higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

FLUÏEDMEGANIKA N5

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Hierdie nasienriglyn bestaan uit 12 bladsye.

.

Kopiereg voorbehou

LET WEL: ✓ = EEN punt
√ = ½-punt√

VRAAG 1

1.1 1.1.1

$$W = \frac{2\sigma\pi r^2}{r}$$
$$= 2\sigma\pi r \quad ✓$$
$$= 2\times 0,085\times \pi \times 3\times 10^{-3} \quad ✓$$
$$\therefore W = 1,602\times 10^{-3} N \quad ✓$$

(3)

1.1.2

$$\Delta P = \frac{W}{A}$$
$$= \frac{1,602\times 10^{-3}}{\pi \times 0,003^2} \quad ✓$$
$$= 56,667 Pa \quad ✓$$

(2)

1.2 1.2.1

$$From, F_{viscous} = \frac{\mu v A}{t}$$
$$= \frac{0,11\times 0,65\times 1,5}{0,3\times 10^{-3}} \quad ✓$$
$$\therefore F_{viscous} = 357,5N \quad ✓$$

(2)

1.2.2

$$From, WD = Fv$$
$$= 357,5\times 0,65 \quad ✓$$
$$\therefore WD = 232,375 J/s \ or \ 232,375W \quad ✓$$

(2)

1.2.3

$$From, \nu = \frac{\mu}{\rho}$$
$$\sin ce, \rho_{rel} = \frac{\rho_{substance}}{\rho_{water}}$$
$$\rho_{substance} = \rho_{rel}\times \rho_{water} \quad √$$
$$= 0,95\times 1000 \quad √$$
$$\therefore \rho_{substance} = 950 kg/m^3 \quad ✓$$
$$thus, \nu = \frac{0,11}{950} \quad ✓$$
$$\therefore \nu = 115,79\times 10^{-6} m^2/s \quad ✓$$

(4)

1.2.4

$$From, F = \frac{\mu v A}{t}$$
$$where, WD = Fv$$
$$90 = F \times 0,78 \quad \checkmark$$
$$\therefore F = 115,38462N \quad \checkmark$$
$$F = \frac{\mu v A}{t} \quad \checkmark$$
$$\therefore A = \frac{115,38462 \times 0,2 \times 10^{-3}}{0,07} \quad \checkmark$$
$$\therefore A = 329,67034 \times 10^{-3} m^2 \quad \checkmark$$
$$thus, A = w \times l$$
$$w = \frac{329,67034 \times 10^{-3}}{0,6} \quad \checkmark$$
$$\therefore w = 549,451mm \quad \checkmark$$

(7)
[20]

VRAAG 2

2.1 Eienskap van materie van vloeistof- of gasfase,✓ wat die vermoë meet van om enige vorm van samedrukking (saamdrukbaarheid) te weerstaan wanneer 'n krag daarop toegepas word✓ (2)

2.2 2.2.1

$$Applying\ Pascal's\ principle:$$
$$where, P_{ram} = P_{plunger}$$
$$as, P = \frac{F}{A}$$
$$now, F_{ram} = 6 \times 10^6 \times \frac{\pi \times 0,06^2}{4} \quad \checkmark$$
$$\therefore F_{ram} = 16,965kN \quad \checkmark$$

(2)

2.2.2

$$from, F_{plunger} = PA_{plunger}$$
$$= 6 \times 10^6 \times \frac{\pi \times 0,02^2}{4} \quad \checkmark$$
$$\therefore F_{plunger} = 1,88496kN \quad \surd$$
$$also, MA = \frac{F_{plunger}}{F_{lever}}$$
$$F_{lever} = \frac{1,88496 \times 10^3}{8} \quad \checkmark$$
$$= 235,62N \quad \surd$$

(3)

2.2.3 $from, SV_{plunger} = SV_{ram}$

$n \times A_{plunger} \times SL_{plunger} = A_{ram} \times SL_{ram}$ √

$n = \left(\frac{60}{20}\right)^2 \times \frac{120}{35}$ ✓

$\therefore n = 30,857$ √

$thus, a\ total\ of\ 31\ strokes\ is\ required\ to\ lift\ the\ ram\ 120mm$ ✓ (3)

2.2.4 $from, \frac{1}{K_e} = \frac{1}{K_l} + \frac{1}{K_{cyl}} + \frac{V_{air}}{V_{total} K_{air}}$

with no air in the system and modulus *of elasticity*

$thus, \frac{1}{K_e} = \frac{1}{K_l}$ √

$K_e = K_l = 1,9GPa$ ✓

$as, K_e = \frac{\Delta P \times V}{\Delta V_{play}}$ √

$\Delta L_{play} = \frac{\Delta P \times L}{K_e}$ √

$= \frac{6 \times 10^6 \times 120}{1,9 \times 10^9}$ ✓

$\therefore \Delta L_{play} = 378,947mm$ √ (4)

2.2.5

$$from, \frac{1}{K_e} = \frac{1}{K_l} + \frac{1}{K_{cyl}} + \frac{V_{air}}{V_{total} K_{air}}$$

$$with V_{air} = 1,55ml$$

$$also, K_{air} = P\gamma$$

$$= 6 \times 10^6 \times 1,4 \quad \surd$$

$$\therefore K_{air} = 8,4MPa \quad \surd$$

$$and, V_{total} = AL$$

$$= \frac{\pi \times 0,06^2}{4} \times 0,12 \quad \surd$$

$$\therefore V_{total} = 339.29201 \times 10^{-6} m^3 \quad \surd$$

$$thus, \frac{1}{K_e} = \frac{1}{1,9 \times 10^9} + \frac{1,55 \times 10^{-6}}{339,29201 \times 10^{-6} \times 8,4 \times 10^6} \quad \checkmark$$

$$\frac{1}{K_e} = 526,31579 \times 10^{-12} + 543,84956 \times 10^{-12} \quad \surd$$

$$\frac{1}{K_e} = 1,07017 \times 10^{-6} \quad \surd$$

$$\therefore K_e = 934,435MPa \quad \surd$$

$$\Delta L_{play} = \frac{\Delta P \times L}{K_e}$$

$$= \frac{6 \times 10^6 \times 120}{934,435 \times 10^6} \quad \checkmark$$

$$\therefore \Delta L_{play} = 770,519mm \quad \surd$$

(6)
[20]

VRAAG 3

3.1 3.1.1 Opwaartse druk of krag van vloeistof wat reageer (teenoorgestelde rigting) teen enige voorwerp wat 'n krag (gewig) uitoefen op die oppervlak van eweredige grootte

3.1.2 Afstand gemeet van vloeistofoppervlak na basis of onderste punt onder die oppervlak van die vloeistof verplaas deur 'n drywende of ondergedompelde voorwerp

(2 × 1) (2)

3.2 3.2.1

$$\sin ce, \bar{y} = 3 + \frac{0,9}{2} \quad \checkmark$$
$$= 3,45m \quad \checkmark$$
$$and, A = \frac{\pi \times 0,9^2}{4} \quad \surd$$
$$= 636,17251 \times 10^{-3} m^2 \quad \surd$$
$$F_{hydrostatic} = \rho g \bar{y} A$$
$$= 1020 \times 9,81 \times 3,45 \times 636,17251 \times 10^{-3} \quad \checkmark$$
$$= 21,962kN \quad \checkmark$$

(5)

3.2.2

$$from, \bar{h} = \frac{I_G \sin^2 \theta}{A \bar{y}} + \bar{y}$$
$$as, I_G = \frac{\pi \times 0,9^4}{64} \quad \surd$$
$$= 32,20623 \times 10^{-3} m^4 \quad \surd$$
$$\checkmark$$
$$hus, \bar{h} = \frac{32,20623 \times 10^{-3} \times \sin^2 90}{636,17251 \times 10^{-3} \times 3,45} + 3,45 \quad \surd$$
$$= 14,67391 \times 10^{-3} + 3,45 \quad \checkmark$$
$$\therefore \bar{h} = 3,465m \quad \surd$$

(4)

3.3 3.3.1

$$Application\ of\ Archimedes\ law\ for\ partially\ or\ fully\ submerged\ objects$$
$$where, F_{ball} = F_{bouyancy} \quad \surd$$
$$mg = \rho g V_{\substack{water \\ displaced}} \quad \surd$$
$$= 1000 \times 6,25 \times 4 \times 1,2 \quad \surd$$
$$\therefore m = 30tonnes \quad \surd$$

(2)

3.3.2

$$Application\ of\ Archimedes\ law\ for\ partially\ or\ fully\ submerged\ objects$$
$$where, F_{ball} = F_{bouyancy} \quad \surd$$
$$mg = \rho g V_{\substack{water \\ displaced}} \quad \surd$$
$$m = \rho V_{\substack{water \\ displaced}} \quad \surd$$
$$30 \times 10^3 = 1020 \times 6,25 \times 4 \times draught \quad \checkmark$$
$$\therefore draught = 1,177m \quad \surd$$

(3)

3.3.3 *Application of Archimedes law for partially or fully submerged objects:*

$where, F_{pantoon} + F_{water} = F_{bouyancy}$ √

$m_{pantoon}g + m_{water}g = \rho g V_{\substack{water \\ displaced}}$ √

$m_{pantoon} + m_{water} = \rho V_{\substack{water \\ displaced}}$ √

$30 \times 10^3 + m_{water} = 1000 \times 6,25 \times 4 \times 1,66$ √

$m_{water} = 41,5 \times 10^3 - 30 \times 10^3$ √✓

$\therefore m_{water} = 11500\ l$ √

(4)
[20]

VRAAG 4

4.1 4.1.1 Lyn getrek of gevolg deur 'n gegewe of bekende partikel.✓ Gegenereer deur 'n matrys in die vloeistof te plaas sodat die beweging van die partikel op 'n baan gevolg kan word.✓

4.1.2 Lyn ingeneem of gevolg deur 'n vloeistofpartikel in oombliklike beweging.✓ Die partikel sal tangensiaal lê tot die stroomlyn by 'n spesifieke punt of posisie.✓

(2 × 2) (4)

4.2 4.2.1

$from, \overset{o}{W} = \overset{o}{m}\, g$

$as, \overset{o}{m} = \rho Q$

$now, \overset{o}{W} = \rho g Q$ √

$= 9810 \times \frac{\pi \times 0,065^2}{4} \times 8$ √

$\therefore \overset{o}{W} = 260,421 N/s$ ✓

(2)

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

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

from, $Q_{inlet}=Q_{outlet}$ *...continuity of flow principle*:

$$thus, v_o=\frac{d_i^2}{d_o^2}\times v_i \quad \surd$$

$$=\frac{60^2}{45^2}\times 8 \quad \surd$$

$$\therefore v_o=14,22222m/s \quad \surd$$

$$thus, \frac{P_i}{\rho g}+\frac{8^2}{19,62}+0=\frac{50\times 10^3}{9810}+\frac{14,22222^2}{19,62}+5,5+3$$

$$\frac{P_i}{\rho g}=\frac{50\times 10^3}{9810}+\frac{14,22222^2}{19,62}+5,5+3-\frac{8^2}{19,62} \quad \surd$$

$$P_i=9810\times 20,64432 \quad \surd$$

$$\therefore P_i=202,521kPa \quad \surd$$

(6)

4.2.3 *Energy head at entry*:

$$E_i=\frac{P_i}{\rho g}+\frac{v_i^2}{2g}+Z_i$$

$$=20,64432+\frac{8^2}{19,62}+0 \quad \surd$$

$$\therefore E_i=23,9063m \quad \surd$$

$$P_i=\rho g Q E_i$$

$$=9810\times\frac{\pi}{4}\times 0,06^2\times 8\times 23,9063 \quad \surd$$

$$\therefore P_i=5,305kW \quad \surd$$

(3)

4.2.4 *Energy head at exit*:

$$E_o=\frac{P_o}{\rho g}+\frac{v_o^2}{2g}+Z_o$$

$$=\frac{50\times 10^3}{9810}+\frac{14,22222^2}{19,62}+5,5$$

$$\therefore E_o=20,90627m \quad \surd$$

$$P_i=\rho g Q E_i$$

$$=9810\times\frac{\pi}{4}\times 0,045^2\times 14,22222\times 20,90627 \quad \surd$$

$$\therefore P_i=4,639kW \quad \surd$$

(3)

4.2.5
$$\eta_o = \frac{P_o}{P_i} \times 100\%$$
$$= \frac{4,639}{5,305} \times 100\% \quad ✓$$
$$= 87,446\% \quad ✓$$
(2)
[20]

VRAAG 5

5.1 Voordele:
- Relatief goedkoper
- Kompak, wat dit makliker maak om tussen twee meetposisies in te pas, soos pypflense

Nadele:
- Nie so akkuraat met dataverskaffing tydens vloeimeetbewerking nie

(2 + 1) (3)

5.2 5.2.1 *Application of Bernoulli's energy equation between the inlet and outlet*:
$$\frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i = \frac{P_o}{\rho g} + \frac{v_o^2}{2g} + Z_o + h_{loss} \quad √$$
$$as, P_i = P_o \quad √$$
$$also, h_{loss} = 0$$
$$now, \frac{v_o^2}{2g} = \frac{v_i^2}{2g} + Z_i - Z_o \quad √$$
$$\frac{v_o^2}{2g} = \frac{2,55^2}{19,62} + 5 \quad ✓$$
$$\therefore v_o = \sqrt{19,62\left(\frac{2,55^2}{19,62} + 5\right)} \quad ✓$$
$$= 10,228 m/s \quad √$$
(4)

5.2.2 $from, Q_{inlet} = Q_{outlet} ... continuity\ of\ flow\ principle$:
$$thus, v_o \times d_o^2 = d_i^2 \times v_i \quad √$$
$$d_o = \sqrt{\frac{30^2 \times 2,55}{10,228}} \quad ✓$$
$$\therefore d_o = 14,98 mm \ √$$
(2)

5.2.3 *KE per unit weight*;

$$\frac{KE}{W} = \frac{mv_o^2}{2W} \quad \surd$$

$$= \frac{v_o^2}{2g} \quad \surd$$

$$= \frac{10,228^2}{19,62} \quad \checkmark$$

$$= 5,332m \quad \checkmark$$

(3)

5.3 *Application of Bernoulli's energy equation between the inlet and throat*:

$$\frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i = \frac{P_t}{\rho g} + \frac{v_t^2}{2g} + Z_t + h_{loss}$$

$as, Z_i = Z_t ...horizontal$

$also, h_{loss} ...are\ ignored$

$$thus, \frac{P_i - P_t}{\rho g} = \frac{v_t^2 - v_i^2}{2g} \checkmark$$

$from, Q_{inlet} = Q_{outlet} ...continuity\ of\ flow\ principle$:

$thus, v_t \times d_t^2 = d_i^2 \times v_i \surd$

$$v_i = \frac{d_t^2}{d_i^2} v_t \quad \surd$$

$$now, \frac{P_i - P_t}{\rho g} = \frac{v_t^2 - \left(\frac{d_t^2}{d_i^2} v_t\right)^2}{2g}$$

$$\frac{25 \times 10^3}{9,81 \times 900} = \frac{v_t^2 - \left(\frac{40^2}{65^2} v_t\right)^2}{19,62} \checkmark$$

$$55,55556 = 0,85659 v_t^2 \surd$$

$$\therefore v_t = \sqrt{\frac{55,55556}{0,85659}} \quad \checkmark$$

$$= 8,05337 m/s \surd$$

$$Q_t = A_t v_t$$

$$= \frac{\pi \times 0,04^2}{4} \times 8,05337 \checkmark$$

$$= 10,12017\ l/s \surd$$

$$Q_{actual} = 0,87 \times 0,12017 \quad \checkmark$$

$$= 8,805\ l/s \quad \surd$$

(8)

[20]

VRAAG 6

6.1 6.1.1 Onwaar
6.1.2 Onwaar
6.1.3 Waar

(3 × 1) (3)

6.2 6.2.1

$$from, \sum\left(\frac{l}{d}\right)_{system} = \left(\frac{l}{d}\right)_{valve} + \left(\frac{l}{d}\right)_{filter} + \left(\frac{l}{d}\right)_{pipe} + \left(\frac{l}{d}\right)_{bend}$$

$$= 50 + \frac{3,5}{4\times 0,0015} + \frac{15}{15,5\times 10^{-3}} + 2\left(\frac{0,8}{4\times 0,0015}\right)$$

$$= 50 + 583,33333 + 967,74194 + 266,66667$$

$$= 1867,742$$

(5)

6.2.2

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

$$thus, hf = \frac{4\times 0,0015\times 4,15^2}{19,62}\times 1867,742$$

$$\therefore hf = 9,837m$$

(2)

6.3 6.3.1 *Application of Bernoulli's energy equation between the inlet and throat*:

$$\frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i = \frac{P_t}{\rho g} + \frac{v_t^2}{2g} + Z_t + h_{loss}$$

$$as, v_i = v_o ... cons\tan t\ pipe\ diameter$$

$$where, \frac{Z_i - Z_t}{L} = \sin\theta$$

$$Z_i - Z_t = 580\times\frac{1}{110}$$

$$= 5,273m$$

$$\frac{400\times 10^3}{9810} + 5,273 = \frac{4\times 0,0012\times 580 v_{pipe}^2}{19,62\times 0,03} + \frac{6,25 v_{pipe}^2}{19,62}$$

$$v_{pipe}^2 = \frac{46,04772}{\left(\frac{4\times 0,0012\times 580}{19,62\times 0,03} + \frac{6,25}{19,62}\right)}$$

$$= \sqrt{9,12121}$$

$$\therefore v_{pipe} = 3,02m/s$$

(6)

6.3.2 $P_{loss} = \rho g Q h_{loss}$

$where, h_{loss} = \frac{kv_{pipe}^2}{2g} + \frac{4flv_{pipe}^2}{2gd}$ ✓ ✓

$= \frac{4 \times 0,0012 \times 580 \times 3,02^2}{19,62 \times 0,03} + \frac{6,25 \times 3,02^2}{19,62}$

$\therefore h_{loss} = 46,04361m$ √

$= 9810 \times \frac{\pi \times 0,03^2}{4} \times 3,02 \times 46,04361$ ✓

$= 964,225W$ √

(4)
[20]

TOTAAL: 100

Kopiereg voorbehou