Bintang Gumilang Imron
20/464345/SV/18664

x	Y	Z
4	5	4

Tugas Hidrolika

(1) Aliran Melalui Pipa

Air dengan kekentalan kinematik $1,15 \times 10^{-6}$ m²/d dipompa dari kolam A menuju kolam B dengan selisih elevasi muka air sebesar 25 m, melalui pipa besi tuang ($K_o = 0,00018$ m) sepanjang 1440 m dan diameter 0,25 m. Debit aliran adalah 0,05 m³/d. Setelah dipakai selama 10 tahun debit aliran berkurang menjadi 0,044 m³/d. Apabila debit aliran pada 20 tahun berikutnya meningkat sebesar 24,54 %. Berapakah daya pompa yang diperlukan untuk memenuhi kebutuhan air tersebut, apabila efisiensi pompa 94 % ?

Jawab

Diket :

$v = 1,15 \times 10^{-6}$ m²/d

$H_s = 25$ m

$K_o = 0,00018$ m

$L = 1440$ m

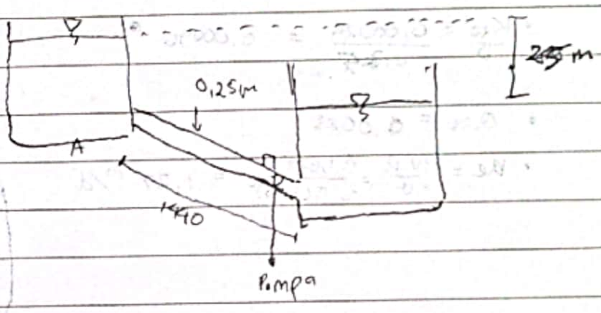
$D = 0,25$ m

$Q_0 = 0,05$ m³/d

$Q_{10} = 0,044$ m³/d

$Q_{20} = \left(\frac{24,54}{100} \times 0,05\right) + 0,05 = 0,0623$ m³/d

$\eta = 94\% = 0,94$



Ditanya : daya pompa ... ?

- $V = \frac{Q_0}{A} = \frac{0,05}{\frac{1}{4}\pi(0,25)^2} = \frac{0,05}{0,049} = 1,02$ m/d
- $Re = \frac{V.D}{v} = \frac{1,02 \cdot 0,25}{1,15 \times 10^{-6}} = 0,2217 \cdot 10^{-6} = 2,217 \times 10^{-5}$
- $\frac{K_o}{D} = \frac{0,00018}{0,25} = 0,00072 \rightarrow$ Grafik moody $F = 0,018$
- Kehilangan tenaga karena gesekan

$h_f = \frac{8FL}{g\pi^2 D^5} Q^2 = \frac{8(0,018)(1440)}{9,81(3,14)^2(0,25)^5}(0,05)^2 = \frac{0,5184}{0,0944} = 5,491$ m $\approx 5,5$ m

- Tinggi Tekanan Total

$H = H_s + H_f \rightarrow 25 + 5,5 = 30,5$ m

- Daya Pompa : $P = \frac{Q.H.\gamma}{75\eta} = \frac{0,05(30,5)(1000)}{75(0,94)} = \frac{1525}{70,5} = 21,63$ hp
- Umur 10 tahun :
  - $Q = 0,044$ m³/d $\rightarrow V = \frac{Q}{A} = \frac{0,044}{\frac{1}{4}\pi.(0,25)^2} = \frac{0,044}{0,049} = 0,898$ m/d
  - $Re = \frac{V.D}{v} = \frac{0,898.(0,25)}{1,15 \times 10^{-6}} = \frac{0,2245}{1,15 \times 10^{-6}} = 0,195 \times 10^{-6} = 1,95 \times 10^{-5}$
  - $H_f = \frac{8f.L}{g\pi^2 D^5} Q^2 \rightarrow F = \frac{h_f.g.\pi^2.D^5}{8L.Q^2} = \frac{5,5.(9,81).(3,14)^2.(0,25)^5}{8(1440)(0,044)^2} = \frac{0,52}{22,302} = 0,0233$

- Grafik Moody $\frac{K_{20}}{D} = 0{,}001$

$K_{20} = 0{,}001 \times 0{,}21 = 0{,}00021$

- Kekasaran Pipa :

$K_{20} = K_0 + \alpha . 10$

$0{,}00021 = 0{,}00018 \alpha . 10$

$\alpha = \frac{0{,}00021 - 0{,}00018}{10}$

$\alpha = 0{,}000003$ m/tahun

Setelah 20 tahun

$K_{20} = K_0 + \alpha . 20$

$= 0{,}00018 + 0{,}00003 (20) = 0{,}00024$

- $\frac{K_{20}}{D} = \frac{0{,}00024}{0{,}25} = 0{,}00096$

- $Q_{20} = 0{,}0623$

- $V = \frac{Q}{A} = \frac{0{,}0623}{\frac{1}{4} . \pi (0{,}25)^2} = 1{,}27$ m/d

- $Re = \frac{V.D}{\nu} = \frac{1{,}27 . 0{,}25}{1{,}15 \times 10^{-6}}$

$= \frac{0{,}3175}{1{,}15 \times 10^{-6}} = 0{,}276 \times 10^{-6}$

$= 2{,}76 \times 10^{-5}$

- $\frac{K_{20}}{D} = \frac{0{,}00024}{0{,}25} = 0{,}00096$

Grafik moody : $0{,}02 = F$

- Kehilangan Tenaga : $HF = \frac{8FL}{g \pi^2 D^5} Q^2$

$= \frac{8 (0{,}02) . (1940)}{9{,}81 . (3{,}14)^2 (0{,}25)^5} (0{,}0623)^2$

$= \frac{0{,}894}{0{,}0944} = 9{,}470$ m

- Tinggi tekanan total $H = Hs + Hf$

$= 25 + 9{,}470$

$= 34{,}47$ m

Jadi Daya Pompa 20 tahun.

$P = \frac{Q . H . \gamma}{75 \eta}$

$= \frac{0{,}0623 (34{,}47) (1000)}{75 (0{,}94)}$

$= \frac{2147{,}48}{70{,}5} = 30{,}46$ HP

(2) Saluran pipa terbuat dr beton dengan diameter 1,52 m mengalirkan air dengan kekentalan kinematik $1{,}12 \times 10^{-6}$ m²/d dengan debit 2 m³/detik dan kehilangan tenaga 5m tiap 1000 m panjang. Hitung kekasaran permukaan rerata pipa tersebut.

Jawab :

diket $D = 1{,}52$ $\quad HF = 5$m

$\vartheta = 1{,}12 \times 10^{-6}$ m²/d $\quad L = 1000$ m

$Q = 2$ m³/d

K ?

$V = \frac{Q}{A} = \frac{2}{\frac{1}{4} . 3{,}14 . 1{,}52^2} = \frac{2}{1{,}81} = 1{,}105$ m/d

$Re = \frac{V.D}{\nu} = \frac{1{,}105 . 1{,}52}{1{,}12 \times 10^{-6}} = 1{,}49 \times 10^{-6}$

$Hf = f \frac{L}{D} \frac{V^2}{2g}$

$f = \frac{Hf . D . 2g}{L . V^2} = \frac{5 . (1{,}52) . 2 . (9{,}81)}{1000 . (1{,}105)^2} = \frac{149{,}112}{1221{,}025}$

$= 0{,}1221$

Koef. Gesek Aliran Turbulen

$\frac{1}{\sqrt{f}} = \frac{2 \log \frac{3{,}71 D}{K}}{\sqrt{0{,}1221}} = \frac{2 \log \frac{3{,}71 (1{,}52)}{K}}{\frac{1}{0{,}35 . 2}} = \frac{\log \frac{5{,}64}{K}}{K}$

$K = 0{,}7 \times 0{,}751$

$= 0{,}5257$ m

(3) Saluran pipa terbuat dari beton dengan diameter 1,0 m mengalirkan air dengan kekentalan kinematik $1,12 \times 10^{-6}$ m²/d dengan debit 3,4 m³/detik dan kehilangan tenaga 4,44 m dalam 1050 m panjang. hitung kekasaran permukaan rerata pipa tersebut.

Jawab

diket

$d = 1,0$ m
$v = 1,12 \times 10^{-6}$ m²/d
$Q = 3,4$ m³
$hF = 4,44$ m / 1050 m
$L = 1040$ m
K?

Jawab

$V = \frac{Q}{A} = \frac{3,4}{\frac{1}{4}\pi . 1^2}$

$= \frac{3,4}{0,785} = 4,33$ m/detik

$Re = \frac{V.D}{v} = \frac{4,33 \times 1,0}{1,12 \times 10^{-6}} = 3,866 \times 10^{-6}$

$HF = f \frac{L}{D} \frac{V^2}{2g}$

$F = \frac{hF . D . 2g}{L . V^2}$

$= \frac{4,44 . 1 . (2 . 9,81)}{1050 . (4,33)^2} = \frac{87,113}{19686,345}$

$= 0,004425$

Kekasaran Permukaan

$\frac{1}{\sqrt{F}} = \frac{2 \log 3,71 D}{K}$

$\frac{1}{\sqrt{0,004425}} = \frac{2 \log 3,71.1}{K}$

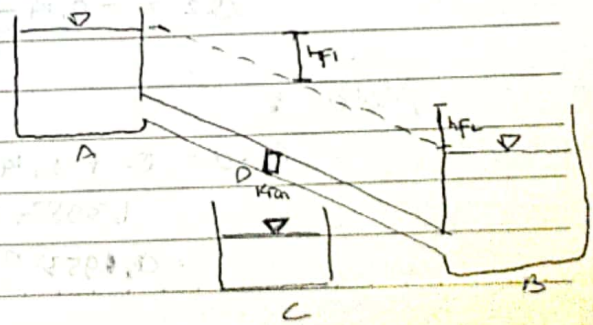
$\frac{1}{0,1330} = \frac{0,569}{K} \rightarrow K = 0,075677$

$K = 0,757$

(4) Suatu pipa sepanjang 7,4 Km dan diameter 75,5 cm menghubungkan 2 buah kolam A dan B dengan elevasi muka air kolam B lebih 34,5 m dibawah kolam A. ditengah pipa AB tersebut terdapat kran yg dapat mengalirkan air untuk mengisi kolam C. Koefisien gesekan pipa $f = 0,0064$. Kehilangan tenaga sekunder diabaikan, percepatan gravitasi $g = 9,81$ m/d². Ditanyakan debit aliran menuju kolam B apabila
(a) Kran menuju kolam C ditutup
(b) kran dibuka dengan debit 140 l/detik

Diket

$L = 7,4$ Km $= 7400$ m
$D = 75,5$ cm $= 0,755$ m
$HF = 34,5$ m
$F = 0,0064$
$g = 9,81$ m/d²



ⓐ $h_f = \frac{8 f L}{\pi^2 g D^5} Q^2 \rightarrow 34,5 = \frac{8 \cdot 0,0069 \cdot 7400}{3,14^2 \cdot 9,81 \cdot (0,755)^5} Q^2$

$34,5 = \frac{378,88}{23,73} Q^2$

$34,5 = 15,96\ Q^2$

$2,16 = Q^2$

$\sqrt{2,16} = Q$

$1,47\ m^3/d = Q$

ⓑ $Q = 140$ l/detik $= 0,14\ m^3$/detik

$Q_{AD} = Q + 0,14$

$Q_{DB} = Q$

Kehilangan Tenaga

$h_{f1} + h_{f2} = 34,5 \rightarrow \frac{8 f L_1}{\pi^2 g D_1^5} (Q+0,14)^2 + \frac{8 f L_2}{\pi^2 g D_2^5} Q^2 = 34,5$

$\frac{8 f L}{\pi^2 g D^5} \cdot \left((Q+0,14)^2 + Q^2 \right) = 34,5$

$\frac{8 \cdot 0,0069 \cdot 3700}{\pi^2 \cdot 9,81 \cdot (0,755)^5} \times (2Q^2 + 0,28Q + 0,0196) = 34,5$

$\frac{189,44}{23,73} \times (2Q^2 + 0,28Q + 0,0196) = 34,5$

$7,983 \times (2Q^2 + 0,28Q + 0,0196) = 34,5$

$2Q^2 + 0,28Q + 0,0196 = 4,32$

$2Q^2 + 0,28Q - 4,3004 = 0$:2

$Q^2 + 0,14Q - 2,1502 = 0$

$Q_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{-0,14 \pm \sqrt{0,14^2 - 4 \cdot 1 \cdot (-2,1502)}}{2 \cdot 1} \rightarrow \frac{-0,14 \pm \sqrt{8,5812}}{2}$

$= \frac{-0,14 \pm 2,93}{2}$

$Q_1 = \frac{-0,14 + 2,93}{2} = 1,395$ → MEMENUHI

$Q_2 = \frac{-0,14 - 2,93}{2} = -1,535$

Maka :

$Q_{AD} = Q + 0,14$

$= 1,395 + 0,14$

$= 1,535\ m^3/d$

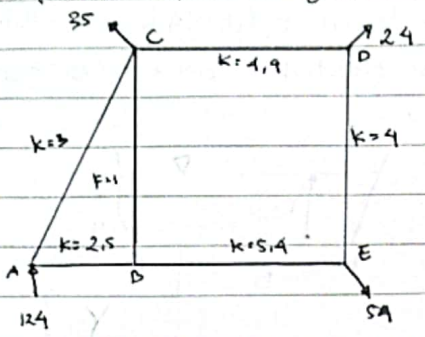
$Q_{DB} = Q$

$= 1,395\ m^3/d$

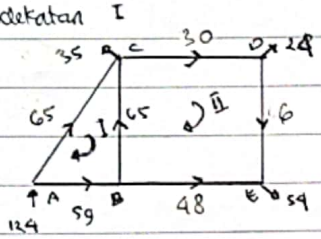
Jadi $Q_{total} = 1,535 + 1,395$

$= 2,93\ m^3/d$

(5) Jaringan pipa seperti terlampir. Hitung debit ditiap pipa menggunakan cara Cross



▷ Pendekatan I



Jaring I	KQ^2	$\|2KQ\|$
AC	12615	390
CB	- 4225	130
BA	- 7310,1	247,8 +
	1139,9	767,8

Koreksi :

$\Delta Q_1 = \frac{1139,9}{767,8} = 1,48$ (Belum mendekati 0)

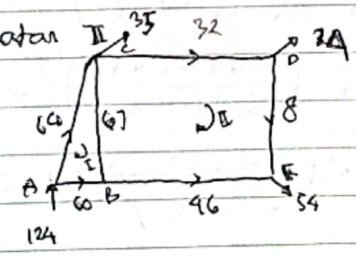
Jaring II	KQ^2	$\|2KQ\|$
BC	4225	130
CD	3960	264
DE	144	48
EB	-12441,6	518,4 +
	-4112,6	960,4

Koreksi

$\Delta Q_2 = -\frac{4112,6}{960,4}$

$= -4,28$ (Belum Mendekati 0)

▷ Pendekatan II



Jaring I	KQ^2	$\|2QK\|$
AC	12288	384
CB	-4489	134
BA	-7560 +	252 +
	239	770

Koreksi

$\Delta Q = \frac{239}{770} = 0,31$ (Mendekati 0)

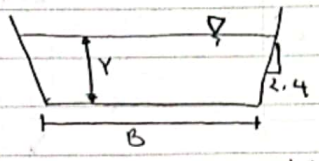
Jaring II	KQ^2	$\|2KQ\|$
BC	4489	134
CD	4505,6	281,6 +
DE	256	64
EB	-11,426,4 +	496,8 +
	-2175,8	3510,8

Koreksi

$\Delta Q = \frac{-2175,8}{3510,8} = -0,619$

(Mendekati 0)

⑥ Tentukan kedalaman aliran pada saluran trapesium dengan koefisien manning $n = 0{,}014$, kemiringan lereng 0,024, dan debit yg terjadi adalah 14,45 cfs. Bila lebar bawah saluran adalah 3,4 feet. Gunakan Iterasi Newton dalam estimasi kedalaman aliran dengan debit yg terjadi. 1:2 · 1 = 2,4



Y ?

Diket : $n = 0{,}014$
$S_0 = 0{,}024$
$Q = 14{,}45$ cfs
$B = 3{,}4$ feet
$z = 2{,}4$

Jawab

1) luas Tampang basah

$$A = \left(B + (B + 2zY)\right)\frac{Y}{2}$$
$$= \left(3{,}4 + (3{,}4 + 2 \cdot 2{,}4 \cdot Y)\right)\frac{Y}{2}$$
$$= (6{,}8 + 4{,}8Y)\frac{Y}{2}$$
$$= 3{,}4Y + 2{,}4Y^2$$

2) Keliling basah

$$P = B + 2(Y\sqrt{1+z^2})$$
$$= 3{,}4 + 2(Y\sqrt{1+(2{,}4)^2})$$
$$= 3{,}4 + 2(Y\sqrt{6{,}76})$$
$$= 3{,}4 + 2(2{,}6Y)$$
$$= 3{,}4 + 5{,}2Y$$

3) Jari - jari

$$R = \frac{A}{P} = \frac{3{,}4Y + 2{,}4Y^2}{3{,}4 + 5{,}2Y}$$

4) Debit Aliran

$$Q = A \cdot V = A\,\frac{1}{n}R^{2/3}S_0^{1/2}$$
$$14{,}45 = (3{,}4Y + 2{,}4Y^2)\cdot\frac{1}{0{,}014}\cdot\left(\frac{3{,}4Y + 2{,}4Y^2}{3{,}4 + 5{,}2Y}\right)^{2/3}\cdot 0{,}024^{1/2}$$
$$14{,}45 = (3{,}4Y + 2{,}4Y^2)\cdot\frac{1}{0{,}014}\left(\frac{3{,}4Y + 2{,}4Y^2}{3{,}4 + 5{,}2Y}\right)^{2/3}\cdot 0{,}1549$$
$$0{,}2023 = (3{,}4Y + 2{,}4Y^2)\cdot\left(\frac{3{,}4Y + 2{,}4Y^2}{3{,}4 + 5{,}2Y}\right)^{2/3}\cdot 0{,}1549$$

Q Mendekati 14,45, dengan Iterasi di excel

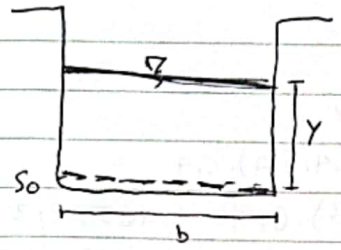
Y	Q
0,6	7,6004
0,7	10,6139
0,8	14,2849 ✓
0,9	18,6629
1	23,79511
1,1	29,7272
1,15	33,0071
1,16	33,6883

Jadi Kedalaman
$Y = 0{,}8$

(7) Saluran segi empat lebarnya 4,5 m dan kedalaman 3,4 m merupakan kemiringan dasar saluran 0,0014, Hitung debit aliran menggunakan rumus bazin bila koefisien $\gamma_B = 0,447$. Sketsa

Diket : $B = 4,5m$ $S_o = 0,0014$ d ?

$y = 3,4m$ $\gamma_B = 0,447$



$$C = \frac{87}{1 + \frac{\gamma_B}{\sqrt{R}}}$$

$$= \frac{87}{1 + \frac{0,447}{1,363}}$$

$$C = 60,124$$

$$R = CA\sqrt{R.S_o}$$

$$= 60,124.15,3\sqrt{1,363.0,0014}$$

$$= 919,89\sqrt{0,0019}$$

$$= 40,097$$

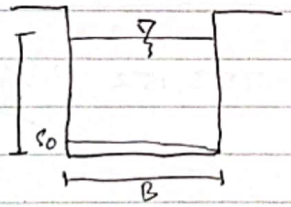
$$R = \frac{A}{P} = \frac{B.y}{B+2y}$$

$$= \frac{4,5.3,4}{4,5+2.3,4} = \frac{15,3}{11,3} = 1,363\ m$$

(8) Saluran terbuka segi empat memiliki lebar 12,4 m dan kedalaman 3,4 m. Kemiringan dasar saluran 0,00155. Koefisien Kutter 0,024. Hitung debit aliran. Sketsa.

Diket : $B = 12,4\ m$ $S_o = 0,00155$ d ?

$y = 3,4\ m$ $n = 0,024$



$$R = \frac{A}{P} = \frac{B.y}{B+2y}$$

$$= \frac{12,4.3,4}{12,4+2.3,4} = \frac{42,16}{19,2}$$

$$= 2,1958\ m$$

$$= 2,2\ m$$

$$C = \frac{23 + \frac{0,00155}{S_o} + \frac{1}{n}}{1 + 23 + \frac{0,00155}{S_o} + \frac{n}{\sqrt{R}}}$$

$$= \frac{23 + \frac{0,00155}{0,00155} + \frac{1}{0,024}}{1 + 23 + \frac{0,00155}{0,00155} + \frac{0,024}{\sqrt{2,2}}}$$

$$= \frac{23 + 1 + 41,67}{1 + 23 + 1 + 0,016} = \frac{65,67}{25,016}$$

$$= 2,625$$

$$R = C.A\sqrt{R.S_o}$$

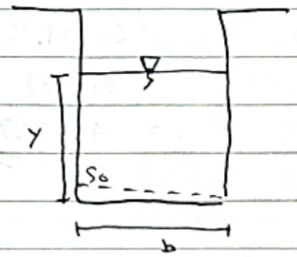
$$= 2,625.42,16\sqrt{2,2.0,00155}$$

$$= 6,4626\ m^3/detik$$

(9) Saluran tubuka berbentuk trapesium terbuat dari tanah (coi n tanah) dengan lebar 10,47 m dan kemiringan tebing 1 : m (Vertikal : Horizontal) dengan * m = 2,4. Kemiringan dasar saluran 0.000146, kedalaman sungai 6,4 m. Hitung debit. sketsa.

» Diket B = 10,47 S_0 = 0,000146 n = 0,03

m = 2,4 y = 6,4 m Q = ?



$A = (B + my)y$

$= (10,47 + 2,4 \cdot 6,4) \cdot 6,4$

$= (25,83) \cdot 6,4 = 165,312$

$= 165,31 \ m^2$

$P = (B + (2y\sqrt{m^2+1}))$

$= (10,47 + (2 \cdot 6,4\sqrt{(2,4)^2+1}))$

$= (10,47 + 12,8\sqrt{6,76})$

$= 10,47 + 33,28$

$= 43,75 \ m$

$R = \frac{A}{P} = \frac{165,31}{43,75} = 37,78$

$AR^{2/3} = \frac{n \cdot Q}{S_0^{1/2}}$

$165,31 (37,78)^{2/3} = \frac{0,03 \cdot Q}{(0,000146)^{1/2}}$

$Q = \frac{165,31 \cdot (37,78)^{2/3} \cdot (0,000146)^{1/2}}{0,03}$

$= \frac{165,31 \cdot 11,39 \cdot 0,012}{0,03}$

$= 753,152 \ m^3/d.$