



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE
AUGUST EXAMINATION
POWER MACHINES N5

5 Augusts 2014

This marking guideline consists of ⁹ ~~8~~ pages.

Dmcm

8/8/2014

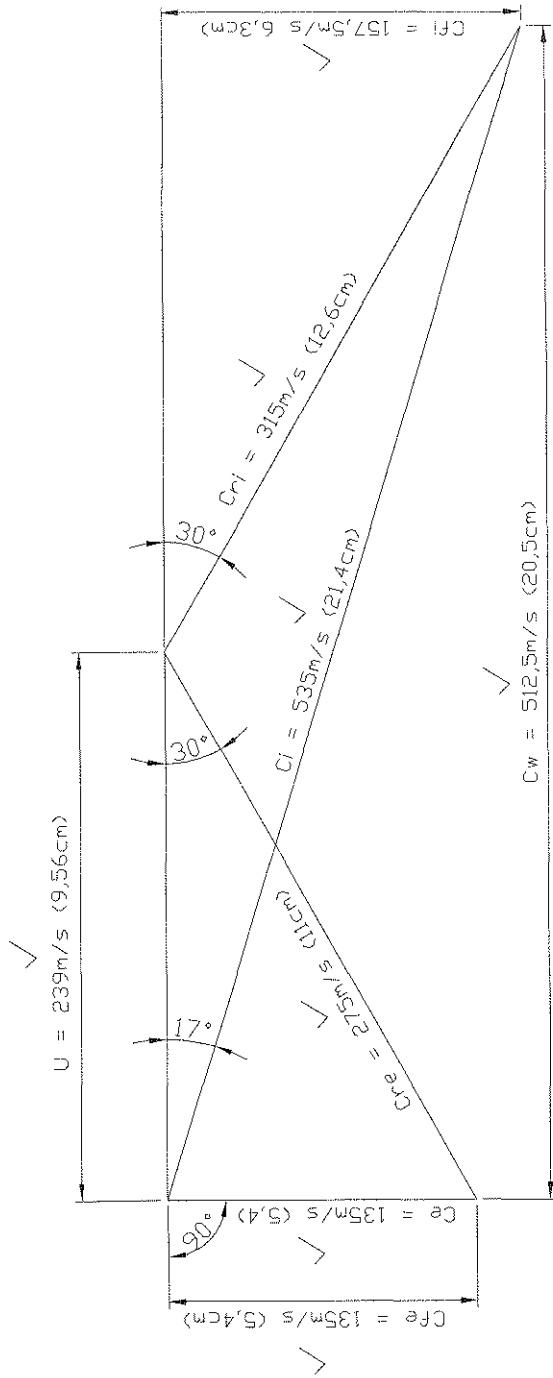
Duseya 08/08/14

QUESTION 1

1.1 1.1.1 $U = \frac{\pi DN}{60}$ ✓
 $U = \frac{\pi \times 0,96 \times 4755}{60}$ ✓
 $U = \boxed{239 \text{ m/s}}$ ✓

(3)

1.1.2



TOLERANCE = $\pm 30 \text{ m/s}$ (8)

$$1.1.3 \quad A \quad 17^\circ (16,8^\circ - 17,2^\circ) \quad \checkmark \quad (1)$$

$$\begin{aligned}
 B \quad P &= MUC_w \quad \checkmark \\
 M &= \frac{P}{U \times C_w} \quad \checkmark \\
 &= \frac{100 \times 10^3}{239 \times 512,5} \quad \checkmark \\
 &= \boxed{0,816 \text{ kg/s}} \quad \checkmark
 \end{aligned} \quad (3)$$

$$\begin{aligned}
 C \quad \eta &= \frac{2 \times U \times V_w}{V_i^2} \times \frac{100}{1} \quad \checkmark \\
 &= \frac{2 \times 239 \times 512,5}{535^2} \times \frac{100}{1} \quad \checkmark \\
 &= 85,6\% \quad \checkmark
 \end{aligned} \quad (3)$$

TOLERANCE = $\pm 3\%$

$$1.2 \quad V_{su} = 0,7108 \text{ m}^3 / \text{kg} \quad \checkmark$$

$$h_{su} = 3484 \text{ kJ/kg} \quad \checkmark \quad (2)$$

[20]

QUESTION 2

2.1

$$\begin{aligned}
 2.1.1 \quad h_{wet} &= M(hf + xhfg) \quad \checkmark \\
 &= 2\{634 + (0,927 \times 2112)\} \quad \checkmark \\
 &= 5183,648 \text{ kJ} \quad \checkmark
 \end{aligned} \quad (3)$$

$$\begin{aligned}
 2.1.2 \quad h_{sup} &= hg + C_p(t_{su} - t_s) \quad \checkmark \\
 &= 2790 + 2,1(396 - 198,3) \quad \checkmark \\
 &= 3205,17 \text{ kJ/kg} \quad \checkmark
 \end{aligned} \quad (3)$$

$$\begin{aligned}
 2.1.3 \quad h_{wet} &= hf + xhfg \\
 x &= \frac{h_{wet} - hf}{hfg} \quad \checkmark \\
 &= \frac{2650 - 815}{1971} \quad \checkmark \\
 &= 0,93 \quad \checkmark
 \end{aligned} \quad (3)$$

$$\begin{aligned}
 2.1.4 \quad h_{dry} &= M\{(hf + hfg) - hf_w\} \quad \checkmark & h_{dry} &= M(hg - hf_w) \quad \checkmark \\
 &= 2,3\{(763 + 2014) - 130\} \quad \checkmark & \text{or} &= 2,3(2777 - 130) \quad \checkmark \\
 &= 6088,1 \text{ kJ} \quad \checkmark & &= 6088,1 \text{ kJ} \quad \checkmark
 \end{aligned}
 \tag{3}$$

2.2 Barrel Calorimeter \checkmark

Separating Calorimeter \checkmark

Throttling Calorimeter \checkmark

Combined Separating and Throttling Calorimeter (Any 3 x 1) (3)

$$2.3 \quad h_1 = 121 \text{ kJ / kg} \quad \checkmark$$

$$\begin{aligned}
 h_2 &= hf + xhfg \\
 &= 721 + (0,905 \times 2047) \\
 &= 2573,535 \text{ kJ / kg} \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \eta &= \frac{M_s(h_2 - h_1)}{mf \times Cv} \times \frac{100}{1} \quad \checkmark \\
 &= \frac{5600(2573,535 - 121)}{11 \times 60 \times 35 \times 10^3} \times \frac{100}{1} \quad \checkmark \\
 &= \boxed{59,455\%} \quad \checkmark
 \end{aligned}$$

(5)
[20]

QUESTION 3

$$3.1 \quad x = 12 \quad y$$

$$= 4$$



$$[(12 \times 12) + (4 \times 1)] + 13(2 \times 16) = 12[12 + (2 \times 16)] + 2[(2 \times 1) + 16] \quad \checkmark$$

$$(144 + 4) + 416 = 528 + 36 \quad \checkmark$$

$$(\div 148): \quad 1 + 3,685 = 2,966 + 1,719 \quad \checkmark$$

$$148 \quad 1 + 2,811 = 3,568 + 0,243 \quad \checkmark$$

$$\therefore \text{Theoretical mass of air reqd.} = 2,811 \times \frac{100}{23} \quad \checkmark$$

$$= \boxed{12,22 \text{ kg / kg of fuel}} \quad \checkmark$$

(8)

$$3.2 \quad \therefore \text{Actual mass of air reqd.} = 12,22 \times 1,4 \quad \checkmark$$

$$= \boxed{17,11 \text{ kg / kg of fuel}} \quad \checkmark$$

(2)

3.3 Products of Combustion

$$CO_2 = 3,568 \text{ kg} \quad \checkmark$$

$$H_2 O = 0,243 \text{ kg} \quad \checkmark$$

$$O_2 = 2,811 \times \frac{40}{100} \quad \checkmark$$

$$= 1,1244 \text{ kg} \quad \checkmark$$

$$N_2 = 17,11 \times \frac{77}{100} \quad \checkmark$$

$$= 13,175 \text{ kg} \quad \checkmark$$

(6)

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3.4	$CO_2 = 3,568kg$	$=$	$\frac{3,568}{18,11} \times \frac{100}{1} =$	$19,7\%$	✓
	$H_2O = 0,243kg$	$=$	$\frac{0,243}{18,11} \times \frac{100}{1} =$	$1,34\%$	✓
	$O_2 = 1,1244kg$	$=$	$\frac{1,1244}{18,11} \times \frac{100}{1} =$	$6,21\%$	✓
	$N_2 = 13,175kg$	$=$	$\frac{13,175}{18,11} \times \frac{100}{1} =$	$72,761\%$	✓
	$18,11kg$				✓

(4)
[20]

QUESTION 4

Given:

$M = 56,4 \text{ m}^3/\text{hour}$

$PV^{1,35} = C$

Bore to Stroke Ratio = 1,6:1

$P_1 = 103 \text{ kPa}$

$P_2 = 900 \text{ kPa}$

$\eta_{mech} = 88\%$

$T_1 = 295K$

$N = 350 \text{ r/min}$

$\eta_{motor} = 90\%$

$$\begin{aligned}
 4.1 \quad P &= \frac{n}{n-1} \times P_1 V_1 \left\{ \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right\} && \checkmark \\
 &= \frac{1,35}{1,35-1} \times 103 \times \frac{56,4}{3600} \left\{ \left(\frac{900}{103} \right)^{\frac{1,35-1}{1,35}} - 1 \right\} && \checkmark \\
 &= \boxed{4,694 \text{ kW}} && \checkmark
 \end{aligned}$$

(4)

$$\begin{aligned}
 4.2 \quad Vol / cycle &= \frac{Vol / min}{N} \quad \checkmark \\
 &= \frac{56,4}{60} \times \frac{1}{350} \quad \checkmark \\
 &= 0,002686 m^3 \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 Vol / cycle &= \frac{\pi \times D^2}{4} \times L \quad \checkmark \\
 &= \frac{\pi \times D^2}{4} \times 1,6D \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 D &= \sqrt[3]{\frac{Vol \times 4}{\pi \times 1,6}} \\
 &= \sqrt[3]{\frac{0,002686 \times 4}{\pi \times 1,6}} \quad \checkmark \\
 &= 0,1288 m \quad \checkmark \\
 &= \boxed{128,8 mm} \quad \checkmark
 \end{aligned}$$

(8)

$$\begin{aligned}
 4.3 \quad Stroke &= 1,6 \times D \quad \checkmark \\
 &= 1,6 \times 128,8 \\
 &= \boxed{206,08 mm} \quad \checkmark
 \end{aligned}$$

(2)

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4.4

$$\eta_{mech} = \frac{\text{Indicated Power}}{\text{Shaft Power}} \quad \checkmark$$

$$\text{Shaft Power} = \frac{\text{Indicated Power}}{\eta_{mech}} \quad \checkmark$$

$$= \frac{4,694}{0,88} \quad \checkmark$$

$$= 5,334 \text{ kW} \quad \checkmark$$

$$\eta_{motor} = \frac{\text{Shaft Power}}{\text{Input Power}} \quad \checkmark$$

$$\text{Input Power} = \frac{\text{Shaft Power}}{\eta_{motor}} \quad \checkmark$$

$$= \frac{5,334}{0,9} \quad \checkmark$$

$$= 5,93 \text{ kW}$$

$$\therefore \text{Power rating of motor reqd.} = \boxed{5,93 \text{ kW} \quad \text{or} \quad 6 \text{ kW}} \quad \checkmark \quad (6)$$

[20]

QUESTION 5

5.1 The reciprocating compressor \checkmark The rotary compressor \checkmark (2)5.2 Boyle's law states that at constant temperature, the pressure and volume of a certain mass of gas are inversely proportional. \checkmark (4)5.3 Charles' law states that during the change of state of any gas in which the mass and pressure remain constant, the volume varies in proportion with the Absolute temperature. \checkmark (5)

5.4

Given:

$$m = 3,3 \text{ kg}$$

$$C_v = 0,718 \text{ kJ/kg.K}$$

$$T_1 = 294 \text{ K}$$

$$T_2 = 410 \text{ K}$$

$$V_1 = 0,87 \text{ m}^3$$

$$R = 0,289 \text{ kJ/kg.K}$$

$$\begin{aligned} 5.4.1 \quad Q &= \Delta U + W \quad \checkmark \\ &= M \times C_v (T_2 - T_1) + 0 \quad \checkmark \\ &= 3,3 \times 0,718 (410 - 294) \quad \checkmark \\ &= \boxed{274,85 \text{ kJ}} \quad \checkmark \end{aligned}$$

(3)

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5.4.2

$$P_1 V_1 = MRT_1 \quad \checkmark$$

$$P_1 = \frac{MRT_1}{V_1} \quad \checkmark$$

$$= \frac{3,3 \times 0,289 \times 294}{0,87} \quad \checkmark$$

$$= 322,285 \text{ kPa} \quad \checkmark$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad \checkmark$$

$$P_2 = \frac{P_1 T_2}{T_1} \quad \checkmark$$

$$= \frac{322,285 \times 410}{294} \quad \checkmark$$

$$= 449,445 \text{ kPa} \quad \checkmark$$

(6)
[20]

AN ALTERNATIVE METHOD

$$P_2 V_2 = mRT_2 \dots\dots\dots (P_2) \quad \checkmark$$

$$P_2 = mRT_2 / V_2 \quad \checkmark \quad \checkmark$$

$$= 3,3 \times 0,289 \times 410 / 0,87 \quad \checkmark$$

$$= 449,445 \text{ kPa} \quad \checkmark$$

(6)

TOTAL: 100