higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

FLUÏEDMEGANIKA N5

5 Augustus 2021

Hierdie nasienriglyn bestaan uit 11 bladsye.

Kopiereg voorbehou

VRAAG 1

1.1 Die doel van laersmering is om direkte metaalkontak (metaal op metaal) tussen verskillende roterende en skuiwende komponente in 'n meganiese meganisme te voorkom. (2)

1.2
- Elimineer vinnige materiaaluitsetting weens 'n styging in temperatuur
- Verhoog die verwagte lewensduur van die materiaal
- Reduksie van wrywing en slytasie
- Hittedissipasie
- Voorkom metaalverval weens korrosie
- Beskerm teen skadelike elemente
- Kragverlies weens wrywing (Enige 2 × 1) (2)

1.3 Die geneigdheid om weerstand te bied teen skuiwende lae vloeistof wat in Pa.s gemeet word. ✓
Die kinetiese viskositeit is die verhouding van die absolute viskositeit tot die massadigtheid✓ wat in m^2/s gemeet word.✓ (3)

1.4 1.4.1

$$from, F = \frac{\mu A v}{t}$$

$$t = \frac{D-d}{2}$$

$$= \frac{0,1503-150}{2} \quad \surd$$

$$= 150\times10^{-6} m \quad \surd$$

$$A = \pi DL$$

$$= \pi \times 0,15 \times 0,17 \quad \surd$$

$$= 80,111\times10^{-3} m^2 \quad \surd$$

$$v = \pi DN$$

$$= \pi \times 0,15 \times 20 \quad ✓$$

$$= 9,425 m/s \quad ✓$$

$$F = \frac{\mu A v}{t}$$

$$= \frac{0,02\times80,111\times10^{-3}\times9,425}{150\times10^{-6}} \quad ✓$$

$$= 100,673N \quad ✓$$

$$P = Fv$$

$$= 100,673\times9,425 \quad ✓$$

$$= 0,949kW \quad ✓$$

(8)

1.4.2
$$\upsilon = \frac{\mu}{\rho}$$
$$= \frac{0,02}{830} \quad \checkmark$$
$$= 24,096 \times 10^{-6} m^2 / s \quad \checkmark$$ (2)

1.4.3
$$from, P = Fv$$
$$t = 150,3 - 150 \quad \checkmark$$
$$= 300 \times 10^{-6} m \quad \checkmark$$

$$P = \frac{0,02 \times 80,111 \times 10^{-3} \times 5}{300 \times 10^{-6}}$$
$$= 0,0267 kW \quad \checkmark$$ (3)
[20]

VRAAG 2

2.1 2.1.1
$$P_c = P_p ... Pascal's\ law$$
$$\frac{F_c}{A_c} = \frac{F_p}{A_p} \quad \surd$$
$$F_p = \frac{d_c^2}{d_c^2} F_c \quad \surd$$
$$= \frac{0,68^2}{0,0425^2} \times (2550) \quad \checkmark$$
$$= 652,8 kN \quad \checkmark$$ (3)

2.1.2
$$SV_c = SV_p$$
$$A_c \times SL_c = nA_p \times SL_p \quad \surd$$
$$n = \frac{d_c^2}{d_p^2} \times \frac{SL_c}{SL_p} \quad \surd$$
$$= \frac{0,68^2}{0,0425^2} \times \frac{3,4}{0,425} \quad \checkmark$$
$$= 2048\ strokes \quad \checkmark$$ (3)

2.1.3
$$WD = F_P \times sl$$
$$= 652,8 \times 3,4 \quad \checkmark$$
$$= 2219,52 J \quad \checkmark$$ (2)

2.1.4
$$P = \frac{WD}{time}$$
$$= \frac{2219,5}{51} \checkmark$$
$$= 43,52W \checkmark$$ (2)

2.2 2.2.1
$$SV = A \times SL$$
$$= \frac{\pi}{4} \times 0,06^2 \times 0,17 \checkmark$$
$$= 480,664 \times 10^{-3} m^3 \checkmark$$ (2)

2.2.2
$$P = \frac{F}{A}$$
$$= \frac{4 \times 3,4 \times 10^3}{\pi \times 0,06^2} \checkmark$$
$$= 1,203MPa \checkmark$$ (2)

2.2.3
$$K_{air} = P\gamma$$
$$= 1,203 \times 1,4 \surd$$
$$= 1,684MPa \surd$$ (1)

2.2.4
$$from, \frac{1}{K_e} = \frac{1}{K_l} + \frac{1}{K_c} + \frac{V_{air}}{V_{total} K_{air}} \surd$$
$$= \frac{1}{2,035 \times 10^9} \surd + \frac{2,5}{8,8 \times 10^9} \surd + \frac{3,44 \times V_{total}}{100V_{total} \times 1,684 \times 10^6}$$
$$= 491,40049 \times 10^{-12} + 284,09091 \times 10^{-12} + 20,427553 \times 10^{-9} \surd$$
$$\frac{1}{K_e} = 21,203044 \times 10^{-9} \surd$$
$$K_e = 47,143MPa \surd$$ (3)

2.2.5
$$from, P = K_e \times \frac{\Delta V}{V_{total}}$$
$$P = K_e \times \frac{A \times \Delta L}{A \times SL} \surd$$
$$\Rightarrow \Delta L = \frac{1,203 \times 10^6}{47,143 \times 10^6} \times 0,17 \surd$$
$$= 4,336mm \checkmark$$ (2)
[20]

VRAAG 3

3.1 3.1.1

$$\bar{y} = \frac{d}{2}$$
$$= \frac{1,45}{2} \quad \surd$$
$$= 0,725m \quad \surd$$
$$P = \rho g \bar{y}$$
$$= 0,963 \times 1000 \times 9,81 \times 0,725 \quad \checkmark$$
$$= 6,849kPa \quad \checkmark \qquad (3)$$

3.1.2

$$F = PA$$
$$= 6,849 \times \frac{\pi}{4} \times 1,45^2 \quad \checkmark$$
$$= 11,31kN \quad \checkmark \qquad (2)$$

3.1.3

$$I_G = \frac{\pi D^4}{64}$$
$$= \frac{\pi \times 1,45^4}{64} \quad \checkmark$$
$$= 216,991 \times 10^{-3} m^4 \quad \checkmark \qquad (2)$$

3.1.4

$$\bar{h} = \bar{y} + \frac{I_G \sin^2 \theta}{A\bar{y}}$$
$$\surd \quad \checkmark$$
$$= 0,75 + \frac{216,991 \times 10^{-3}}{\frac{\pi \times 1,45^2}{4} \times 0,75}$$
$$= 0,75 + 0,175208 \quad \surd$$
$$= 925mm \quad \checkmark \qquad (3)$$

3.2 3.2.1

$$F_b = W_m$$
$$\rho g V_{displaced} = W_m \quad \surd$$
$$as, V_{displaced} = 0,925 \times \frac{\pi}{6} \times 0,05^3 \quad \surd$$
$$= 60,54111 \times 10^{-6} m^3 \quad \checkmark$$
$$thus, W_m = 1260 \times 9,81 \times 60,54111 \times 10^{-6} \quad \checkmark$$
$$= 784,324 \times 10^{-3} N \quad \checkmark \qquad (4)$$

3.2.2 $W_m = \rho g V_m$

$748,324\times10^{-3} = \rho \times 9,81 \times \frac{\pi \times 0,05^3}{6}$ ✓

$\rho = 1165,499 kg/m^3$ ✓ (2)

3.2.3 $F_b = W_m + W_{added}$

$\rho g V_{\substack{fully \\ displaced}} = W_m + W_{added}$ √

$1260 \times 9,81 \times \frac{\pi}{6} \times 0,05^3 = 784,324\times10^{-3} + 9,81 m_{added}$ (√ √ √)

$808,999378\times10^{-3} - 748,324\times10^{-3} = 9,81 m_{added}$ √

$m_{added} = \frac{60,675378\times10^{-3}}{9,81}$

$m_{added} = 6,185\times10^{-3} kg$ ✓ (4)

[20]

VRAAG 4

4.1 4.1.1 Die is die pad of roete wat deur bewegende vloeistofdeeltjies gevolg word wat mekaar nooit sny nie,✓ waar die lyn die oombliklike tangens tot die snelheidsvektor op daardie bepaalde punt in die stroomlyn is.✓

4.1.2 Dit is die verbeelde grens✓ of gebied van die bewegende vloeistof wat deur stroomlyne, wat getrek word om 'n buisvormige vloeistreek, wat 'n vloeibuis genoem word, te vorm, beperk of ingeperk word, waarvan die vloeiende vloeistof nooit hierdie lyne sny nie.✓

4.1.3 Dit is die pad of die roete wat 'n vloeistofdeeltjie in 'n vloeistof sal volg waar die pad van elke deeltjie met verloop van tyd deur die stroomlynroete bepaal sal word.✓

4.1.4 Dit is die tipe vloei wat gepaardgaan met willekeurige✓ werwelstrome wat veroorsaak dat die vloeistofdeeltjies op 'n ongeorganiseerde manier ten opsigte van die padlyn vloei.✓

4.1.5 Dit is die tipe vloei wat nie met willekeurige werwelstrome gepaardgaan nie✓ wat veroorsaak dat die vloeistofdeeltjie op 'n ordelike manier vloei sonder om met die langsliggende padlyn in te meng.✓

(5 × 2) (10)

4.2 4.2.1

$$Q = \frac{volume}{time}$$
$$= \frac{93,45\times10^{-3}}{21,96} \quad \surd$$
$$= 4,256\times10^{-3} m^3/s \quad \surd$$ (1)

4.2.2

$$Q = Av$$
$$4,256\times10^{-3} = \frac{\pi}{4}\times0,0549^2 v \quad \surd$$
$$v = \frac{4,256\times10^{-3}}{2,367198\times10^{-3}} \quad \surd$$
$$= 1,798 m/s \quad \checkmark$$ (2)

4.3 4.3.1

$$from, Q = Av$$
$$v_{\phi425} = \frac{4\times\frac{10540\times10^{-3}}{60}}{\pi\times0,425^2} \quad \checkmark$$
$$= 1,238 m/s \quad \checkmark$$ (2)

4.3.2

$$v_{\phi425} = \frac{4\times\frac{10540\times10^{-3}}{60}}{\pi\times0,2125^2} \quad \checkmark$$
$$= 4,953 m/s \quad \checkmark$$ (2)

4.3.3

$$\frac{P_1}{\rho g} + \frac{v_1}{2g} + Z_1 - \sum h_{losses} = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2$$
$$\frac{1351,5\times10^3}{9810} + \frac{1,238^2}{19,62} + 0 = \frac{P_2}{\rho g} + \frac{4,953^2}{19,62} + (-6,8) \quad \surd \quad \surd$$
$$\frac{P_2}{9810} = 137,76758 + 0,0781164 + 6,8 - 1,250367 \quad \checkmark$$
$$P_2 = 1,407 MPa \quad \checkmark$$ (3)

[20]

VRAAG 5

5.1 'n Opening is 'n gat aan die onderste sykant van die tenk wat gebruik word om vloeistof op 'n gegewe tyd vry te laat. (2)

5.2 5.2.1 *with the aid of Bernoulli's theorem*:

$$v_{orifice} = \sqrt{2gh}$$
$$= \sqrt{19,62 \times 59,4} \quad ✓$$
$$= 34,138 m/s \quad ✓$$ (2)

5.2.2 $from, Q = Av_{jet}$

$$v_{jet} = \frac{4 \times 4,774 \times 10^{-3}}{\pi \times 0,0134^2} \quad ✓$$
$$= 33,852 m/s \quad ✓$$ (2)

5.2.3

$$C_c = \frac{A_j}{A_t}$$
$$= \frac{d_j^2}{d_o^2} \quad √$$
$$= \left(\frac{0,0134}{0,0145}\right)^2 \quad √$$
$$= 0,854 \quad ✓$$ (2)

5.2.4

$$C_v = \frac{v_j}{v_o}$$
$$= \frac{33,852}{34,138} \quad ✓$$
$$= 0,992 \quad ✓$$ (2)

5.2.5

$$C_q = C_v \times C_c$$
$$= 0,992 \times 0,854 \quad ✓$$
$$= 0,847 \quad ✓$$

Alternatively:

$$C_q = \frac{Q_j}{Q_o}$$
$$= \frac{4,774}{\frac{34,138 \times \pi \times 0,0145^2}{4}} \quad ✓$$
$$= 0,847 \quad ✓$$ (2)

5.2.6 $h_{loss} = h\left(1 - C_v^2\right)$ ✓

$= 59,4\left(1 - 0,992^2\right)$ ✓

$= 0,947m$ ✓

Alternatively:

$h_{loss} = h - \frac{v_j^2}{2g}$ ✓

$= 59,4 - \frac{33,852^2}{19,62}$

$= 0,992m$ ✓ (3)

5.3 *with the aid of Bernoulli's equation*:

$\Delta h = \frac{P_1 - P_2}{\rho g}$

$= \frac{6,8 \times 10^3}{9,81 \times 880}$ ✓

$= 787,69345mm$ ✓

$from, Q = C_Q \times a \frac{\sqrt{2g\Delta h}}{\sqrt{1 - \frac{a^2}{A^2}}}$

$= 0,715 \times \frac{\pi}{4} \times 0,2135^2 \times \frac{\sqrt{19,62 \times 787,69345 \times 10^{-3}}}{\sqrt{1 - \frac{\left(\frac{\pi \times 0,2135^2}{4}\right)^2}{\left(\frac{\pi \times 0,34^2}{4}\right)^2}}}$ ✓

$= \frac{0,0255972 \times 3,931227}{0,8445195}$ ✓

$= 120,899l/s$ ✓ (5)

[20]

VRAAG 6

6.1
$$from, \overset{0}{W} = \overset{0}{m}\, g$$
$$as, Q_{system} = Q_{in} = Q_{out} ...continuity\ of\ flow$$
$$\overset{0}{W} = \rho Q g$$
$$= 820 \times \frac{\pi}{4} \times 0,22^2 \times 2,356 \times 9,81 \quad \checkmark$$
$$= 720,433 N/s \quad \checkmark$$
(2)

6.2
$$Q_{system} = Q_{in} = Q_{out} ...continuity\ of\ flow$$
$$A_{in} v_{in} = A_{out} v_{out}$$
$$v_{out} = \frac{d_{in}^2}{d_{out}^2} \times v_{in} \surd$$
$$= \frac{0,22^2}{0,125^2} \times 2,356 \surd$$
$$= 7,298 m/s \checkmark$$
(2)

6.3
$$from, \overset{0}{m}_{system} = \overset{0}{m}_{in} = \overset{0}{m}_{out} ...continuity\ of\ flow$$
$$as, \overset{0}{m} = \rho Q$$
$$= 820 \times \pi \times \frac{0,22^2}{4} \times 2,356 \checkmark$$
$$= 73,439 kg/s \checkmark$$
(2)

6.4
$$Applying\ Bernoulii's\ equation\ between\ the\ bend\ inlet\ and\ outlet:$$
$$E_1 - H_{loss} = E_2$$
$$\frac{P_{in}}{\rho g} + \frac{v_{in}^2}{2g} + Z_{in} - H_{loss} = \frac{P_{out}}{\rho g} + \frac{v_{out}^2}{2g} + Z_{out} \surd$$
$$\Rightarrow \frac{P_{out}}{\rho g} = \frac{P_{in}}{\rho g} + \frac{v_{in}^2}{2g} + Z_{in} - \frac{v_{out}^2}{2g} - Z_{out} - H_{loss} \surd$$
$$\frac{P_{out}}{820 \times 9,81} = \frac{86,856 \times 10^3}{820 \times 9,81} + \frac{2,356^2}{19,62} + 0 - 1,35 - \frac{7,298^2}{19,62} - 1,063 \quad \checkmark$$
$$P_{out} = 820 \times 9,81 \times 5,952639 \checkmark$$
$$= 47,884 kPa \checkmark$$
(4)

6.5
$$F_{in} = \overset{0}{m}_{in}\, v_{in}$$
$$= 73,439 \times 2,356 \quad \surd$$
$$= 173,022 N \surd$$
(1)

6.6 $F_{in} = P_{in} A_{in}$

$= 86,856 \times 10^3 \times \frac{\pi}{4} \times 0,22^2 \surd$

$= 3301,681N \surd$ (1)

6.7 $F_{out} = \overset{0}{m}_{out} v_{out}$

$= 73,439 \times 7,298 \surd$

$= 535,956N \surd$ (1)

6.8 $F_{out} = P_{out} A_{out}$

$= 47,884 \times 10^3 \times \frac{\pi}{4} \times 0,125^2 \surd$

$= 587,625N \surd$ (1)

6.9 $F_x = F_{in} - F_{out} \cos\theta$

$= (173,022 \surd + 3301,681) - (535,956 \surd + 587,625) \cos 52$

$= 2782,95N$ ✓

$F_y = (535,956 + 587,625) \sin 52 \surd$

$= 885,394N \surd$

$from, F_r^2 = F_x^2 + F_y^2$

$F_r = \sqrt{2782,95^2 + 885,394^2}$ $\surd$

$= 2920,4N$ $\surd$ (4)

6.10 $\tan\theta = \frac{F_y}{F_x}$

$= \tan^{-1}\left(\frac{885,394}{2782,95}\right)$ ✓

$= 17,648^0$ ✓ (2)

[20]

TOTAAL: 100

Kopiereg voorbehou