higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

FLUID MECHANICS N6

24 November 2022

This marking guideline consists of 7 pages.

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QUESTION 1

1.1 1.1.1 $h_f = \frac{4flv^2}{2gd}$

$8 = \frac{4 \times 0{,}01 \times 720\ x\ v^2}{2 \times 9{,}81 \times (1{,}2)^2}$ ✓

V = 2,557 m/s✓

Q = Va

$= 2{,}557 \times \frac{\pi}{4} (1{,}2)^2$

$= 2{,}892\ m^3/s$✓ (3)

1.1.2 $\frac{Pr_1}{\rho g} + \frac{v^2}{2g} + z_1 = \frac{Pr_2}{\rho g} + \frac{v^2}{2g} + z_2$

$\frac{101{,}3}{9{,}81} + 0 + 8$✓ $= 3 + \frac{P_{rB}}{9{,}81} + \frac{2{,}557^2}{2 \text{ x } 9{,}81} + 11$✓

P_{rB} = 68,6 kPa✓ (3)

1.2 $V_1 = \frac{0{,}05 \text{ x } 4}{\pi \text{ x } (0{,}3)^2} = 0{,}707$ m/s✓

$V_2 = \frac{0{,}05 \text{ x } 4}{\pi \text{ x } (0{,}1)^2} = 6{,}366$ m/s✓

$\frac{Pr_1}{\rho g} + \frac{v^2}{2g} + z_1 = \frac{Pr_2}{\rho g} + \frac{v^2}{2g} + z_2$

$\frac{P_{r1}}{9{,}81} + \frac{0{,}707^2}{2 \text{ x } 9{,}81} + 0$✓ $= \frac{P_{r2}}{9{,}81} + \frac{6{,}366^2}{2 \text{ x } 9{,}81} + 0$✓

$\Delta P = \left\{\frac{6{,}366^2 - 0{,}707^2}{2\ x\ 9{,}81}\right\} \times 9{,}81$✓

$= 20{,}013$ kPa✓ (6)

1.3 $H_{f1} = H_{f2}$

$(\frac{flQ^2}{3d^5})1 = (\frac{flQ^2}{3d^5})2 \quad \blacktriangleright \quad (\frac{Q^2}{d^5})1 = (\frac{Q^2}{d^5})2$✓

$\frac{0{,}088^2}{d^5} = \frac{Q^2}{(2d)^5}$✓

$Q_2 = 1678{,}094$ l/s✓

$(\frac{flQ^2}{3d^5})1 = (\frac{flQ^2}{3d^5})3 \quad \blacktriangleright \quad (\frac{Q^2}{d^5})1 = (\frac{Q^2}{d^5})3$✓

$\frac{0{,}088^2}{d^5} = \frac{Q^2}{(3d)^5}$✓

$Q_3 = 1371{,}784$ l/s✓ (6)

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1.4 1.4.1 $h_f = h_1 - h_2$
$= 10 - 4$
$= 6$ m✓ (1)

1.4.2 $i = \frac{h_f}{L}$
$= \frac{6}{2\,500}$✓

$= 2{,}4 \times 10^{-3}$✓ (2)

1.4.3 $m = \frac{d}{4}$
$= \frac{0{,}9}{4}$✓
$= 0{,}225$ m✓ (2)

1.4.4 $f = 0{,}005\left(1 + \frac{1}{40d}\right)$
$= 0{,}005\left(1 + \frac{1}{40 \times 0{,}9}\right)$✓
$= 0{,}00514$✓ (2)

1.4.5 $V = \sqrt{\frac{2gdh_f}{4fl}}$
$V = \sqrt{\frac{2 \times 9.81 \times 0{,}9 \times 5{,}5}{4 \times 0{,}00514 \times 2500}}$✓
$= 1{,}375$ m/s✓ (2)
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QUESTION 2

2.1 $Q = Cd\frac{8}{15}\sqrt{2g}\tan\frac{\theta}{2}H^{2,5}$✓

$\frac{860}{1\,000}$✓ $= 0{,}98 \times \frac{8}{15}\sqrt{2 \times 9{,}81}\tan\left(\frac{90}{2}\right)H^{2,5}$✓

$H = 0{,}673$ m

$= 672{,}9296$ mm✓ (4)

2.2 2.2.1 $V = \sqrt{\frac{gx^2}{2y}}$

$= \sqrt{\frac{9{,}81\ x\ 4{,}2^2}{2\ x\ 2}}$✓

$= 6{,}577$ m/s✓

$t = \frac{s}{V}$

$= \frac{4{,}2}{6{,}577}$✓

$= 0{,}639$ s✓ (4)

2.2.2 $V_A = C_v\sqrt{2gh}$

6,577 = 0,98 $\sqrt{2\ x\ 9{,}81\ x\ h}$✓

h = 2,296 m✓ (2)

2.2.3 Q_{th} = $\sqrt{2gh}$ x $\frac{\pi}{4}$ × d^2

= $\sqrt{2\ x\ 9{,}81\ \times\ 2{,}296}$✓ × $\frac{\pi}{4}$ × $(0{,}06)^2$✓

= 18,977 l/s✓ (3)

2.3 $S_A = wh\ \times\ L$
= 0,8 × 0,95 × 110
= 83,6 m^2✓

$S_B = \pi DL$
= π × 0,8 × 75
= 188,496 m^2✓

$a_A = L\ x\ B$
= 0,8 × 0,95
= 0,76 m^2✓

$a_B = \frac{\pi\ x\ 0{,}8^2}{4}$
= 0,503 m^2✓

$P_{rA} = P_{rB}$

$\frac{S_A \times v^2}{a_A} = \frac{S_B \times v^2}{a_B}$

$\frac{83{,}6 \times\ v^2}{0{,}76} = \frac{188{,}496\ \times v^2}{0{,}503}$

V_A = 1,846 V_B.....(1)

$Q_T = Q_A + Q_B$

$= V_A a_A + V_B a_B$

25 = 1,846 V_B × 0,76 + 0,503 V_B

V_B = 13,118 m/s✓

V_A = 24,216 m/s✓

Q_A = 13,118 × 0,76 = 9,97 m/s✓

Q_B = 24,216 × 0,503 = 12,181 m/s✓ (8)

[21]

QUESTION 3

3.1 3.1.1 $U = \frac{\pi DN}{60}$

$= \frac{\pi \ x \ 0,21 \ x \ 1500}{60}$✓

= 16,493 m/s✓ (2)

3.1.2 $Q = \frac{300}{3\,600}$ = 0,0833 m3/s✓

Q = πDwVo

$Vo = \frac{0,0833}{\pi \ x \ 0,21 \times 0,06}$✓

= 2,105 m/s✓ (3)

3.1.3 $\eta H = \frac{g \ H_t}{U \ V_{wo}}$

$= \frac{9,81 \times 10}{15,87 \times 0,85}$✓

Vwo = 6,997 m/s✓ (2)

3.1.4 $x = U_o - V_{wo}$
= 16,493 – 6,997
= 9,496 m/s✓

$Tan \ \beta = \frac{V_o}{x} = \frac{2,105}{9,496}$✓
β = 12,50✓ (3)

3.1.5 $P = \frac{\rho g Q H}{\eta}$

$= \frac{1000 \times 9,81 \times 0,0833 \ x \ 10}{0,82}$✓

= 9,969 kW✓ (2)

3.1.6 $N = \frac{60\sqrt{2ghs}}{\pi \ D_o}$

$= \frac{60\sqrt{2 \times 9,81 \ x \ 7}}{\pi \times 0,21}$✓

= 1065,812 r/min✓ (2)

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3.2 3.2.1 Q_{th} = ALSEN/60
= $\frac{\pi}{4}$ 0,15^2 × 0,4 × 3 × 1 × $\frac{50}{60}$✓

= 0,01767 m^3/s✓

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

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

Q_A = 0,0168 m^3/s✓ (4)

3.2.2 P = $\frac{\rho g Q H}{\eta}$

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

= 161,109 kW✓ (2)

3.3 3.3.1 Water hammer > When water was delivered through the delivery pipe during the delivery stroke and in the next delivery stroke the water already in the pipe collides with the other bulk during a new delivery stroke

3.3.2 Cavitation > When the pump is not pumping/running in a constant pattern due to the foreign particle entering the system.

3.3.3 Piston pump > The length of the piston is longer that it's stoke length (3 × 1)

(3)
[23]

QUESTION 4

4.1.1 h = 430 × 0,85 = 365,5✓

V = $C_v\sqrt{2gh}$

= 0,97$\sqrt{2\ x\ 9,81\ \times\ (430\ \times\ 0,85)}$✓

= 82,142 m/s✓ (3)

4.1.2. U = 0,5V
= 0,5 × 82,142 = 41,071 m/s✓

$U_i = \frac{\pi\ D\ N}{60}$
$41,071 = \frac{\pi\ D \times 500}{60}$✓

D = 1,569 m✓ (3)

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4.1.3. $P_{in} = \frac{P_{out}}{\eta}$

$= \frac{7\ x\ 10^6}{0,92}$✓

= 7,609 MW✓

$P = \rho g Q h$

$7,609 \times 10^6 = 1\ 000 \times 9,81 \times Q \times 365,5$✓

$Q = 2,122\ m^3/s$ for 3 jets✓

$Q = 0,7073\ m^3/s$ for 1 jet✓

$Q = V_i \times A$

$0,7073 = 82,142 \times \frac{\pi}{4} d^2$✓

d = 104,710 mm✓ (7)

4.1.4 $h_f = \frac{flQ^2}{3d^5}$

64,5✓ = $\frac{0,005 \times 3\ 000 \times 2,122^2}{3d^5}$✓

= 349,061 mm✓ (3)

4.2
- Outward flow (radial)
- Inward flow
- Parallel (axial) flow
- Mixed flow (4)

4.3 4.3.1 $V_i = \frac{Q}{A}$ =✓ = 1,267 m/s✓

$V_o = \frac{Q}{A} = \frac{0,358 \times 4}{\pi \times 1,2^2}$✓= 0,317 m/s✓

$z_1 + \frac{Pr_1}{\rho g} + \frac{Vi^2}{2g} - H_e = z_1 + \frac{Pr_2}{\rho g} + \frac{Vo^2}{2g}$

$2,4 + \frac{195 \times 10^3}{1\ 000 \times 9,81} + \frac{1,267^2}{2 \times 9,81} - H_e$✓ $= 0 + \frac{-27 \times 10^3}{1000 \times 9,81} + \frac{0,317^2}{2 \times 9,81}$✓

$H_e = 25,107$ m✓ (7)

4.3.2 $P = \rho g Q H_e$

= 1 000 × 9,81 × 0,358 × 25,107✓

= 88,174 kW✓ (2)

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TOTAL: 100

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