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 10 bladsye.

Kopiereg voorbehou

VRAAG 1

1.1 1.1.1 Druk is die krag wat uitgeoefen word deur ’n fluïed✓ op enige oppervlak waarmee dit in aanraking kom, of deur een deel van ’n fluïed op die aangrensende dele. ✓

1.1.2

Atmosferiese druk is die druk wat op die oppervlak van die aarde inwerk✓ of uitgeoefen word as gevolg van die gewig van die atmosferiese druk. ✓

1.1.3

Absolute druk is die druk ✓ wat bo die absolute nulpunt gemeet word en is die totaal van die atmosferiese✓ en meterdruk.

1.1.4 Meterdruk is die intensiteit van druk wat bo✓ of onder atmosferiese druk gemeet word, en word deur ’n maatinstrument gemeet. ✓

(4 × 2) (8)

1.2 1.2.1

$$SG = \frac{\rho_{ice}}{\rho_{water}}$$
$$\rho_{ice} = SG \times \rho_{water}$$
$$= 1{,}1 \times 1\,000 \checkmark$$
$$= 1\ 100\ kg/m^3 \checkmark$$

(2)

1.2.2

$$W = mg = \rho V_{ice} g$$
$$= (1\,100 \times 2) \times 9{,}81 \checkmark$$
$$= 21{,}582\ kN \checkmark$$

(3)

1.2.3

$$W_{ice} = F_{bouyancy}$$
$$\rho_{ice} V_{ice} g = \rho_w V_{disp} g$$
$$21{,}582 \times 10^3 = 1000 \times 2 \times 2 \times h \times 9{,}81 \checkmark$$
$$V_{disp} = 4h = \frac{21{,}582 \times 10^3}{9\,810} \checkmark$$
$$h = \frac{2{,}2}{4} \checkmark$$
$$= 0{,}55\ m \checkmark$$

(4)

1.3 Oppervlakspanning is die spanning wat veroorsaak word as gevolg van die kohesie ✓ van kragte tussen molekules op die oppervlak van die fluïed (vloeistof) wat grens aan ’n ander onmengbare fluïed (vloeistof). Dit is ook die eienskap wat voorwerpe in staat stel om op die oppervlak te dryf en word in N/m gemeet. ✓ (3)

[20]

VRAAG 2

2.1 2.1.1

$$t = \frac{D - d}{2}$$
$$= \frac{95{,}2 - 95}{2} \checkmark$$
$$= 0{,}1\ mm \checkmark$$

$$\tau = \frac{\mu \times v}{t}$$
$$= \frac{0{,}2 \times 5}{0{,}1 \times 10^{-3}} \checkmark$$
$$= 10\ kPa \checkmark$$

$$F = \tau A = \tau \pi d L$$
$$= 10\ 000 \times (\pi \times 0{,}095 \times 0{,}12) \checkmark \checkmark$$
$$= 358{,}142\ N \checkmark$$ (7)

2.1.2

$$P = Fv$$
$$= 358{,}142 \times 5 \checkmark$$
$$= 1790{,}709\ W \checkmark$$ (2)

2.1.3

$$\upsilon = \frac{\mu}{\rho}$$
$$= \frac{0{,}2}{850} \checkmark$$
$$= 235{,}294 \times 10^{-3}\ m^2/s \ \checkmark$$ (2)

2.2 $V = AL$

$$700\times10^{-6} = \frac{\pi \times D_{LP}^2 \times 0{,}5D_{LP}}{4}\checkmark$$

$$D_{LP} = \sqrt[3]{\frac{8\times700\times10^{-6}}{\pi}}\checkmark$$

$$= 121{,}124\ mm\checkmark$$

$$L = 0{,}5D_{LP}$$

$$= 0{,}5\times121{,}124\checkmark$$

$$\therefore L = 60{,}625mm\checkmark$$

$$F_{HP} = F_{LP}\ \checkmark$$

$$P_{HP}A_{HP} = P_{LP}A_{LP}$$

$$P_{HP}D_{HP}^2 = P_{LP}D_{LP}^2$$

$$D_{HP} = D_{LP}\sqrt{\frac{P_{LP}}{P_{HP}}}\checkmark$$

$$= 121{,}124\sqrt{\frac{7}{15}}\checkmark$$

$$\therefore D_{HP} = 82{,}743\ mm\checkmark$$

(9)
[20]

VRAAG 3

3.1 3.1.1 *Consider oil* :

$$P_{oil-1} = \frac{\rho g h_{oil-1}}{2}$$
$$= \frac{900 \times 9{,}81 \times 2}{2}$$
$$= 8829 Pa \checkmark$$
$$F_{oil-1} = P_{oil-1} \times A_{oil-1}$$
$$= 8\,829 \times 3{,}5 \times 2 \checkmark$$
$$= 61{,}803 kN \checkmark$$
$$F_{oil2} = 900 \times 9{,}81 \times 2 \times 3{,}5 \times 3 \checkmark$$
$$= 238{,}383\ kN \checkmark$$

Consider water

$$P_w = \frac{\rho g h_w}{2}$$
$$= \frac{1\,000 \times 9{,}81 \times 3}{2}$$
$$= 14715 Pa \checkmark$$
$$F_w = P_w \times A_w$$
$$= 8\,829 \times 3{,}5 \times 2 \checkmark$$
$$= 103{,}005 kN \checkmark$$

Total hydrostatic force

$$F_{total} = F_{oil-1} + F_w + F_{oil2} \quad \checkmark$$
$$= 61{,}803 + 238{,}383 + 103{,}005$$
$$= 403{,}191\ kN$$

(10)

3.1.2

$$h_{oil-1} = 3 + \frac{2}{3} = 3{,}6667\ m \checkmark$$
$$h_{oil-2} = \frac{3}{2} = 1{,}5\ m \checkmark$$
$$h_w = \frac{3}{3} = 1\ m \checkmark$$

Moments taken about the turning point :

$$(F_w \times h_w) + (F_{oil-1} \times h_{oil-1}) + (F_{oil-2} \times h_{oil-2}) = F_{total}\, y_{total}$$
$$(103{,}005 \times 1) + (61{,}803 \times 3{,}6667) + (238{,}383 \times 1{,}5) = 403{,}191 y_{total} \checkmark$$
$$y_{total} = 1{,}704\ m\ (from\ bottom) \checkmark$$
$$y_{total} = 5 - 1{,}704 = 3{,}3 m\ (from\ free\ surface) \checkmark$$

(6)

3.2 Die beginsel van Archimedes bepaal dat die opwaartse momentum of krag ✓ van dryfvermoë wat op 'n liggaam inwerk wat in 'n fluïed (vloeistof) gedompel word ✓ of ondergedompel is, gelyk is aan die gewig van die fluïed wat verplaas word. Hoe groter die digtheid van die fluïed (vloeistof), hoe groter die uitwerking van die opwaartse momentum ✓ of krag van dryfvermoë ✓. (4)
[20]

VRAAG 4

4.1 4.1.1 Die deursneeoppervlakte en snelheid van 'n stroom kan varieer van deursnee tot deursnee, ✓ maar nie met betrekking tot tyd: dalende pyp ✓ nie.

4.1.2 Die deursneeoppervlakte en snelheid van 'n stroom varieer ✓ met betrekking tot tyd: golf in 'n kanaal. ✓

4.1.3 Die deursneeoppervlakte en snelheid van 'n stroom is dieselfde ✓ by opvolgende seksies: pyp van konstante diameter wat voluit loop ✓

4.1.4 Die deursneeoppervlakte en snelheid van 'n stroom ✓ is nie dieselfde by opvolgende seksies nie: pyp van konstante diameter wat water uit suierpomp ✓ lewer

(4 × 2) (8)

4.2 4.2.1

$$V = \frac{m}{\rho}$$
$$= \frac{10\,000}{950}\checkmark$$
$$= 10{,}526316\ m^3\checkmark$$
$$Q = \frac{V}{t}$$
$$t = \frac{10{,}526316}{12 \times 10^{-3}}\checkmark$$
$$= 877{,}193\,\text{sec}\checkmark$$
$$= 14{,}62\,\text{min}\checkmark$$

(5)

4.2.2

$$P = \rho g h$$
$$= 950 \times 9{,}81 \times 4\checkmark$$
$$= 37{,}278\ kPa\checkmark$$

(3)

4.2.3 *Applying Bernoulli's theorem* :

$$\frac{P_1}{\rho g}+\frac{v_1^2}{2g}+Z_1=\frac{P_2}{\rho g}+\frac{v_2^2}{2g}+Z_2 \checkmark$$

$\sin ce: P_1 = P_2 ...atmospheric\ conditions$

$v_1 \approx 0$

$$thus,\ Z_1=\frac{v_2^2}{2g}+Z_2 \checkmark$$

$$v_2^2 = 2g(Z_1 - Z_2) \checkmark$$

$$= \sqrt{19{,}62 \times 6} \checkmark$$

$$\therefore v_2 = 10{,}85\ m/s \checkmark$$

(4)
[20]

VRAAG 5

5.1 5.1.1

$$C_c = \frac{A_{vena}}{A_{ori}} = \frac{d_{vena}^2}{d_{ori}^2}$$

$$= \frac{13{,}382}{16} \checkmark$$

$$= 0{,}836 \checkmark$$

$$v_{ori} = \sqrt{2gh}$$

$$= \sqrt{19{,}62 \times 60} \checkmark$$

$$34{,}310348\ m/s \checkmark$$

$$Q_{ori} = \frac{34{,}310348 \times \overset{\checkmark}{\pi} \times \left(13{,}382 \times 10^{-3}\right)^2}{4} \checkmark$$

$$= 4{,}82566\ m^3/s \checkmark$$

$$C_Q = \frac{Q_{jet}}{Q_{ori}}$$

$$= \frac{3{,}61111}{4{,}82566} \checkmark$$

$$= 0{,}748 \checkmark$$

$$C_Q = C_c \times C_v$$

$$C_v = \frac{0{,}748}{0{,}836} \checkmark$$

$$= 0{,}894 \checkmark$$

(11)

5.1.2 $h_{loss} = h\left(1 - C_v^2\right)$
$= 60\left(1 - 0{,}894^2\right)$ ✓✓
$= 12{,}046\ m$ ✓

Alternatively

$h_{loss} = h - \frac{v_{vena}^2}{2g}$
$= 60 - \frac{\left(0{,}894 \times 34{,}310348\right)^2}{19{,}62}$ ✓✓
$= 12{,}046\ m$ ✓ (3)

5.2 5.2.1 $h_{loss} = \frac{\left(v_1 - v_2\right)^2}{2g}$
$= \frac{\left(6{,}9 - 3{,}5\right)^2}{19{,}62}$ ✓
$= 0{,}589\ m$ ✓ (2)

5.2.2 *Applying Bernoulli's theorem* :

$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2 + h_{loss}$
$\frac{\Delta P}{\rho g} = \frac{v_1^2 - v_2^2}{2g} - h_{loss}$
$= \frac{6{,}9^2 - 3{,}5^2}{19{,}62} - 0{,}589$ ✓
$= 1{,}213\ m$ ✓
$\Delta P = 9\,810 \times 1{,}213$ ✓
$= 11{,}902\ kPa$ (4)
[20]

VRAAG 6

6.1
$$\overset{0}{W} = \overset{0}{m}\,g = \frac{\rho V g}{t} = \rho g Q$$
$$\overset{0}{W} = \frac{9\,810 \times \pi \times 0{,}2^2 \times 4{,}5}{4} \checkmark$$
$$= 1389{,}856\ N/s \checkmark$$
(2)

6.2
$$Q_i = Q_o$$
$$A_i v_i = A_o v_o$$
$$v_o = \frac{d_i^2 v_i}{d_o^2} \checkmark$$
$$= \left(\frac{0{,}2}{0{,}15}\right)^2 \times 4{,}5 \checkmark$$
$$= 8\ m/s \checkmark$$
(3)

6.3
$$\frac{P_i}{\rho g} + \frac{v_i^2}{2g} + Z_i = \frac{P_o}{\rho g} + \frac{v_o^2}{2g} + Z_0 + h_{loss}$$
$$\frac{P_o}{\rho g} = \frac{P_i}{\rho g} + \frac{v_i^2}{2g} - \left(\frac{v_o^2}{2g} + h_{loss}\right) \checkmark$$
$$= \frac{70 \times 10^3}{9\,810} + \frac{4{,}5^2}{19{,}62} - \frac{8^2}{19{,}62} - 2 \checkmark$$
$$= 9\,810 \times 2{,}9057085 \checkmark$$
$$\therefore P_o = 28{,}505\ kPa$$
(4)

6.4

$$F_i = P_i A_i + \overset{0}{m} v_i$$

$$\overset{0}{m} = \rho Q = \rho A_i v_i = \rho A_o v_o$$

$$F_i = \left(70 \times 10^3 \times \frac{\pi \times 0{,}2^2}{4}\right) + \left(1\,000 \times \frac{\pi \times 0{,}2^2}{4} \times 4{,}5\right)$$

$$\therefore F_i = 2340{,}4865N$$

$$F_o = \left(28{,}507 \times 10^3 \times \frac{\pi \times 0{,}15^2}{4}\right) + \left(1\,000 \times \frac{\pi \times 0{,}15^2}{4} \times 8\right)$$

$$\therefore F_o = 645{,}0966N$$

Horizontal forces

$$F_h = F_i - F_o \cos\theta$$

$$= 2340{,}4865 - 645{,}0966\cos 40$$

$$= 1846{,}31383N$$

Vertical forces

$$F_v = F_i - F_o \cos\theta$$

$$= 645{,}0966\sin 65$$

$$= 414{,}6601N$$

Consider resul tan *t force*

$$F_r = \sqrt{F_v^2 + F_h^2}$$

$$= \sqrt{1846{,}31383^2 + 414{,}6601^2}$$

$$= 1892{,}30488N$$

$$\tan\beta = \frac{F_v}{F_h}$$

$$\beta = \tan^{-1}\left(\frac{414{,}6601}{1892{,}30488}\right)$$

$$\therefore \beta = 12{,}36^0$$

(11)
[20]

TOTAAL: 100

Kopiereg voorbehou