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 8 pages.

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QUESTION 1

1.1 1.1.1

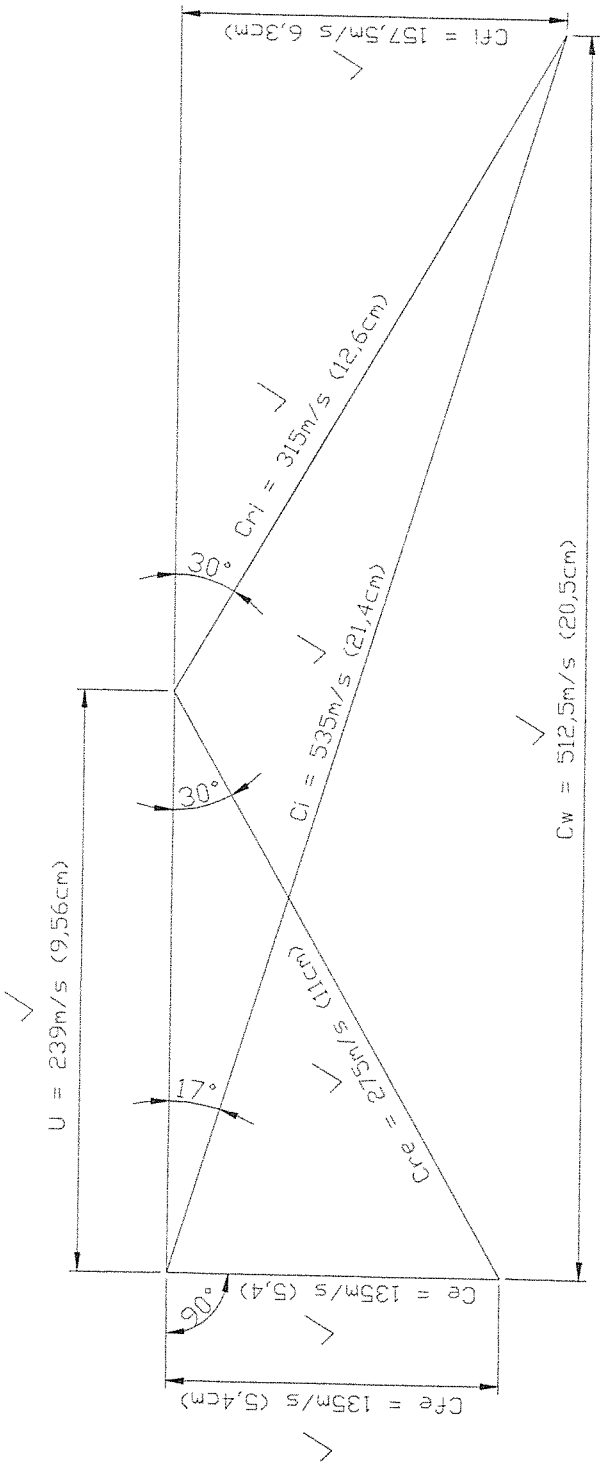
$$U = \frac{\pi DN}{60} \quad \checkmark$$

$$U = \frac{\pi \times 0{,}96 \times 4755}{60} \quad \checkmark$$

$$U = \boxed{239\ m/s} \quad \checkmark$$

(3)

1.1.2



(8)

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1.1.3 A 17° ✓ (1)

B $P = MUCw$

$M = \frac{P}{U \times Cw}$ ✓

$= \frac{100 \times 10^{3}}{239 \times 512.5}$ ✓

$= \boxed{0{,}816\ kg/s}$ ✓ (3)

C $\eta = \frac{2 \times U \times V_{w}}{V_{1}^{2}} \times \frac{100}{1}$ ✓

$= \frac{2 \times 239 \times 512{,}5}{535^{2}} \times \frac{100}{1}$ ✓

$= 85{,}6\,\%$ ✓ (3)

1.2 $V_{su} = 0{,}7108\ m^{3}/kg$ ✓

$h_{su} = 3484\ kJ/kg$ ✓ (2)

[20]

QUESTION 2

2.1

2.1.1 $h_{wet} = M(hf + xhfg)$ ✓

$= 2\{634 + (0{,}927 \times 2112)\}$ ✓

$= 5183{,}648\ kJ$ ✓ (3)

2.1.2 $h_{sup} = hg + C_{p}(t_{su} - t_{s})$ ✓

$= 2790 + 2{,}1(396 - 198{,}3)$ ✓

$= 3205{,}17\ kJ/kg$ ✓ (3)

2.1.3 $h_{wet} = hf + xhfg$

$x = \frac{h_{wet} - hf}{hfg}$ ✓

$= \frac{2650 - 815}{1971}$ ✓

$= 0{,}93$ ✓ (3)

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2.1.4 $h_{dry} = M\{(hf + hfg) - hf_w\}$ ✓ $= 2,3\{(763 + 2014) - 130\}$ ✓ $= 6088,1\,kJ$ ✓

or $h_{dry} = M(hg - hf_w)$ ✓ $= 2,3(2777 - 130$ ✓ $= 6088,1\,kJ$ ✓

(3)

2.2 Barrel Calorimeter ✓

Separating Calorimeter ✓

Throttling Calorimeter ✓

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

2.3 $h_1 = 121\,kJ/kg$ ✓

$h_2 = hf + xhfg$

$= 721 + (0,905 \times 2047)$

$= 2573,535\,kJ/kg$ ✓

$\eta = \frac{M_s(h_2 - h_1)}{mf \times Cv} \times \frac{100}{1}$ ✓

$= \frac{5600(2573,535 - 121)}{11 \times 60 \times 35 \times 10^3} \times \frac{100}{1}$ ✓

$= \boxed{59,455\%}$ ✓

(5)
[20]

QUESTION 3

3.1 $x = 12$ $y = 4$

$C_xH_y + \left(x + \frac{y}{4}\right)O_2 = xCO_2 + \frac{y}{2}H_2O$ ✓

$C_{12}H_4 + \left(12 + \frac{4}{4}\right)O_2 = 12CO_2 + \frac{34}{2}H_2O$ ✓

$C_{12}H_4 + 13O_2 = 12CO_2 + 2H_2O$ ✓

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

$(144 + 4) + 416 = 528 + 36$

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

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

$\therefore$ *Theoritical mass of air reqd.* $= 2,811 \times \frac{100}{23}$ ✓

$= \boxed{12,22\,kg/kg\ of\ fuel}$ ✓ (8)

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3.2 $\therefore$ *Actual mass of air reqd.* $= 12,22 \times 1,4$ ✓

$= \boxed{17,11\,kg\,/\,kg\ of\ fuel}$ ✓

(2)

3.3 Pr*oducts of Combustion*

$CO_2 = 3,568\,kg$ ✓

$H_2O = 0,243\,kg$ ✓

$O_2 = 2,811 \times \frac{40}{100}$ ✓

$= 11244\,kg$ ✓

$N_2 = 17,11 \times \frac{77}{100}$ ✓

$= 13,175kg$ ✓

(6)

3.4

$CO_2 = 3,568kg = \frac{3,568}{18,11} \times \frac{100}{1} = 19,7\,\%$ ✓

$H_2O = 0,243\,kg = \frac{0,243}{23,429} \times \frac{100}{1} = 1,34\,\%$ ✓

$O_2 = 1,1244kg = \frac{1,1244}{18,11} \times \frac{100}{1} = 6,21\,\%$ ✓

$N_2 = 13,175\,kg = \frac{13,175}{23,429} \times \frac{100}{1} = 73,71\,\%$ ✓

$\boxed{18,11\,kg}$

(4)
[20]

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QUESTION 4

Given:

M = 56,4 m^3/hour
$PV^{1,35}$ = C
Bore to Stroke Ratio = 1,6:1

P_1 = 103 kPa
P_2 = 900 kPa
$\eta_{mech} = 88\%$

T_1 = 295K
N = 350 r/min
$\eta_{motor} = 90\%$

4.1

$$P = \frac{n}{n-1} \times P_1 V_1 \left\{ \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right\} \quad \checkmark \quad \checkmark$$

$$= \frac{1,35}{1,35-1} \times 103 \times \frac{56,4}{3600} \left\{ \left(\frac{900}{103} \right)^{\frac{1,35-1}{1,35}} - 1 \right\} \quad \checkmark$$

$$= \boxed{4,694\,kW} \quad \checkmark$$

(4)

4.2

$$Vol/cycle = \frac{Vol/\min}{N} \quad \checkmark$$

$$= \frac{56,4}{60} \times \frac{1}{350} \quad \checkmark$$

$$= 0,002686\,m^3 \quad \checkmark$$

$$Vol/cycle = \frac{\pi \times D^2}{4} \times L \quad \checkmark$$

$$= \frac{\pi \times D^2}{4} \times 1,6D \quad \checkmark$$

$$D = \sqrt[3]{\frac{Vol \times 4}{\pi \times 1,6}}$$

$$= \sqrt[3]{\frac{0,002686 \times 4}{\pi \times 1,6}} \quad \checkmark$$

$$= 0,1288\,m \quad \checkmark$$

$$= \boxed{128,8\,mm} \quad \checkmark$$

(8)

4.3

$$Stroke = 1,6 \times D \quad \checkmark$$

$$= 1,6 \times 128,8$$

$$= \boxed{206,08\,mm} \quad \checkmark$$

(2)

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4.4

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

$$ShaftPower = \frac{Indicated\ Power}{\eta_{mech}}$$

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

$$= 5,334\,kW \quad \checkmark$$

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

$$InputPower = \frac{Shaft\ Power}{\eta_{motor}}$$

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

$$= 5,93\,kW$$

$\therefore$ *Power rating of motor reqd.* = 5,93 kW or 6 kW ✓ (6)

[20]

QUESTION 5

5.1 The reciprocating compressor ✓

The rotary compressor ✓ (2)

5.2 Boyle's law states that at constant ✓ temperature, the ✓ pressure and ✓ volume of a certain mass of gas are inversely proportional. ✓ (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. ✓ (5)

5.4 Given:

m = 3,3 kg T_1 = 294 K V_1 = 0,87 m^3

C_v = 0,718 kJ/kg.K T_2 = 410 K R = 0,289 kJ/kg.K

5.4.1 $Q = \Delta U + W$

$= M \times C_v(T_2 - T_1) + 0$ ✓

$= 3,3 \times 0,718(410 - 294)$ ✓

$= \boxed{274,85kJ}$ ✓ (3)

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5.4.2 $P_1V_1 = MRT_1$

$P_1 = \frac{MRT_1}{V_1}$ ✓

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

$= 322,285\,kPa$ ✓

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ ✓

$P_2 = \frac{P_1T_2}{T_1}$

$= \frac{322,285 \times 410}{294}$ ✓

$= 449,445\,kPa$ ✓ (6)
[20]

TOTAL: 100

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