higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

FLUID MECHANICS N6

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This marking guideline consists of 6 pages.

QUESTION 1

1.1 1.1.1 $\rho = 1{,}1 \times 1000$√
$= 1\ 100\ kg/m^3$ √ (1)

1.1.2 $m = \frac{D}{4}$
$= \frac{0{,}152}{4}$✓
$= 0{,}038\ m$✓ (2)

1.1.3 The diameter 'x' of the biggest pipe if the total friction head in the

$hf_T = \left(\frac{flQ^2}{3d^5}\right)_1 + \left(\frac{flQ^2}{3d^5}\right)_2$ ✓

$20 = \frac{0{,}01\ x\ 8\ x\ 0{,}193^2}{3\ x\ 0{,}152^5}$ ✓ + $\frac{0{,}025\ x\ 10\ x\ 0{,}193^2}{3\ x^5}$ ✓

$x = 209{,}142\ mm$✓

OR

$V_1 = \frac{0{,}193\ x\ 4}{\pi\ x\ 0{,}152^2} = 10{,}636\ m/s$√

$V_2 = \frac{0{,}193\ x\ 4}{\pi\ x^2} = \frac{0{,}246}{x^2}$√

$hf_T = \left(\frac{4flv^2}{3gd}\right)_1 + \left(\frac{4flv^2}{2gd}\right)_2$

$20 = \frac{4\ x\ 0{,}01\ x\ 8\ x\ 10{,}636^2}{2\ x\ 9{,}81\ x\ 0{,}152}$ ✓ + $\frac{0{,}01\ x\ 10\ x\ (0{,}246/\ x^2)^2}{2\ x\ 9{,}81\ x}$ ✓

$x = 208{,}232\ mm$ ✓ (4)

1.1.4. $V_2 = \frac{0{,}193\ x\ 4}{\pi\ x\ 0{,}209142^2}$ **OR** $V_2 = \frac{0{,}193\ x\ 4}{\pi\ x\ 0{,}208232^2}$

$= 5{,}618\ m/s$✓ $= 5{,}667\ m/s$✓

$h_l = \frac{(v_1 - v_2)^2}{2g}$

$h_l = \frac{(10{,}636 - 5{,}618)^2}{2\ x\ 9{,}81}$✓ $h_l = \frac{(10{,}636 - 5{,}667)^2}{2\ x\ 9{,}81}$✓

OR

$= 1{,}283\ m$✓ $= 1{,}258\ m$✓ (3)

1.1.5. $\frac{Pr_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{Pr_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + \frac{(v_1 - v_2)^2}{2g}$✓

$\frac{Pr_1}{1100 \times 9,81} + \frac{10,636^2}{2 \times 9,81} = \frac{Pr_2}{1100 \times 9,81} + \frac{5,618^2}{2 \times 9,81} + 1,283$✓

$Pr_1 - Pr_2 = -31,015$ kPa✓

alternatively

$Pr_2 - Pr_1 = 31,015$ kPa✓

Alternatively

$\frac{Pr_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{Pr_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + \frac{(v_1 - v_2)^2}{2g}$✓

$\frac{Pr_1}{1100 \times 9,81} + \frac{10,636^2}{2 \times 9,81} = \frac{Pr_2}{1100 \times 9,81} + \frac{5,667^2}{2 \times 9,81} + 1,258$✓

$Pr_1 - Pr_2 = -30,979$ kPa✓

alternatively

$Pr_2 - Pr_1 = 30,979$ kPa✓ (3)

1.2 $\left(\frac{flQ^2}{3d^5}\right)_1 = \left(\frac{flQ^2}{3d^5}\right)_2$

$\left(\frac{0,01\ x\ Q^2}{(0,152)^5}\right)_1 = \left(\frac{0,025\ Q^2}{(0,209142)^5}\right)_2$ ✓

$Q_2 = 1,405\ Q_1$ .....(1) alternatively $Q_1 = 0,712\ Q_2$ .....(1)✓

$0,193 = 1,405\ Q_1 + Q_1$ alternatively $0,193 = 0,712\ Q_2 + Q_2$✓

$Q_1 = 0,0803$ m³/s✓

$Q_2 = 0,113$ m³/s✓ (5)

1.3 1.3.1 $h_f = \frac{4\ flv^2}{2gd}$

$= \frac{4\ x\ 0,03\ x\ 100\ x\ 2,1^2}{2\ x\ 9,81\ x\ 0,1}$ ✓

$= 26,972$ m ✓ (2)

1.3.2 $C = \sqrt{\frac{2g}{f}}$ $m = \frac{d}{4}$ $A = \frac{\pi}{4} d^2$

$= \sqrt{\frac{2\ x\ 9,81}{0,03}}$✓ $= \frac{0,1}{4}$✓ $= \frac{\pi}{4}(0,2)^2$ ✓

$= 25,573$✓ $= 0,025$ m $= 7,854 \times 10^{-3}$✓

$2,1 = 25,573 \sqrt{0,025 \text{ x i}}$✓

$i = 0,2697$

$\frac{h_f}{L}\surd = 0,2697$

$h_f = 26,972$ m✓ (7)

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QUESTION 2

2.1 $a_A = \frac{\pi \times (0,8)^2}{4}$ = 0,503 m²√ $S_A = \pi \times 0,8 \times 30$ = 75,398 m²√

$a_B = 0,9 \times 0,34$ = 0,306 m²√ $S_B = [2(0,9) + 2(0,34)] \times 25$ = 62 m²√

$\left(\frac{kSv^2}{a}\right)_A = \left(\frac{kSv^2}{a}\right)_B$

$\left(\frac{75,398 \times v^2}{0,503}\right)_A = \left(\frac{62\ x\ v^2}{0,306}\right)_B$ ✓

V_A = 1,162 V_B……(1)✓

10,9 = (1,162 v_B × 0,6362) + v_B x 0,306√

V_B = 12,244 m/s ✓

V_A = 14,231 m/s ✓

Q_A = 14,231 × 0,503 = 7,153 m³/s√

Q_B =12,244 × 0,306 = 3,747 m³/s✓ (8)

2.2. A = ½ πR² = 1,571 R² alternatively A = $\frac{1}{2}\left(\frac{\pi\ x\ D^2}{4}\right)$ = 0,393D²✓

P = ½(2πR) = 3,142 R alternatively P = ½(2πD) = 3,142D✓

m = $\frac{1,571R^2}{3.142R}$ = 0,5R alternatively m = $\frac{0,393D^2}{3.142D}$ = 0,25D✓

$i = \frac{3}{4000}$ = 7,5 × 10^{-4} ✓

Q = AC$\sqrt{mi}$

20 = 1,571 R² × 50$\sqrt{0,5\text{R x } 7,5 \text{ x } 10^{-4}}$

OR 20 = (0,393D² × 50)✓ $\sqrt{0,25\text{D x } 7,5 \text{ x } 10^{-4}}$ ✓

R = 2,803 m **OR** D = 5,605 m R = $\frac{5,605}{2}$ = 2,803 m✓ (7)

2.3 Q = $C_d \times \frac{8}{15}\sqrt{2g}\tan\frac{\theta}{2} H^{2,5}$✓

= 0,7 × $\frac{8}{15}$ x $\sqrt{2\ x\ 9,81}\tan\frac{90}{2}$ × $0,899^{2,5}$✓

= 1,267 m³/s✓ (3)

2.4 2.4.1 h = $\frac{P}{\rho g}$

= $\frac{480}{9,81}$√

= 48,93 m√

V = Cv$\sqrt{2gh}$

= 0,97$\sqrt{2\ x\ 9,81\ x\ 48,93}$✓

= 30,054 m/s✓ (3)

2.4.2 F = PA

= 480 × 10^3 × $\frac{\pi}{4}(0,04)^2$✓

= 603,186 N✓ (2)

2.4.3 Force on the bolt = (Preassure x Area of pipe) – (Force exerted by nozzle)

= 450 × 10^3 × $\frac{\pi}{4}(0,3)^2$ – 603,186✓

= 33,326 kN✓ (2)

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QUESTION 3

3.1 3.1.1 Q = va = ALSEN/60

$v = \left(\frac{0,13}{0,09}\right)^2 x\ 0,35\ x\ 1\ x\ 2\ x\ \frac{75}{60}$ ✓

= 1,826 m/s✓

$h_f = \frac{4\ flv^2}{2gd}$

$= \frac{4\ x\ 0,007\ x\ (80-4)\ x\ 1,826^2}{2\ x\ 9,81\ x\ 0,09}$ ✓

= 4,0165 m ✓

$H_{pre} = H_{at} + h_d + h_{fd}$✓

= 10,4 + 42 + 4,0165✓

= 56,417 m✓ (7)

3.1.2 $h_a = \frac{4}{9,81}\ x\left(\frac{0,13}{0,09}\right)^2 x\ \left(\frac{2\pi\ x\ 75}{60}\right)^2 x\ \frac{0,35}{2}$ ✓

= 9,184 m✓

$H_{pre} = H_{at} + h_d - h_a$

= 10,4 + 42 - 9,184✓

= 43,216 m✓ (4)

3.2 3.2.1 Q_{th} = ALSEN/60

$= \frac{\pi}{4}\ 0,15^2 \times 0,4 \times 3 \times 1\ x\ \frac{50}{60}$✓

= 0,01767 m^3/s✓

$\%\ slip = \frac{Q_{th} - Q_A}{Q_{th}} \times 100$

$5 = \frac{0,01767 - Q_A}{0,01767} \times 100$✓

Q_A = 0,0168 m^3/s✓ (4)

3.2.2 $P = \frac{\rho gQH}{\eta}$

$= \frac{10^3 x\ 9,81\ x\ 0,0168\ x\ 900}{0,92}$✓

= 161,109 kW✓ (2)

3.3 3.3.1 Q = a × V_{fo}

$0,15 = \frac{\pi}{4}\ x\ d^2 \times 2$✓

d = 309,019 mm✓

Q = a × V_{fo}

$0,15 = \frac{\pi}{4} \times d^2 \times 3$✓

d = 252,313 mm✓ (4)

3.3.2 $N = \frac{total\ head}{head/stage}$✓

$= \frac{400}{150}$✓

= 2,667 say 3 stages✓ (3)

3.3.3 $P = \frac{\rho g Q H_{total}}{\eta}$ ✓

$= \frac{10^3 x\ 9{,}81\ x\ 0{,}15\ x\ 400}{0{,}8}$ ✓

= 735,75 kW✓ (3)

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QUESTION 4

4.1 4.1.1 $V_1 = \frac{0{,}34 \text{ x } 4}{\pi\ x\ 0{,}3^2}$ ✓ = 4,81 m/s✓

$V_2 = \frac{0{,}34 \text{ x } 4}{\pi\ x\ {D_2}^2}$ ✓ $= \frac{0{,}433}{{D_2}^2}$ m/s ✓

$\frac{Pr_1}{\rho g} + \frac{v_1^2}{2g} + z_A - H_e = \frac{Pr_2}{\rho g} + \frac{v_2^2}{2g} + z_2$

$\frac{166}{9{,}81} + \frac{4{,}81^2}{2 \text{ x } 9{,}81} + 2 - 23$✓ $= \frac{-60}{9{,}81} + \frac{9{,}552\ x\ 10^{-3}}{{D_2}^4} + 0$✓

${D_2}^4 = 2{,}9592 \times 10^{-3}$

D = 233,431 mm✓ (7)

4.1.2 Power = ρgQH_e

$= 10^3 \times 9{,}81 \times 0{,}34 \times 23$✓

= 76,714 kW✓ (2)

4.2 4.2.1 $V_i = C_v\sqrt{2gh}$

$= 0{,}97\sqrt{2\ x\ 9{,}81\ x\ 400}$✓

= 85,931 m/s✓

For maximum efficiency

$U_i = 0{,}5\ V_i$

= (0,5 x 85,931) ✓

= 42,966 m/s✓

$N = \frac{60\ U_i}{\pi D}$

$= \frac{60\ x\ 42{,}966}{\pi\ x\ 1{,}6}$ ✓

= 512,864 r/min✓ (6)

4.2.2 $\eta = \frac{U}{gh}(V - U)(1 + n\text{Cos}\theta) \times 100\%$

$= \frac{42{,}966}{9{,}81\ x\ 400}(85{,}931 - 42{,}966)(1 + 0{,}85\text{Cos}14^0) \times 100\%$✓

= 85,845 %✓ (2)

4.2.3 Q = VA

$= 85{,}931 \times \frac{\pi}{4}(0{,}2)^2$✓

$= 2{,}6996\ m^3/s$✓

P_{out} = ρQU (V – U)(1 + nCosθ)

$= 10^3 \times 2{,}6996 \times 42{,}966\ (85{,}931 - 42{,}966)(1 + 0{,}85\text{Cos}14^0)$✓

= 9,094 MW✓ (4)

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TOTAL: 100