka + Kb \left(\frac{D_1}{b_2}\right)^4 + f_1 \cdot \frac{L_1}{D_1} + f_2 \cdot \frac{L_2}{D_2} \left(\frac{D_1}{D_2}\right)^4 \frac{V_1^2}{2g} = H$$

$$0{,}77 + 1{,}37 \left(\frac{0{,}12478}{0{,}12478}\right)^4 + 0{,}0377 \cdot \frac{179}{0{,}12478} + 0{,}0377 \cdot \frac{179}{0{,}12478} \left(\frac{0{,}12478}{0{,}12478}\right)^4 \cdot \frac{V_1}{2 \cdot 9{,}81} = 7{,}77$$

$$\left(0{,}77 + 1{,}37 + 27{,}1232 + 27{,}1232\right) \frac{V_1^2}{19{,}62} = 7{,}77$$

$$56{,}604\ V_1^2 = 152{,}447$$

$V_1 = 1{,}64106\ m/s$ → yang dipakai

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

$V_2 = \left(\frac{0{,}12478}{0{,}12478}\right)^2 \cdot 1{,}64106$

$V_2 = 1{,}64106$ → $V_1 = V_2$

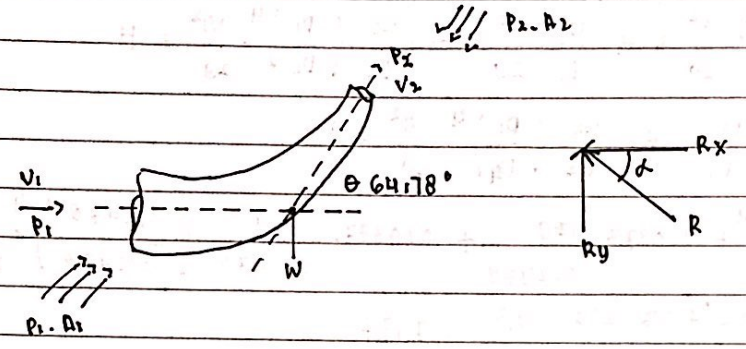
6) Debit

$Q_1 = A_1 \cdot V_1$

$= \frac{1}{4} \cdot \pi \cdot 0{,}12478 \cdot 0{,}12478 \cdot 1{,}64106$

$Q = 0{,}0791\ m^3/s$

⑤ Dengan kasus yang sama dengan nomor 2, bedanya airnya mengalir pada pipa yang membelok dari diameter besar ke kecil dengan sudut belokan 64,78°. Panjang pipa diabaikan. Estimasi kecepatan dengan kasus tersebut kemudian prediksi gaya untuk menahan pipa bila tekanan yang terjadi mengalami kenaikan ~~kenaikan~~ 14,87 % dari tekanan studi kasus awal



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

arah x → $R_x = P_1 . A_1 - P_2 A_2 \cos\theta - \rho Q (V_2 \cos\theta - V_1)$

arah y → $R_y = W - P_2 A_2 \sin\theta = \rho Q V_2 \sin\theta$

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

a) $A_1 V_1 = A_2 V_2$

$V_2 = \frac{A_1}{A_2} \times V_1 = \frac{0{,}0482}{0{,}1012} \times 0{,}13265$

$V_2 = 1{,}31144 \ m/s$

$Q_1 = A_1 \cdot V_1$

$= 0{,}0482 . 0{,}13265$

$= 0{,}01573$

→ $Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$

$\frac{P_1}{1000} + \frac{0{,}13265}{2.9{,}81} = \frac{P_2}{1000} . \frac{1{,}31144}{2.9{,}81}$

$\frac{P_1 - P_2}{1000} = \frac{1{,}31144 - 0{,}13265}{19{,}62}$

$19{,}62 (P_1 - P_2) = 98419$

$(P_1 - P_2) = \frac{0{,}01}{1} \ldots (1)$

Jika P_1 merupakan P awal pada no 2 maka:

$P_1 = 15{,}135 \ N/m^2$

$P_2 = 15{,}135 - 0{,}01 = 15{,}34$

terjadi kenaikan 14,87 %

$P_1 = 15{,}135 + \frac{15135}{1} * 14{,}87\ \%$

$= 19{,}915 \ N/m^2$

a) $P_1 = P_1 + 14{,}87\ \% \cdot P_1$

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

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

$\frac{P_1}{1000} + \frac{0{,}13265}{2.9{,}81} = 0$

$\frac{P_1}{1000} + 1{,}16014 = 0$

$P_1 = 15{,}35 \ N/m^2$

$P_1 = 15135 + 14{,}87\ \%$

$P_2 = P_2 + 14{,}87\ \% \times P_2$

$R = \sqrt{R_X^2 + R_Z^2}$

$\tan\alpha = \frac{R_Z}{R_X}$

$A_1 = \frac{1}{4} \cdot \pi \cdot d_1^2$

$= \frac{1}{4} \cdot 3{,}14 \cdot 0{,}12478^2$

$= 0{,}0048 \ m^2$

$A_2 = \frac{1}{4} . 3{,}14 . 0{,}11328^2$

$= 0{,}0103 \ m^2$ $V_1 = 0{,}3625 \ m/s$

$P_2 = 15135 + 15135 \times 14{,}87\,\%$

$= 19.915$

c) $Rx = P_1 A_1 - P_2 A_2 \cos\theta - \rho . Q (V_2 \cos\theta - V_1)$

$= 19.915 . 0{,}0482 - 19.915 . 0{,}012 \cos 64{,}78 - \frac{1000}{9{,}81} . (1{,}3114 \cos 64{,}78 - 0{,}13265)$

$= 0{,}9599 - 0{,}1018 - 0{,}2322$

$= 0{,}6259\ N$

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

$= 19{,}915 . 0{,}0482 \sin 64{,}78 + \frac{1000}{9{,}81} . 0{,}01573 . 1{,}3144 \sin 64{,}78$

$= 0{,}868 + 1{,}906$

$= 2{,}774$

$R = \sqrt{Rx^2 + Rz^2}$

$R = \sqrt{0{,}6259^2 + 2{,}774^2}$

$R = \sqrt{8{,}0868}$

$R = 2{,}843\ N$