higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

FLUÏEDMEGANIKA N5

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Hierdie nasienriglyn bestaan uit 11 bladsye.

Kopiereg voorbehou

OPMERKING: Studente moet enige VYF van die SES vrae beantwoord.

VRAAG 1

1.1 1.1.1 Dit is 'n eienskap van vloeistof weens die gewigsverhouding per eenheid volume van die vloeistof✓ in N/m^3 gemeet.✓

1.1.2 Dit is die eienskap van vloeistof weens die digtheidsverhouding van enige stof (vloeistof) tot dié van water✓ wat sonder afmetings is.✓

1.1.3 Die is die eienskap van vloeistof langs die oppervlakmembraan om teen enige vormstukrag te werk wat op die oppervlak per eenheid lengte✓ uitgeoefen word en in N/m gemeet word.✓

(3 × 2) (6)

1.2 1.2.1

$$from, \omega_{oil} = \rho_{oil} g$$
$$= \rho_{relative} \times \rho_{water} \times g \surd$$
$$= 1000 \times 0,96 \times 9,81 \surd$$
$$\therefore \omega_{oil} = 9417,6 N/m^3 \checkmark$$

1.2.2

$$also, \omega_{oil} = \frac{W_{oil}}{V_{oil}}$$
$$= \omega_{oil} \times V_{oil} \surd$$
$$= 9417,6 \times 300 \times 10^{-3} \surd$$
$$W_{oil} = 2825,28 N \checkmark$$

(2 × 2) (4)

1.3 1.3.1

$$From, F_{viscous} = \frac{\mu v A_{mean}}{t}$$

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

$$= \frac{310-309,5}{2} \checkmark$$

$$\therefore t = 0,25mm \checkmark$$

$$also, D_{mean} = \frac{D+d}{2}$$

$$= \frac{310+309,5}{2} \checkmark$$

$$\therefore D_{mean} = 309,75mm \checkmark$$

$$and, A_{mean} = \pi D_{mean} L$$

$$A_{mean} = \pi \times 309,75 \times 10^{-3} \times 200 \times 10^{-3} \checkmark$$

$$= 194,62167 \times 10^{-3} m^2 \checkmark$$

$$thus, F_{viscous} = \frac{\mu v A_{mean}}{t}$$

$$= \frac{0,196 \times 3,25 \times 194,62167 \times 10^{-3}}{0,25 \times 10^{-3}} \checkmark$$

$$\therefore F_{viscous} = 495,896N \checkmark$$

(8)

1.3.2

$$P_{viscous} = F_{viscous} \times v_{mean}$$

$$= 495,896 \times 3,25 \checkmark$$

$$\therefore P_{viscous} = 1,612kW \checkmark$$

(2)
[20]

VRAAG 2

2.1 Volgens Pascal se wet word die druk wat in 'n geslote stelsels uitgeoefen word in alle rigtings✓ eweredig versprei, gegewe dat geen vloeistofveranderinge (vloeistof wat tot die stelsel bygevoeg of verwyder word) in die stelsel plaasvind nie. ✓ Die meeteenheid is pascal (Pa).✓ (3)

2.2 2.2.1 *Application of Pascal's principle*:

where, $P_{mc} = P_{sc}$

$$F_{mc} = \left(\frac{d_{mc}}{d_{sc}}\right)^2 \times F_{sc}$$

$$= \left(\frac{40^2}{60^2}\right) \times 6000 \surd$$

$$= 2,66667kN \surd$$

$$as, MA = \frac{F_{mc}}{F_{pedal}}$$

$$F_{pedal} = \frac{2,66667}{5} \surd$$

$$= 533,333N \surd$$

$$P_{mc} = \frac{2,66667 \times 1000 \times 4}{\pi \times 0,04^2} \surd$$

$$= 2,122MPa \surd$$

(3)

2.2.2 $from, SV_{mc} = SV_{sc}$

$$d_{mc}^2 \times SL_{mc} = d_{sc}^2 \times SL_{sc} \surd$$

$$= \frac{d_{sc}^2}{d_{mc}^2} \times SL_{sc} \surd$$

$$SL_{mc} = \frac{60^2}{40^2} \times 7,41 \surd$$

$$\therefore SL_{mc} = 16,6725mm \surd$$

$$MA = \frac{SL_{pedal}}{SL_{mc}}$$

$$SL_{pedal} = MA \times SL_{mc} \surd$$

$$= 5 \times 16,6725 \surd$$

$$\therefore SL_{pedal} = 83,363mm \checkmark$$

(4)

2.3 2.3.1

$$from, Q = \frac{volume}{time} = \frac{A \times L}{time}$$

$$as, A_{foward} = \frac{\pi\left(D^2 - d^2\right)}{4}$$

$$= \frac{\pi}{4}\left(0,21^2 - 0,06^2\right) \checkmark$$

$$A_{foward} = 31,80863 \times 10^{-3} m^3 \checkmark$$

$$also, A_{return} = \frac{\pi D}{4}$$

$$= \frac{\pi \times 0,21^2}{4} \checkmark$$

$$A_{return} = 34,63606 \times 10^{-3} m^3 \checkmark$$

$$now, t_{foward} = \frac{31,80863 \times 10^{-3} \times 0,5}{0,56 \times 10^{-3}} \checkmark$$

$$\therefore t_{foward} = 28,401 \text{s} \checkmark$$

$$and, t_{return} = \frac{34,63606 \times 10^{-3} \times 0,5}{0,56 \times 10^{-3}} \checkmark$$

$$\therefore t_{return} = 30,925 \text{s} \checkmark$$ (8)

2.3.2

$$from, P = \frac{F}{A}$$

$$= \frac{6000}{1,80863 \times 10^{-3}} \checkmark$$

$$\therefore P = 3,317 MPa \checkmark$$ (2)

[20]

VRAAG 3

3.1 3.1.1

$$W_{object} + F_{oil} = F_{total}$$
$$as, F_{total} = F_{total} ... Achimede's\ law$$
$$F_{total} = mg + \rho Vg \surd$$
$$= (90 \times 9,81) + \left(840 \times 9,81 \times \frac{\pi}{4} \times 3,6^2 \times 6 \right)$$
$$\therefore F_{total} = F_{bouyancy} = 504145,233N \checkmark$$

3.1.2

$$Now, F_{total} = F_{bouyancy} \surd$$
$$504145,233 = 1025 \times 9,81 \times \frac{\pi}{4} \times 3,6^2 h \surd$$
$$504145,233 = 102349,9785h \surd$$
$$h = \frac{504145,233}{102349,9785} \surd$$
$$\therefore h = 4,946m\ below\ the\ surface \surd$$

(2 × 2½) (5)

3.2 3.2.1

$$W_{object} = F_{bouyancy} \surd$$
$$m_{object} g = \rho g V_{displaced} \surd$$
$$= 9810 \times \frac{\pi \times 1,55^2}{4} \times 3,8 \times 0,45 \checkmark$$
$$9,81 m_{object} = 31653,256 \checkmark$$
$$m_{object} = \frac{31653,256}{9,81} \checkmark$$
$$\therefore m_{object} = 3,227 tonnes \checkmark$$

(5)

3.2.2

$$Application\ of\ Achimedes\ principle:$$
$$where, W_{object} + W_{load} = F_{bouyancy}$$
$$m_{object} g + m_{load} g = \rho g V_p \checkmark$$
$$9,81(3,227 \times 10^3 + m_{load}) = 9810 \times \frac{\pi \times 1,55^2}{4} \times 3,8$$
$$3,227 \times 10^3 + m_{load} = 7170,29253 \checkmark$$
$$m_{load} = 7170,29253 - 3,227 \times 10^3 \checkmark$$
$$\therefore m_{load} = 3943,293kg \checkmark$$

(6)

3.2.3

$$F = \rho g \bar{y} A$$
$$\bar{y} = 2,55 + \frac{1,55}{2} \checkmark$$
$$\therefore \bar{y} = 3,325m \checkmark$$
$$F = 9810 \times 3,325 \times \frac{\pi}{4} \times 1,55^2 \checkmark$$
$$\therefore F = 615,48kN \checkmark$$

(4)
[20]

VRAAG 4

4.1 4.1.1

$$from, Q = \frac{volume}{time}$$
$$V = Qt$$
$$= 13 \times 10^{-3} \times 18 \times 60 \checkmark$$
$$\therefore V = 14,04m^3 \surd$$
$$also, \rho = \frac{mass}{volume}$$
$$m = \rho V$$
$$= 870 \times 14,04 \checkmark$$
$$\therefore m = 12,215tonnes \surd$$

4.1.2 *Application of Bernoulli's energy equation between the inlet and outlet*:

$$\frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i = \frac{P_o}{\rho g} + \frac{v_o^2}{2g} + Z_o + h_{loss} \text{...ignoring all possible losses} \surd$$
$$v_i = v_o$$
$$thus, Z_i - Z_o = \frac{P_o}{\rho g} \surd$$
$$Z_i - Z_o = \frac{34 \times 10^3}{870 \times 9,81} \checkmark$$
$$\therefore Z_i - Z_o = 3,984m \checkmark$$

(2 × 3) (6)

4.2 4.2.1 $from, Q_i = Q_o ... continuity\ flow\ principle:$

$$Q_{250} = Q_{300}$$

$$\frac{\pi d_{250}^2}{4} \times v_{250} = \frac{\pi d_{300}^2}{4} \times v_{250} \surd$$

$$\frac{\pi \times 250^2}{4} \times v_{250} = \frac{\pi \times 300^2}{4} \times v_{250} \checkmark$$

$$v_{250} = \left(\frac{300}{250}\right)^2 \times 4 \checkmark$$

$$v_{250} = 5,76 m/s \surd$$ (3)

4.2.2 $from,$

$$Q_{250} = Q_{300} = Q_{95} + Q_{140}$$

$$\frac{\pi d_{250}^2}{4} \times v_{250} = \frac{\pi d_{95}^2}{4} \times v_{95} + Q_{140} \checkmark$$

$$\frac{\pi \times 0,3^2}{4} \times 5,76 = \frac{\pi \times 0,095^2}{4} \times 3,85 + Q_{140} \checkmark$$

$$407,1504 \times 10^{-3} = 27,28964 \times 10^{-3} + Q_{140} \checkmark$$

$$Q_{140} = 407,1504 \times 10^{-3} - 27,28964 \times 10^{-3} \surd$$

$$\therefore Q_{140} = 379,861 l/s \surd$$ (4)

4.2.3 $from, Q = Av$

$$\frac{\pi d_{140}^2}{4} \times v_{140} = 379,861 \times 10^{-3} \checkmark$$

$$v_{140} = \frac{379,861 \times 10^{-3} \times 4}{\pi \times 0,14^2} \checkmark$$

$$v_{140} = 24,676 m/s \checkmark$$ (3)

4.2.4 $\overset{o}{W}_{140} = \rho g Q_{140}$

$= 9810 \times 379,861 \times 10^{-3} \checkmark$

$= 3,726 kN/s \checkmark$

$also, \overset{o}{W}_{95} = \rho g Q_{95}$

$= 9810 \times 27,28964 \times 10^{-3} \checkmark$

$= 267,711 N/s \checkmark$ (4)

[20]

VRAAG 5

5.1 5.1.1 In laminêre stroming vloei elke deeltjie van 'n vloeistof gladweg saam met, of langs mekaar✓ sonder turbulensie of om langs die pad met mekaar in te meng.✓

5.1.2 Vloei is onbestendig wanneer toestande in verhouding tot tyd onbestendig is. Die vloeistof vloei langs 'n pad met nie-parallelle lae✓ of met turbulensie of toestande wat konstant in verhouding tot tyd verander.✓

(2 × 2) (4)

5.2

$$h_l = h_m\left(\frac{\rho_m}{\rho_s}-1\right)$$ ✓

$$= 40\left(\frac{13600}{900}-1\right)$$ ✓

$$= 564mm$$ ✓

$$v_{ave} = C_v\sqrt{2gh_l}$$

$$v_{\max} = \sqrt{19,62\times 0,564} = 3,3265m/s$$ ✓

$$= 0,9\times 3,3265$$ ✓

$$\therefore v_{\max} = 2,99386m/s$$ ✓

$$Q = v_{\max}\times A$$

$$= \frac{\pi\times 0,35^2\times 2,99386}{4}$$ ✓

$$\therefore Q = 288,043l/s$$ ✓ (8)

5.3 5.3.1

$$v_1 = \frac{Q}{A_1}$$

$$= \frac{4\times 6\times 10^{-3}}{\pi\times 0,05^2}$$ ✓

$$= 3,05578m/s$$ ✓

$$v_2 = \frac{Q}{A_2}$$

$$= \frac{4\times 6\times 10^{-3}}{\pi\times 0,02^2}$$ ✓

$$= 19,09856m/s$$ ✓

$$h_v = \frac{19,09856^2 - 3,05578}{19,62}$$ ✓

$$= 18,115m$$ ✓ (6)

5.3.2

$$from, hs = \left(\frac{1}{C_c} - 1\right)^2 \times \frac{v_{exit}^2}{2g}$$

$$= \left(\frac{1}{0,7} - 1\right) \times \frac{19,09856^2}{19,62} \checkmark$$

$$= 7,968m \checkmark$$

(2)
[20]

VRAAG 6

6.1 Die funksie van 'n pomp in 'n hidrouliese stelsel is om meganiese energie✓ deur hefkrag (deur middel van 'n vakuum of negatiewe druk) na hidrouliese energie aan die suigkant om te sit ten einde die vloeistof te lewer.✓ (2)

6.2 6.2.1

$$from, l/d_{sytem} = \left(\frac{l}{d}\right)_{filter} + \left(\frac{l}{d}\right)_{bends} + \left(\frac{l}{d}\right)_{valve} + \left(\frac{l}{d}\right) pipe$$

$$l/d_{sytem} = \frac{4}{4 \times 0,015} \checkmark + 2\left(\frac{0,85}{4 \times 0,015}\right) \checkmark + 60 \checkmark + \frac{15}{0,03} \checkmark$$

$$= 66,66667 + 28,33333 + 60 + 500$$

$$= 655 \checkmark$$

(6)

6.2.2

$$from, hf = \frac{4flv^2}{2gd}$$

$$and, Q = Av$$

$$v = \frac{4Q}{\pi d^2} \surd$$

$$= \frac{10 \times 10^{-3}}{\pi \times 0,03^2} \checkmark$$

$$= 3,53678m/s \surd$$

$$thus, hf = \frac{4fv^2}{2g} \times l/d_{sytem} \quad \checkmark$$

$$= \frac{4 \times 0,015 \times 3,53678^2}{19,62} \times 655$$

$$= 25,056m \checkmark$$

(4)

6.2.3 *Application of Bernoulli's energy equation between the inlet and outlet*:

$$\frac{P_i}{\rho g}+\frac{v_i^2}{2g}+Z_i+H_{pump}=\frac{P_o}{\rho g}+\frac{v_o^2}{2g}+Z_o+h_{loss}$$

$$H_{pump}=\frac{4,25\times10^{6}}{960\times9,81}+\frac{3,53678^{2}}{19,62}-6+25,056$$

$$=470,976m\surd$$

$$from, P=\rho gQH_{pump}$$

$$=960\times9,81\times10\times10^{-3}\times470,976\ \checkmark$$

$$=44,355kW\surd$$ (4)

6.2.4

$$from, h_{filter}=\frac{kv^2}{2g}$$

$$where, \left(\frac{l}{g}\right)_{filter}=\frac{k}{4f}\surd$$

$$60=\frac{k}{4\times0,015}\ \checkmark$$

$$k=3,6\surd$$

$$now, h_{filter}=\frac{3,6\times3,53678^{2}}{19,62}\checkmark$$

$$\therefore h_{filter}=2,295m\checkmark$$ (4)

[20]

TOTAAL: 100

Kopiereg voorbehou