higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

FLUID MECHANICS N6

6 APRIL 2018

This marking guideline consists of 7 pages.

QUESTION 1

1.1 Uniform flow> The cross-sectional area and the velocity of the fluid is the same at each successive cross section.✓
Steady flow> The cross-sectional area and the velocity of the fluid vary from cross section to cross section.✓ (2)

1.2. 1.2.1 Same,✓ because they are running parallel.✓ (2)

1.2.2 Same,✓ because the quantity is independent of the cross-sectional area and the system from ① to ③ is continuous/The pipes are connected in series.✓ (2)

1.2.3 Differ,✓ because the cross-sectional areas/diameters differ.✓ (2)

1.2.4 $V = \frac{Q}{A}$
$= \frac{0,1254 \text{ x } 4}{\pi \text{ x } (0,9)^2}$✓
$= 0,197$ m/s ✓ (2)

1.2.5 $V = \frac{Q}{A}$
$= \frac{0,1254 \text{ x } 4}{\pi \text{ x } (0,22)^2}$✓
$= 3,299$ m/s✓ (2)

1.2.6 $f = 0,005\left(1 + \frac{1}{40d}\right) = 0,005\left(1 + \frac{1}{40(0,22)}\right) = 0,0056$✓

$h_f = \frac{flQ^2}{3d^5}$ OR $h_f = \frac{4flv^2}{2gd}$
$= \frac{0.0056 \text{ x } 11 \text{ x } (0,1254)^2}{3(0,22)^5}$✓ $= \frac{4 \text{ x } 0,0056 \text{ x } 11 \text{ x } (3,299)^2}{2 \text{ x } 9,81 \text{ x } 0,22}$✓
$= 0,623$ m✓ $= 0,618$ m✓ (3)

1.3 1.3.1 $C = \sqrt{\frac{2g}{f}}$
$= \sqrt{\frac{2 \, x \, 9.81}{0,007}}$✓
$= 52,942$ m^{½}/s✓ (2)

1.3.2 $m = \frac{d}{4} = \frac{0,5}{4}$ ✓ = 0,125 m✓

$Q = AC\sqrt{mi}$

$i = \frac{Q^2}{A^2 \times C^2 \times m}$

$= \frac{(1,249)^2}{\left[\frac{\pi}{4} x\ (0,5)^2\right]^2 x\ (52,942)^2 x\ 0,125}$ ✓

= 0,115✓

$h_f = i$ x L

= 0,115 x 1450✓

= 167,464 m✓

NB: Mark wrong if Darcy's formula is used. (6)

1.4 $V_1A_1 = V_2A_2$

$V_1 = \frac{0,084^2}{0,154^2} V_2 \Rightarrow V_1 = 0,298\ V_2$ .....(1)✓

$hf_1 = \frac{4fLv^2}{2gd}$

$= \frac{4 \times 0,008 \times 30 \times v^2}{2 \times 9,81 \times 0,154}$ ✓

$= 0,318v_1^2$ ✓

$hf_2 = \frac{4fLv^2}{2gd}$

$= \frac{4 \times 0,008 \times 40 \times v^2}{2 \times 9,81 \times 0,084}$ ✓

$= 0,777v_2^2$ ✓

$hf_T = hf_1 + hf_2$

$11 = 0,318v_1^2 + 0,777v_2^2$.....(2)✓

Substitute (1) in (2)

$11 = 0,318\ (0,298v_2)^2 + 0,777v_2^2$

V_2 = 3,697 m/s✓

$Q_2 = 3,697 \times \frac{\pi}{4}(0,084^2) = 0,021\ m^3/s$ (8)

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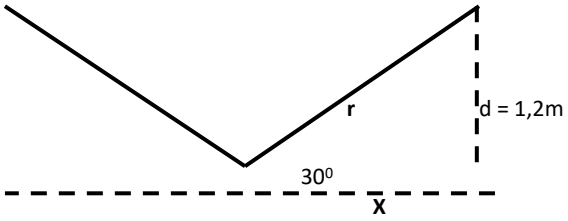
QUESTION 2

2.1 A small opening in the base or on the side of the reservoir. (1)

2.2



x = $\frac{1,2}{\tan 30}$ = 2,078 m✓
r = $\frac{1,2}{\sin 30}$ = 2,4 m✓

A = $\frac{1}{2}$ × (2 × 2,078) × 1,2✓ = 2,494 m²✓ OR A = L × B = 2,078 × 1,2✓
= 2,494 m²✓
P = 2(2,4) = 4,8 m✓
m = $\frac{A}{P}$ = $\frac{2,494}{4,8}$✓ = 0,520 m✓
C = $\frac{87}{1+\frac{k}{\sqrt{m}}}$
= $\frac{87}{1+\frac{0,276}{\sqrt{0,52}}}$✓ = 62,912✓
Q = AC $\sqrt{mi}$
i = $\frac{Q^2}{A^2\ x\ C^2\ x\ m}$

= $\frac{5,783^2}{2,494^2\ x\ 62,912^2\ x\ 0,52}$✓
= 0,00261✓
= 1 : 382,506✓ OR 1 in 382,506 (12)

2.3 Q = Cd × $\frac{8}{15}$ × $\sqrt{2g}$ × tan $\frac{\theta}{2}$ × $H^{2.5}$✓
0,145 = 0,6 × $\frac{8}{15}\sqrt{2\ x\ 9,81}$ × tan$\frac{90}{2}$ × H^{2,5}✓
H^{2,5} = 0,1023✓
H = 0,402 m
= 401,742 mm✓ (4)

2.4 $V_A = \sqrt{\frac{gx^2}{2y}}$ OR $V_A = Cv\sqrt{2\,g\,h}$

$= \sqrt{\frac{9{,}81\ x\ (5{,}3)^2}{2\ x\ 2{,}1}}$✓ $\sqrt{\frac{gx^2}{2y}} = Cv\sqrt{2\,g\,h}$✓

= 8,1 m/s ✓ $\sqrt{\frac{9{,}81\ x\ 5{,}3^{2}✓}{2\ x\ 2{,}1✓}} = 0{,}89\sqrt{2\ x\ 9{,}81\ x\ h}$✓✓

$V_{th} = \frac{V_A}{C_V}$ h = 4,222 m✓

$V_{th} = \frac{8{,}1}{0{,}89}$✓

= 9,101 m/s✓

$V_{th} = \sqrt{2\,g\,h}$

$9{,}101 = \sqrt{2\ x\ 9{,}81\ x\ h}$✓

h = 4,222 m✓ (6)

2.5 This is an opening in the side of the reservoir extending above the free surface✓ and is of any suitable geometrical form.✓ (2)
[25]

QUESTION 3

3.1 3.1.1 For 1 pump

$Q = \frac{22500}{1000\ x\ 3600}$✓ = 0,00625 m³/s ✓

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

$= \frac{10^3\ x\ 9{,}81\ x\ 0{,}00625\ x\ 335}{0{,}86}$✓

= 23,88 kW✓ (4)

3.1.2 Hf_1 = 335 – 320 = 15 m✓

$\frac{Hf_2}{Hf_1} = \left(\frac{Q_2}{Q_1}\right)^2$

$Hf_2 = 15\left(\frac{0{,}0125}{0{,}00625}\right)^2$✓ = 60✓

H = 320 + 60 = 380✓

$P = \frac{103\ x\ 9{,}81\ x\ 0{,}0125\ x\ 380}{0{,}86}$✓

= 54,183 kW✓ (6)

3.2 3.2.1 $H_m = \frac{P}{\rho g}$

$= \frac{285\ x\ 10^3}{10^3 x\ 9{,}81}$✓

= 29,052 m✓

3.2.2 $H_T = \frac{Hm}{\eta}$

$= \frac{29{,}052}{0{,}65}$✓

= 44,695 m✓

3.2.3 $U_O = \frac{\pi D N}{60}$
$= \frac{\pi \times 0,365 \times 1100}{60}$✓
$= 21,022$ m/s✓

3.2.4 $a = \pi D$ Width
$= \pi \times 0,365 \times 0,014$✓
$= 0,0161\ m^2$✓

3.2.5 $V_{fo} = \frac{Q}{a}$
$= \frac{0,0208}{0,0161}$✓
$= 1,298$ m/s✓

3.2.6 $V_{wo} = \frac{g\,H}{U_o \times \eta_m}$
$= \frac{9,81 \times 29,052}{21,022 \times 0,65}$✓
$= 20,857$ m/s✓

(6 × 2) (12)

3.3 3.3.1 $P_{in} = \frac{\rho g Q\, w.g}{\eta}$
$= \frac{1 \times 9,81 \times 550 \times 0,0484}{60 \times 0,78}$✓
$= 5,58$ W✓ (2)

3.3.2 $\frac{P_2}{P_1} = \left(\frac{N_2}{N_1}\right)^3$
$P_2 = \left(\frac{350}{500}\right)^3 \times 5,579$✓
$= 1,914$ W✓ (2)

3.3.3 If you decrease the fan speed the power decreases too. (1)
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QUESTION 4

4.1 4.1.1 $V = \sqrt{2gh}$
$= \sqrt{2 \times 9,81 \times 40,5}$✓
$= 28,189$ m/s✓ (2)

4.1.2 $U = \frac{\pi DN}{60}$
$= \frac{\pi \times 2,3 \times 145}{60}$✓
$= 17,462$ m/s✓ (2)

4.1.3 $E = \frac{U_i \, x \, (V_{wi} - V_{wo})}{g}$

$= \frac{17{,}462 \; x \; (20 - 5)}{9{,}81}$✓

= 26,7 m✓

$H = \frac{E}{H}$

$= \frac{26{,}7}{45} \times 100\ \%$✓

= 59,334%✓ (4)

4.2 4.2.1 $V = Cv\sqrt{2gh}$

$= 0{,}98\sqrt{2 \; x \; 9{,}81 \; x \; 289}$✓

= 73,795 m/s✓ (2)

4.2.2 Q = V A

$A = \left(\frac{7660}{3600} \div 3\right) \div 73{,}795 = 0{,}00961\ m^2$✓

$\frac{\pi D^2}{4} = 0{,}00961$

D = 110,623 mm✓ (2)

4.2.3 $Hf = \frac{flQ^2}{3d^5}$

$d = \sqrt[5]{\frac{0{,}007 \; x \; 1500 \; x \; 2{,}128^2}{3 \; x \; 51}}$✓

= 791,535 mm✓ (2)

4.2.4 $\eta = \frac{U}{gh}(V - U)[1 + n\text{Cos}(180° - y) \times 100\%$

$U = \frac{\pi DN}{60}$ $n = \frac{100 - 9}{100} = 0{,}91$

$= \frac{\pi \; x \; 1{,}8 \; x \; 350}{60}$

= 32,987 m/s✓

$= \frac{32{,}897}{9{,}81 \; x \; 289}(73{,}795 - 32{,}987)[1 + 0{,}91\text{Cos}(180^0 - 162) \times 100\%$✓

= 88,573%✓ (3)

[17]

TOTAL: 100