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NIM = 20/464366/SV/18685

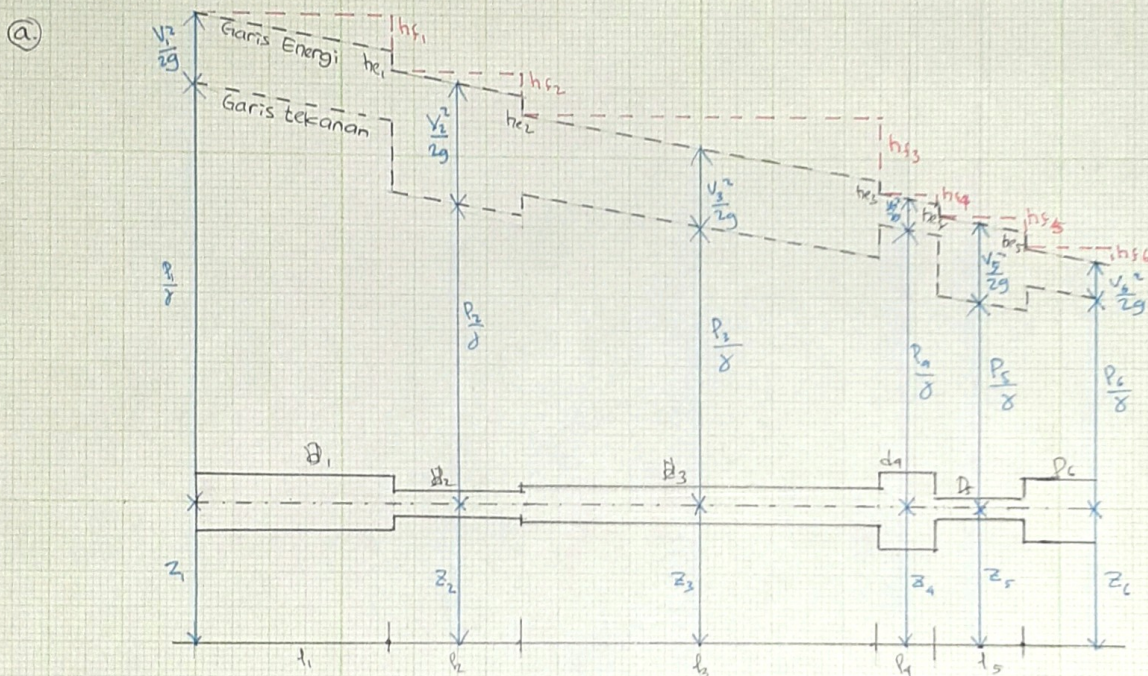
Prodi = D4 TRPBS

Matakul = Hidrolika

x	y	z
6	6	5 (ganjil)

1 Hukum Bernoulli

Diketahui = $D_1 = 16 \text{ cm}$; $l_1 = 550 \text{ m}$
 $D_2 = 7.6 \text{ cm}$; $l_2 = 350 \text{ m}$
 $D_3 = 10 \text{ cm}$; $l_3 = 1000 \text{ m}$
 $D_4 = 20 \text{ cm}$; $l_4 = 160 \text{ m}$
 $D_5 = 20/3 \text{ cm}$; $l_5 = 200 \text{ m}$ ($6.66 = D_5$)
 $D_6 = 15.66 \text{ cm}$



⊕ Persamaan Bernoulli yang terjadi

$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_6 + \frac{P_6}{\gamma} + \frac{V_6^2}{2g} + \Sigma h_e + \Sigma h_f$$

Ⓛ Persamaan tinggi tekanan total

$$Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_6 + \frac{P_6}{\gamma} + \frac{V_6^2}{2g} + \Sigma h_e + \Sigma h_f$$

$$\frac{P_1}{\gamma} - \frac{P_6}{\gamma} = \frac{V_6^2}{2g} - \frac{V_1^2}{2g} + \Sigma h_e + \Sigma h_f$$

ⓐ Persamaan tinggi tekanan antara pipa ke 2 dan ke 3

$$Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + (h_{f1} + \frac{h_{f2}}{2}) + h_{e1} = Z_3 + \frac{P_3}{\gamma} + \frac{V_3^2}{2g} + (h_{f1} + h_{f2} + \frac{h_{f3}}{2}) + (h_{e1} + h_{e2})$$

$$\frac{P_2}{\gamma} - \frac{P_3}{\gamma} = \frac{V_3^2}{2g} - \frac{V_2^2}{2g} + (h_{f2} + h_{f3} + \frac{h_{f3}}{2}) - (h_{f1} + \frac{h_{f2}}{2}) + (h_{e1} + h_{e2}) - h_{e1}$$

$$\frac{P_2}{\gamma} - \frac{P_3}{\gamma} = \frac{V_3^2}{2g} - \frac{V_2^2}{2g} + \frac{h_{f3}}{2} + \frac{h_{f3}}{2} + h_{e2}$$

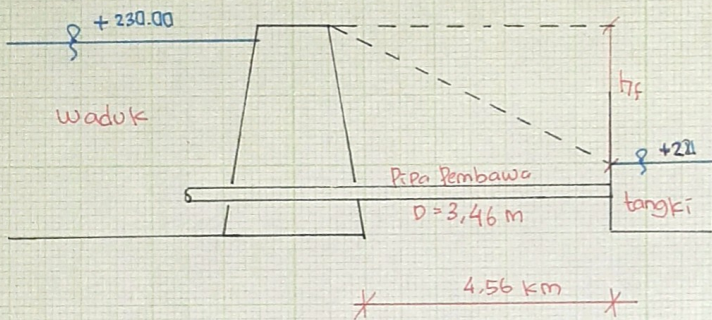
d. Persamaan tinggi kecepatan pada titik antara pipa 3 & 4, jika diameter pipanya sama

$$Z_3 + \frac{P_3}{\rho} + \frac{V_3^2}{2g} + (h_{f1} + h_{f2} + \frac{h_{f3}}{2}) + (h_{e1} + h_{e2}) = Z_4 + \frac{P_4}{\rho} + \frac{V_4^2}{2g} + (h_{f1} + h_{f2} + h_{f3} + \frac{h_{f4}}{2}) + (h_{e1} + h_{e2} + h_{e3})$$

$$\frac{V_3^2}{2g} - \frac{V_4^2}{2g} = \frac{P_4}{\rho} - \frac{P_3}{\rho} + (h_{f3} + h_{f4}) - (h_{f1} + h_{f2} + \frac{h_{f3}}{2}) + (h_{e1} + h_{e2} + h_{e3}) - (h_{e1} + h_{e2})$$

$$\frac{V_3^2}{2g} - \frac{V_4^2}{2g} = \frac{P_4}{\rho} - \frac{P_3}{\rho} + \left(\frac{h_{f3}}{2} - \frac{h_{f4}}{2} \right) + h_{e3}$$

② Aliran mantap melalui sistem pipa



Diketahui = • Muka air waduk = +230 m
• Muka air tangki = +221 m

- $D = 3,46 \text{ m}$
- $L = 4,56 \text{ km} = 4560 \text{ m}$
- $f = 0,0465$
- $h_f = 230 - 221 = 9 \text{ m}$

Ditanya = $Q = ?$
 $V = ?$

Jawab =
a. Dedit

$$H_f = \frac{8f \cdot L \cdot Q^2}{g \cdot \pi^2 \cdot D^5} \Rightarrow 9 = \frac{8 \cdot (0,0465) \cdot 4560 \cdot Q^2}{9,81 \cdot (3,46^2) \cdot (3,46)^5} \Rightarrow 9 = \frac{1696,320 \cdot Q^2}{47963,271}$$

$$Q^2 = 254,474$$

$$Q = 15,95 \text{ m}^3/\text{s}$$

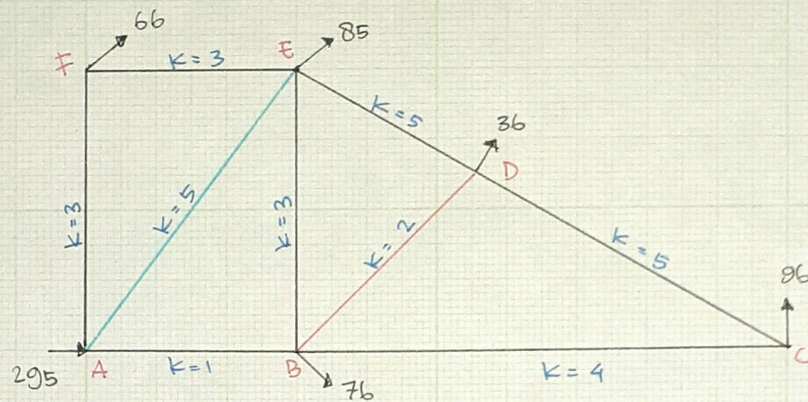
b. Estimasi kecepatan

$$H_f = f \cdot \frac{L}{D} \cdot \frac{V^2}{2g} \Rightarrow 9 = (0,0465) \cdot \frac{4560}{3,46} \cdot \frac{V^2}{2 \cdot 9,81} \Rightarrow 610,967 = 212,040 \cdot V^2$$

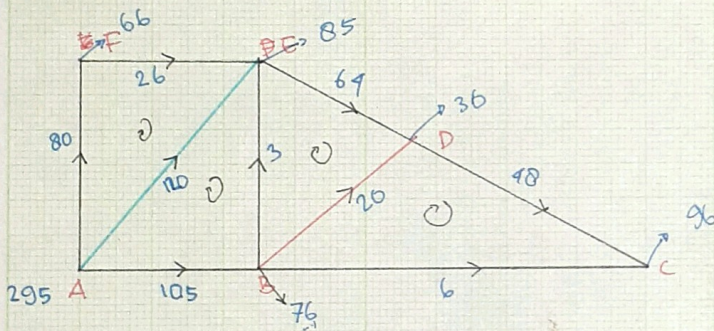
$$V^2 = 2,881$$

$$V = 1,697 \text{ m/s}$$

3. Aliran mantap melalui pipa



Trial 1



• Jaringan AEF

Pipa	KQ^2	$12Q1$
AE	-7200	1200
EF	2028	156
FA	19200	480
	-50772	1836

$$\Delta Q_1 = \frac{-50772}{1836} = -27.654$$

• Jaringan

	ABE	$12Q1$
	KQ^2	
AB	-11025	210
BE	27	18
EA	72000	1200
	61002	1428

$$\Delta Q_2 = \frac{6102}{1428} = 42.718$$

• Jaringan BDE

Pipa	KQ^2	$12KQ1$
BD	800	80
DE	20480	640
EB	-27	-18
	21253	738

$$\Delta Q_3 = \frac{21253}{738} = 28.798$$

• Jaringan BCD

Pipa	KQ^2	$12KQ1$
BC	-144	48
CD	11520	480
DB	800	80
	12176	608

$$\Delta Q_4 = \frac{12176}{608} = 20.026$$

Karena ΔQ belum mendekati nol maka dilakukan trial selanjutnya

Trial 2

Kalibrasi debit

$$Q_{AE} = 120 + (-27,654) - 42,718 = 49,628$$

$$Q_{EF} = 26 - (-27,654) = 53,654$$

$$Q_{FA} = 80 - (-27,654) = 107,654$$

$$Q_{AB} = 105 + (42,718) = 147,718$$

$$Q_{BE} = 3 + (42,718) - 28,798 = -9,681$$

⊙

$$Q_{BD} = 20 + 28,798 - 20,026 = 28,772$$

$$Q_{DE} = 64 - 28,798 = 35,202$$

$$Q_{BC} = 6 + 20,026 = 26,026$$

$$Q_{CD} = 48 - 20,026 = 27,974$$

• Jaringan AEF

Pipa	KQ^2	$12QL$
AE	-12 314,651	496,279
EF	8 636,125	321,922
FA	34 767,889	645,922
	31,089,363	1464,122

$$\Delta Q_1 = \frac{31\,089,363}{1\,464,122} = 21,234$$

• Jaringan ABE

Pipa	KQ^2	$12QL$
AB	-21 020,752	299,437
BE	858,898	101,522
EA	12 314,651	406,279
	-8,647,202	893,238

$$\Delta Q_2 = \frac{-8\,647,202}{893,238} = -9,681$$

• Jaringan BDE

Pipa	KQ^2	$2QL$
BD	1 655,631	115,087
DE	6 195,868	352,019
EB	-858,898	101,522
	6,992,601	568,628

$$\Delta Q_3 = \frac{6\,992,601}{568,628} = 12,297$$

• Jaringan BCD

Pipa	KQ^2	$12QL$
BC	-2 709,476	208,211
CD	3 912,635	275,737
DB	1 655,631	115,087
	2 858,790	603,035

$$\Delta Q_4 = \frac{2\,858,790}{603,035} = 4,741$$

Karena ΔQ belum mendekati nol, maka dilakukan trial ke-3

Kalibrasi debit (Trial 3)

$$Q_{AE} = 80,543$$

$$Q_{EF} = 32,419$$

$$Q_{FA} = 86,419$$

$$Q_{AB} = 138,038$$

$$Q_{BE} = -5,058$$

$$Q_{BD} = 36,382$$

$$Q_{DE} = 22,905$$

$$Q_{BC} = 39,767$$

$$Q_{CD} = 23,233$$

Trial 3

• Pipa AEF

Pipa	KQ^2	$ 2QK $
AE	-32 435,697	809,428
EF	3 153,065	194,517
FA	22 404,872	518,517
	-6 877,660	1 518,461

$$\Delta Q_1 = \frac{-6 877,660}{1 518,461} = -4,529$$

• Jaringan BDE

Pipa	KQ^2	$ 2QK $
BD	2 639,509	145,314
DE	2 623,100	229,046
EB	-76,740	30,946
	5 185,869	404,706

$$\Delta Q_3 = \frac{5 185,869}{404,706} = 12,814$$

• Jaringan ABE

Pipa	KQ^2	$ 2QK $
AB	-19 054 422	276,076
BE	76,740	30,346
EA	32,435,697	809,428
	13,458,014	1 111,849

$$\Delta Q_2 = \frac{13 458,014}{1 111,849} = 12,104$$

• Jaringan BCD

Pipa	KQ^2	$ 2QK $
BC	-3,786,431	246,136
CD	2 698,864	232,330
DB	2 639,509	145,314
	1 551,942	623,780

$$\Delta Q_4 = \frac{1 551,942}{623,780} = 2,488$$

Karena ΔQ belum mendekati nol, maka dilakukan trial ke-4

TRIAL 4

• kalibrasi debit

- $Q_{AE} = 80,543$
- $Q_{EF} = 32,419$
- $Q_{FA} = 86,419$
- $Q_{AB} = 138,038$
- $Q_{BE} = -85,058$
- $Q_{BD} = 36,328$
- $Q_{DE} = 22,905$
- $Q_{AC} = 30,767$
- $Q_{CD} = 23,233$

• Jaringan AEF

Pipa	KQ^2	$ 2QK $
AE	-20 421,959	639,092
EF	9 095,647	221,693
FA	24,815,067	569,693
	8 480,755	1 406,478

$$\Delta Q_1 = \frac{8 480,755}{1 406,478} = 6,035$$

• Jaringan BDE

Pipa	KQ^2	$ 2QK $
BD	4 353,265	186,618
DE	509,106	100,907
EB	-89,789	34,605
	4 762,582	322,129

$$\Delta Q_3 = \frac{4 762,582}{322,129} = 14,785$$

• Jaringan ABE

Pipa	KQ^2	$ 2QK $
AB	-22 542,598	300,384
BE	99,789	34,605
EA	20 421,959	639,092
	-2 020,850	973,981

$$\Delta Q_2 = \frac{-2 020,850}{973,981} = -2,075$$

• Jaringan BCD

Pipa	KQ^2	$ 2QK $
BC	-4 423,568	266,040
CD	2 151,785	207,450
DB	4 353,265	186,618
	2 081,481	660,108

$$\Delta Q_4 = \frac{2 081,481}{660,108} = 3,153$$

Dari 4 kali trial / iterasi yang dilakukan, di dapatkan trial ke 4 yang paling kecil