

12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.

AYRES

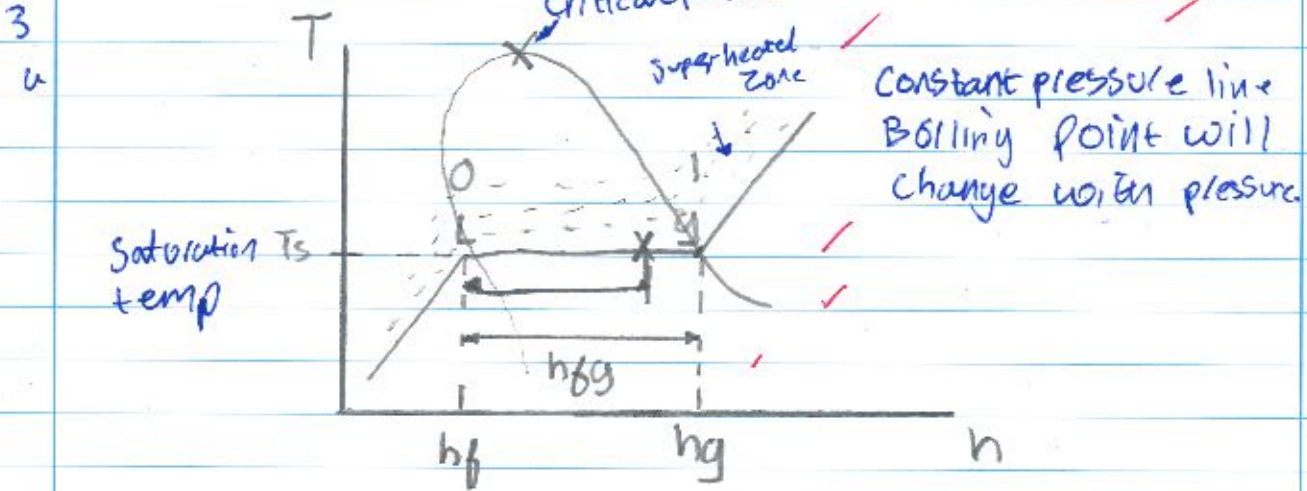
FORENAME(S):

Joshua Leighton

1	Student Number	161315
2	Title of Examination Paper	Thermo 2
3	Module Code	SGDM 5012
4	Date and Time of Examination	Fri 17/12/20 930 1130
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)



(5)

$x = \text{dryness ratio } 0-1$

$h_f = \text{enthalpy for fluid}$

$h_g = \text{enthalpy for gas}$

$h_{fg} = \text{ratio}$

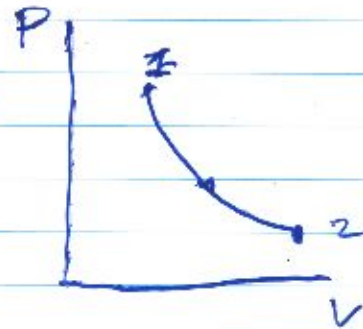
b $P_1 = 30 \text{ bar}$

$T_1 = 350^\circ\text{C}$

$V = 0.16 \text{ m}^3$

$P_2 = 6 \text{ bar}$

$PV^{1.3} = C$



i mass of steam

$PV = mRt$

w.p $\frac{P_1 V_1 - P_2 V_2}{n-1}$

$v_g @ 30 \text{ bar } 350^\circ\text{C} = 0.0405 \text{ m}^3/\text{kg}$

$P_1 V_1^n = P_2 V_2^n$

$m = \frac{\text{Volume}}{\text{Specific Volume}} = \frac{0.16}{0.0405} = 1.77 \text{ kg}$

(5)

$$W_D = \frac{P_1 V_1 - P_2 V_2}{n-1} \quad ?$$

~~$$W_D = 0.3156 \text{ m}^3/\text{kg}$$~~

$$P_1 V_1^n - P_2 V_2^n$$

$$30 \times 10^5 \times 0.0405^{1.3} = 6 \times 10^5 \times V_2^{1.3}$$

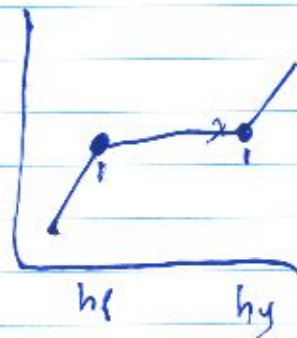
$$132057.9 = 6 \times 10^5 \times V_2^{1.3}$$

$$\frac{132057.9}{6 \times 10^5} = V_2^{1.3}$$

$$\sqrt[1.3]{0.22} = V_2 = 0.31 \text{ m}^3/\text{kg}$$

$x=?$

$h_f + x h_{fg}$



$$W_D = \frac{P_1 V_1 - P_2 V_2}{n-1}$$

$$\frac{30 \times 10^5 \times 0.0405 - 6 \times 10^5 \times 0.31}{1.3 - 1} = 285000 \text{ W}$$

4

$$\begin{aligned} T &= 220 \text{ Nm} \\ W &= 2500 \text{ RPM} \\ \phi &= 110 \text{ mm} \\ L &= 100 \text{ mm} \\ A/F &= 14/1 \\ Sfc &= 0.364 \\ 1.01 \text{ bar} \\ T &= 15^\circ\text{C} \rightarrow 288 \text{ K} \\ CV &= 44,200 \\ R &= 0.287 \text{ kJ/kgK} \quad 287 \end{aligned}$$

$$\frac{110}{m_f \times 44200 \times 10^3}$$

i Brake thermal efficiency

$$\begin{aligned} BP &= TW \\ &= 220 \times 2500 \times \frac{2\pi}{60} = 57545.86 \text{ W} \end{aligned}$$

5

$$\eta = \frac{BP}{m_f \times CV} = \frac{57.5}{m_f \times 44200 \times 10^3}$$

?

$$m_f = Sfc \times CV = \frac{0.364 \times 44200}{1000} = 16.088 \text{ kg}$$

$$\frac{B.P}{m_f \times CV} = \frac{57.5}{16.088 \times 44200 \times 10^3} = 8.08 \times 10^{-8}$$

$$\frac{57.5}{16.088 \times 44200 \times 10^3} \times 100 = 8.08 \times 10^{-8} \%$$

6

Volumetric efficiency

$$= \frac{\text{Induced}}{\text{Swept}}$$

$$\text{mass of fuel} = \frac{16.088}{3600} = 0.0044 \text{ kg/s}$$

$$P_v = m r t$$

$$V = \frac{m r t}{P}$$

$$V = \frac{0.0044 \times 287 \times 288}{1.01 \times 10^5} = 0.0036 \text{ kg/s}$$

$$\text{combined } 0.044 + (0.0036 \times 14) = 0.0944 \text{ kg/s}$$

$$\text{Per cylinder} = \frac{0.0944}{4} = 0.0236 \text{ kg/s}$$

$$\text{Swept} = 0.14 \times 4 \times \pi \times$$

$$\text{Swept} = (\pi \times 0.05^2) \times 0.1 \times \left(\frac{2500}{2 \times 60} \right) = 0.0147 \text{ kg/s}$$

$$\therefore \frac{0.0236}{0.0147} \times 100 = 119.79\%$$

~~119.79%~~

2

b) 60 bar

$$T_1 = 1400^\circ\text{C}$$

$$P_2 = 1 \text{ bar}$$

$$\text{dryness} = 0.94$$

$$\dot{m} = 10 \text{ kg/s}$$

$$P = \dot{m} w$$

$$h_1 - h_2 = w$$

$$h_1 = 3180 \text{ kJ/kg}$$

$$h_2 = 2540 \text{ kJ/kg}$$

$$w = 3180 - 2540 = 640 \text{ kJ/kg}$$

$$P = 10 \times 640 = 6400 \text{ kW}$$

(5)

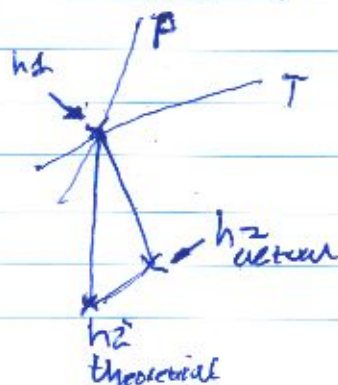
Isentropic efficiency

$$= \frac{h_1 - h_2}{h_1 - h_2'} = \frac{3180 - 2540}{3180 - 2380} = 0.8$$

$$\times 100 = 80\%$$

(5)

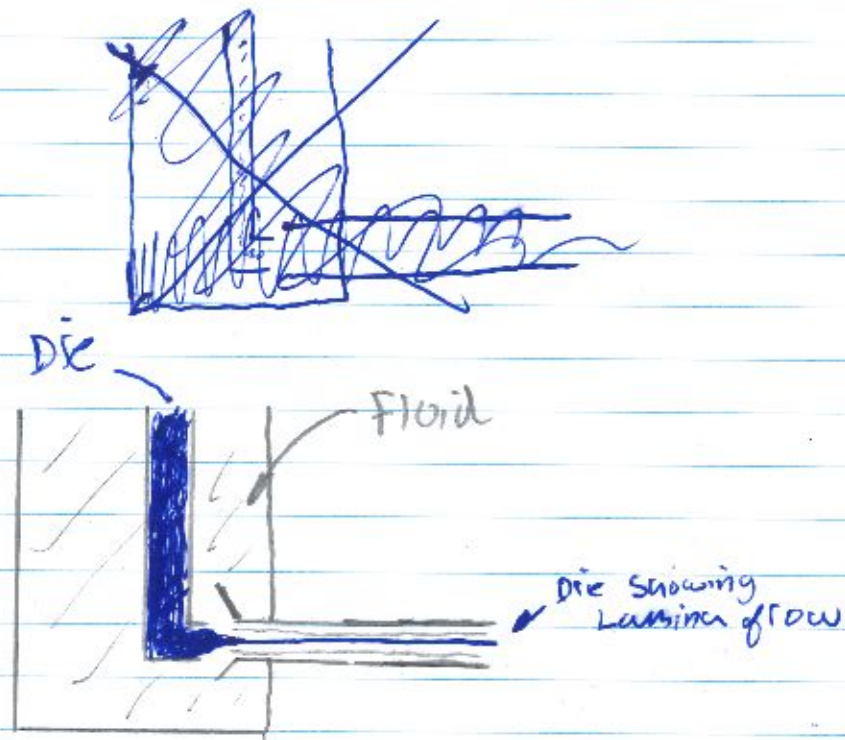
Isentropic efficiency is the efficiency of the turbine by using an actual entropy gain over an idealised cycle with no gain.



(4)

2

- D A testing rig was used with a die to observe the flow of fluid through a tube whilst changing the velocity



the velocity of fluid was changed and observed to find critical points

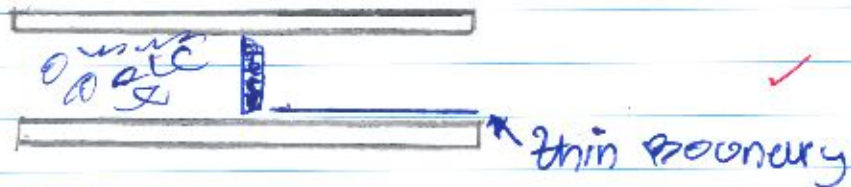
Laminar flow



$Re < 2000$

thick Boundary layer where the velocity equals 99% of max

turbulent flow



$Re > 4000$

an Re between the two points is known as the transitional period.

lower is laminar and upper is turbulent flow

$$Re = \frac{\rho v d}{\mu}$$

where

ρ = density

v = velocity

d = ϕ of pipe

μ = dynamic viscosity

it was found that reducing velocity back would restore laminar flow.

turbulent flow would start approximately $30 \times \phi$ from inlet.

it applies to fluids ~~liquids~~ and gases

it is not restricted to just circular tubes

