higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NASIENRIGLYN

NASIONALE SERTIFIKAAT

KRAGMASJIENE N6

1 Desember 2022

Hierdie nasienriglyn bestaan uit 7 bladsye.

Kopiereg voorbehou

VRAAG 1

1.1 Dit beteken dat die temperatuur ná kompressie✓ daal tot wat dit voor kompressie was.✓ (2)

1.2 1.2.1

$$r_p = \sqrt{\frac{r_{del}}{p_1}} = \sqrt{\frac{9p_1}{p_1}} = 3$$

$$T_2 = T_1\left(r_{p1}\right)^{\frac{n-1}{n}} ✓ = 288(3)^{\frac{0,3}{1,3}} ✓ = 371,106\ K ✓$$

$$T_4 = T_2 = 371,106\ K ✓$$ (4)

1.2.2

$$P_{out} = x\left[\frac{n}{n-1} mRT_1\left(r_p{}^{\frac{n-1}{n}} - 1\right)\right] ✓ \text{ (geen punt vir 'n PLUS} - \text{teken)}$$

$$= 2\left[\frac{1,3\times4,5\times0,287\times288}{0,3}\left(3^{\frac{0,3}{1,3}} - 1\right)\right] ✓$$

$$= 930,1999 \times \frac{1}{60}$$

$$= 15,503\ kW ✓$$ (3)

1.2.3

$$p_1 v_{ind1} = mRT_1 ✓ \Longrightarrow v_{ind1} = \frac{4,5\times0,287\times288}{101,3} = 3,672\ {}^{m^3}/_{min} ✓$$

$$v_s = v_1 - v_c \Longrightarrow v_1 = 1,05v_s ✓\ en$$

$$v_4 = v_c \times r_p{}^{\frac{1}{n}} = 0,05v_s \times 3^{\frac{1}{1,3}} = 0,1164289v_s ✓$$

$$v_{ind} = v_1 - v_4 = 1,05v_s - 0,1164289v_s$$

$$v_s = \frac{3,672}{300(1,05-0,1164089)} ✓ = 13,11 \times 10^{-13} m^3 ✓$$ (6)

1.2.4

$$\eta_{vol} = 1 - \frac{v_c}{v_s}\left[r_p{}^{\frac{1}{n}} - 1\right] ✓ = 1 - 0,05\left[3^{\frac{1}{1,3}} - 1\right] = 0,934 ✓$$

$$p_3 v_3 = mRT_3 \Longrightarrow v_3 = \frac{4,5 \times 0,287 \times 288}{3 \times 101,3 \times 300} = 4,08 \times 10^{-3} m^3 ✓$$

$$\eta_{vol} = \frac{v_{ind}}{v_s} ✓ \Longrightarrow v_s = \frac{4,08\times10^{-3}}{0,934} = 4,37 \times 10^{-3} m^3 ✓$$ (5)

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VRAAG 2

2.1 Werklike droogheidsbreuk is die werklike/ware numeriese meting van hoe naby die stoom aan versadiging is.✓ Isentropiese droogheidsbreuk is die droogheidsbreuk wat stoom✓ sou gehad het as sy entropie nie verander het nie.✓ (3)

2.2 2.2.1

$$h_c = h_f + xh_{fg} = 640 + 0{,}96 \times 2107\checkmark = 2662{,}72\ {}^{kJ}/_{kg}\ \checkmark$$

$$h_1 = h_g = 2773\ {}^{kJ}/_{kg}\ \checkmark$$

$$C_c = \sqrt{2000(h_1 - h_c)\checkmark} = \sqrt{2000(2773 - 2662{,}72)} = 469{,}64\ m/s\ \checkmark$$

$$v_c = x_c v_g\checkmark = 0{,}96 \times 0{,}3747\checkmark = 0{,}3597\ {}^{m^3}/_{kg}\ \checkmark$$ (8)

2.2.2

$$h_2 = h_f + x_{2a}h_{fg} = 584 + 0{,}945\checkmark \times 2147 = 2612{,}915\ {}^{kJ}/_{kg}\ \checkmark$$

$$H_2 = mh_2 = 0{,}645 \times 2612{,}915\checkmark = 1685{,}33\ kJ\checkmark$$

$$h_{2s} = h_f + x_{2s}h_{fg} = 584 + 0{,}929\checkmark \times 2147 = 2578{,}563\ {}^{kJ}/_{kg}\ \checkmark$$

$$H_{2s} = mh_{2s} = 0{,}645 \times 2578{,}563 = 1663{,}173\ kJ\checkmark$$

$$\eta_{noz} = \frac{h_1 - h_2}{h_1 - h_{2s}}\checkmark = \frac{2773 - 2612{,}915}{2773 - 2578{,}563} = 0{,}8233\checkmark$$ (9)

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VRAAG 3

3.1 Om die rigting/hoek✓ van stoom/gas/vloeistof te verander✓ as dit vanaf eerste na tweede fase✓ van looplemme vloei (3)

3.2 Verwys na FIGUUR 1 (op laaste bladsy)

Let wel:

i. Elke diagram tel maksimum VYF punte.
ii. Punte word toegeken spesifiek volgens die regmerke (kandidate se opdrag was om alle lengtes en hoeke te toon).
iii. GEEN punt as gegewe lengte nie in centimeter is nie.

Nasiener moet diskresie gebruik vir verskillende lengtes en hoeke. (10)

3.2.1 $\beta = 26°$ (1)

3.2.2 $F_{ax} = m(C_{f1} - C_{f2})$✓ $= 2{,}1[40(5{,}5 - 4{,}7)]$✓ $= 67{,}2N$✓ (3)

3.2.3 $$\eta_{dia} = \frac{2U(\Delta V_w)}{V_1{}^2}$✓ $= \frac{2 \times 117{,}8097(1040 + 424)}{700^2}$✓ $= 70{,}4\%$✓ (3)

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VRAAG 4

4.1 In 'n termodinamiese siklus is die som van die netto hitte✓ toegevoeg tot die stelsels en die netwerktoevoer✓ is nul.✓ (3)

4.2 4.2.1 $h_1 = 101\ {}^{kJ}/_{kg}$✓; $h_2 = 351\ kJ/kg$✓

$$Q_{eco} = \frac{m_s}{m_f}(h_2 - h_1)$✓ $\Rightarrow \frac{m_s}{m_f} = \frac{2100}{351 - 101} = 8{,}4\ {}^{kg_s}/_{kg_f}\ of\ 8{,}4$✓ (4)$$

4.2.2 $h_4 = h_g + c_p(t_{sup} - t_s) = 2802 + 3{,}1125(305 - 242{,}5)$✓

$= 2996{,}53\ {}^{kJ}/_{kg}$✓

$$\eta_{plant} = \frac{m_s}{m_f} \times \frac{(h_4 - h_1)}{CV} = \frac{8{,}4(2996{,}53 - 101)}{32000}$✓ $= 76{,}01\%$✓ (4)$$

4.2.3 $h_3 = h_g + xh_{fg}$

$= 1050 + 0{,}9787 \times 1752$✓

$= 2764{,}68\ {}^{kJ}/_{kg}$✓

$Q_{evap} = \frac{m_s}{m_f}(h_3 - h_2) = 8{,}4(2764{,}68 - 351) = 20274{,}93\ {}^{kJ}/_{kg}$✓

$Q_{sup} = \frac{m_s}{m_f}(h_4 - h_3) = 8{,}4(2996{,}53 - 27764{,}68) = 1947{,}54\ {}^{kJ}/_{kg}$✓

$Q_{aph} = m_a c_{pa}(t_{out} - t_{in})$

$= 18 \times 1{,}005(119 - 25)$✓

$= 1700{,}46\ {}^{kJ}/_{kg}$✓ (6)

4.2.4 $Q_{chim} = m_g c_{pg}(t_{out} - t_{in})$

$= 19 \times 1{,}07(177{,}09 - 25)$✓

$= 3091{,}99\ {}^{kJ}/_{kg}$ ✓

$\% = \frac{Q_{chim}}{CV} = \frac{3091{,}99}{32000} \times 100 = 9{,}66\%$✓ (3)

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VRAAG 5

5.1 Geïndikeerde termiese rendement is slegs teoreties✓ en meet hoe goed die brandstofenergie na geïndikeerde lewering omskakel is. Termiese remrendement is werklike✓ rendement en meet die hoeveelheid termiese brandstofenergie wat na meganiese arbeid of vermoë omskakel word.✓ (3)

5.2 5.2.1 $P_b = 0{,}5p_b \times AlNn$✓

$en\ Al = \frac{\pi}{4} \times 0{,}212^2 \times 0{,}292 = 10{,}3073 \times 10^{-3} m^3$

$\therefore P_b = \frac{0{,}5\times593\times10{,}3073\times10^{-3}\times720\times4✓}{60✓} = 146{,}689\ kW$✓ (4)

5.2.2 $sfc_b = \frac{m}{P_b}$✓ $\Longrightarrow m = 0{,}226 \times 146{,}689$✓ $= 33{,}152\ kg/h$✓ (3)

5.2.3 $\eta_{BT} = \frac{P_b}{m\times CV}$✓ $= \frac{146{,}689\times3600}{33{,}152\times44200}$✓ $= 36{,}039\%$✓ (3)

5.2.4 $v_s = 10{,}3073 \times 10^{-3} m^3\ (from\ 5.2.1)$

$v_{sTOT} = 4 \times 0{,}5 \times 10{,}3073 \times 10^{-3} = 20{,}615 \times 10^{-3}$

$en\ vloeitempo, v_s = 720 \times 20{,}615 \times 10^{-3} = 14{,}843\ {}^{m^3}/_{min}$ ✓

$m_{ind} = r_{AF} \times m$✓ $= 25 \times 33{,}154 = 828{,}85\ kg/h$✓

$pv_{ind} = m_{ind}RT$✓ $\Longrightarrow v_{ind} = \frac{828{,}85 \times 0{,}287 \times 288}{101{,}1 \times 60}$

$= 11{,}294\ {}^{m^3}/_{min}$ ✓

$\eta_{vol} = \frac{v_{ind}}{v_s}$✓ $= \frac{11{,}294}{14{,}843} = 0{,}761$✓ (7)

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VRAAG 6

6.1 $T_{2s} = T_1\left(\frac{p_2}{p_1}\right)^{\frac{\gamma-1}{\gamma}} = 293\left(\frac{550}{95}\right)^{\frac{1,4-1}{1,4}}$ ✓ $= 483,91\ K$✓

$\eta_{ci} = \frac{T_{2s}-T_1}{T_2-T_1} \Longrightarrow T_2 = 293 + \frac{483,91-293}{0,83}$ ✓ $= 523,012\ K$✓ (4)

6.2 $T_4 = T_3\left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}} = 1143\left(\frac{95}{550}\text{✓}\right)^{\frac{1,4-1}{1,4}} = 692,07\ K$✓

$\eta_{Ti} = \frac{T_3 - T_4}{T_3 - T_{4s}}$ ✓ $\Longrightarrow T_4 = 1143 - 0,8(1143 - 692,07) = 782,256\ K$✓ (4)

6.3 $P_{com} = mc_p(T_2 - T_1)$✓ $= 10 \times 1,03(523,012 - 293) = 2369,12\ kW$✓

$P_{turb} = mc_p(T_2 - T_1) = 10 \times 1,03(1143 - 782,26) = 3715,62\ kW$✓

$P_{net} = P_{turb} - P_{comp}$✓ $= 3715,62 - 2369,12 = 1346,502\ kW$✓ (5)

6.4 $Q_{in} = mc_p(T_3 - T_2) = 10 \times 1,03(1143 - 550)$✓ $= 6107,9\ kJ/s$✓

$\eta_{therm} = \frac{P_{net}}{Q_{in}}$ ✓ $= \frac{1346,502}{6107,9} = 22,045\%$✓ (4)

6.5 $R_{work} = \frac{P_{net}}{P_{turb}}$ ✓ $= \frac{1346,502}{3715,62}$ ✓ $= 0,36239$✓ (3)

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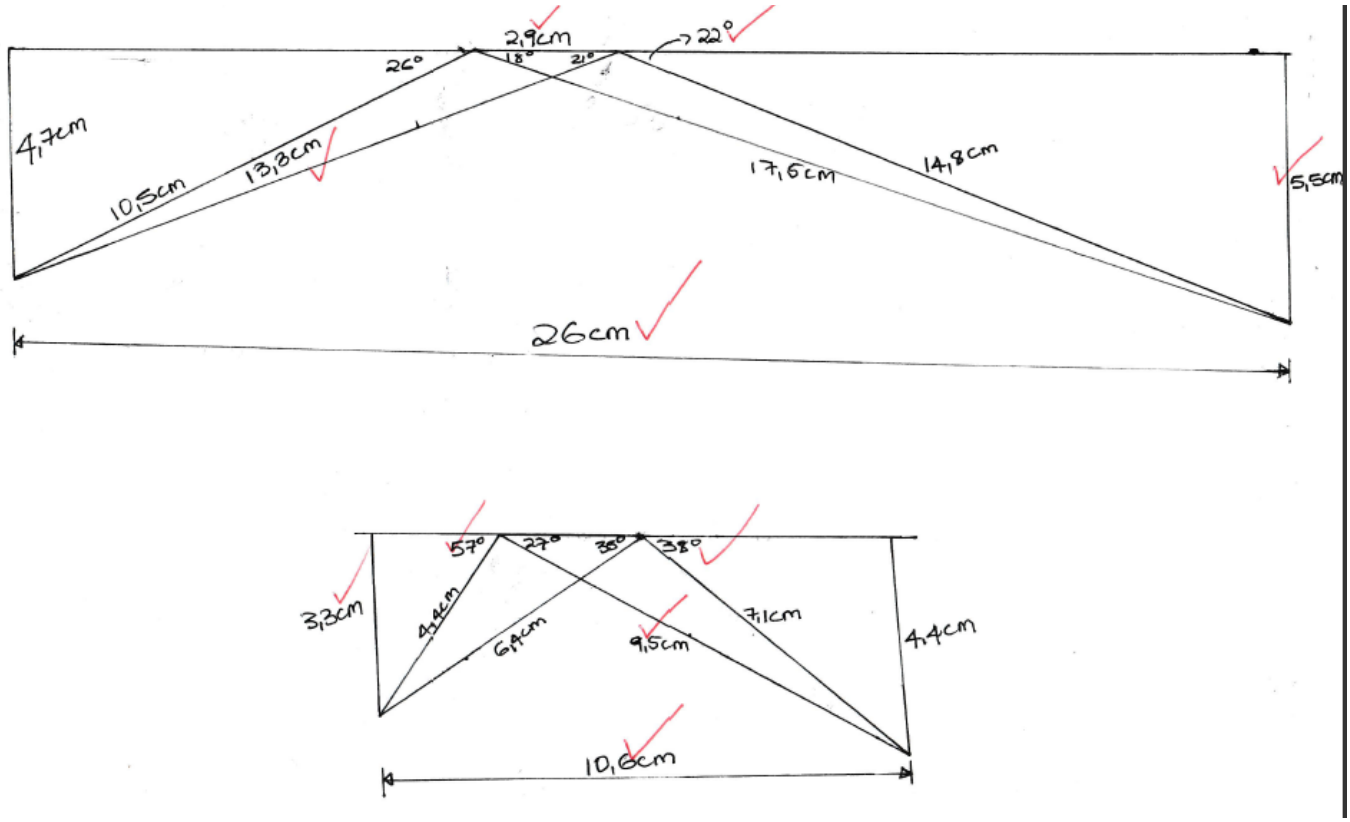
TOTAAL: 100



FIGUUR 1

Kopiereg voorbehou