



Complete, fold and seal
(see note 2 below)

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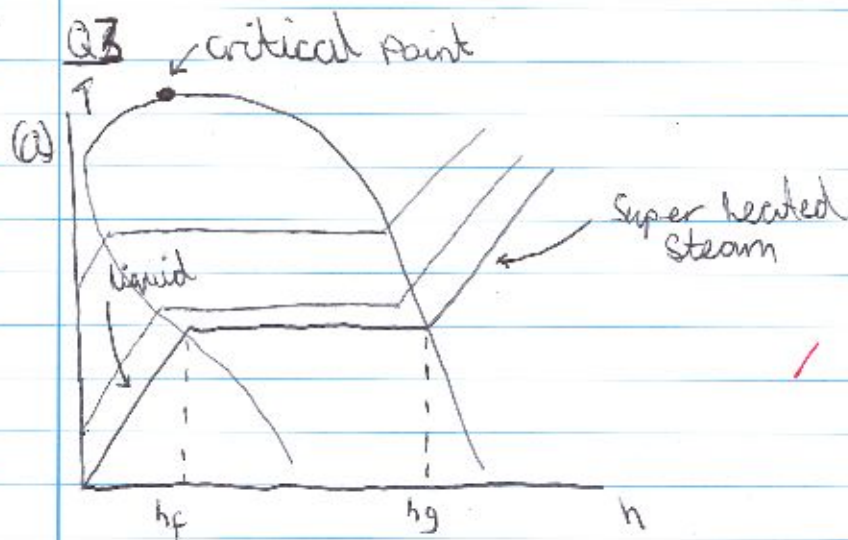
Instructions to Candidates

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.**

1	Student Number	160548
2	Title of Examination Paper	THERMO 2
3	Module Code	SGTDM 5012
4	Date and Time of Examination	
5	Examination Venue	
6	Seat Number	
7	Number of Answer Books handed in	

[illegible]

(Gweler yr ochr arall am y fersiwn Cymraeg)



(3)

As the liquid is heated up the temperature and enthalpy rise ~~at a~~ at a steady rate until they reach a certain temperature at this temperature ~~it~~ it starts to transition into ~~an~~ steam. The heat energy that goes into the liquid at this point is used to transition the fluid between the 2 states and is called latent heat. The points h_f and h_g differ between different pressures. It takes less time to transition as the pressure rises until it reaches a point where it just flashes straight to ~~an~~ steam. In the latent stage the fluid is evaporating with a dryness fraction. After that stage it is super heated steam.

(2)

(b) $P_1 = 30 \text{ bar}$ $P_2 = 6 \text{ bar}$ $PV^{1.3} = C$

$T_1 = 350 \text{ bar}$

$V_1 = 0.16 \text{ m}^3$

$V_1 = 0.0905 \text{ m}^3/\text{kg}$

(i) $\text{mass} = \frac{V}{V_1} = \frac{0.16}{0.0905} = 1.77 \text{ Kg}$

(5)

(ii) ~~xxxxxx~~ $P_1 V_1^{1.3} = P_2 V_2^{1.3}$
 $= (30 \times 10^5) \times (0.0905)^{1.3} = 6 \times 10^5 \times (V_2)^{1.3}$
 $= \frac{132057.9}{6 \times 10^5} = V_2^{1.3}$

$\sqrt[1.3]{0.22} = V_2 = 0.312 \text{ m}^3/\text{kg}$

$$W.D = \frac{P_1 V_1 - P_2 V_2}{1.3 - 1}$$

$$W.D = \frac{(30 \times 10^5 \times 0.0905) - (6 \times 10^5 \times 0.312)}{0.3}$$

$$W.D = 281 \text{ kW}$$

$$(ii) x_2 = \frac{V_2}{V_g} = \frac{0.312}{0.3156} = 0.99 \text{ dry}$$

Q4

$$T = 220 \text{ Nm} \quad N = 2500 \text{ rpm}$$

$$A/F = 14/1 \quad SFC = 0.36 \text{ kg/kWh}$$

$$P = 1.01 \text{ bar} \quad T_c = 15^\circ \text{C} \quad C_v = 44.200 \text{ kJ/kg} \quad L = 100 \text{ mm}$$

$$(i) \eta_{\text{bth}} = \frac{B.P.}{F.P.} = \frac{57.6}{926.6} \times 100 = 6.2\%$$

$$B.P. = T W$$

$$= 220 \times (2500 \times \frac{2\pi}{60})$$

$$= 57595.87 \text{ W or } 57.6 \text{ kW}$$

$$\frac{0.364}{3600} = 0.0001$$

$$5.76$$

$$F.P. = m_f \times C_v$$

$$F.P. = 20924 \times 44.200$$

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$$m_f = SFC \times B.P.$$

$$= 0.364 \times 57595.87$$

$$= 20924 \times 44.200$$

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$$(ii) \eta_{\text{vol}} = \frac{\text{actual induced vol}}{\text{swept vol}}$$

Q4

Total induced vol $\rightarrow$ ~~258.36 W~~

$$F.P = m_f \times C_v$$

$$\frac{372}{0.0058} \times 14.200$$

$$258.36 \text{ W}$$

$$m_f = \text{sfc} \times \text{B.P}$$

$$\frac{0.364}{3600} \times \frac{5759.87}{1000}$$

$$= 0.0058 \text{ Kg/s}$$

$$(ii) \text{ } Z_{\text{vol}} = \frac{\text{total induced vol}}{\text{swept vol}}$$

$$\begin{aligned} \text{Swept vol} &= A_{\text{cyl}} \times h_{\text{cyl}} \times N \\ &= (\pi \times (0.055)^2) \times 0.1 \times \left(\frac{2500}{60 \times 2}\right) \\ &= 0.198 \text{ m}^3/\text{s} \end{aligned}$$

Total induced vol = vol of fuel + vol of Air

~~or~~

$$PV = mRT$$

$$V = \frac{mRT}{P}$$

$$V = \frac{0.0058 \times 287 \times 288}{1.01 \times 10^5}$$

$$V = 4.75 \times 10^{-3} \text{ so } 0.0048 \text{ m}^3/\text{s}$$

$$AF = 14:1 \therefore 0.0048 \times 15 = 0.072 = \text{total mass induced}$$

$$Z_{\text{vol}} = 0.072$$

Q5

$$(i) \dot{Q} = C \times A$$

$$C = \frac{\dot{Q}}{A}$$

$$C_{0.004} = \frac{0.004}{\pi \times (0.05^2)} = 0.509 \text{ m}^3/\text{s}$$

$$C_{0.008} = 1.019 \text{ m}^3/\text{s}$$

$$C_{0.012} = 1.528 \text{ m}^3/\text{s}$$

$$C_{0.014} = 1.783 \text{ m}^3/\text{s}$$

Primary losses 0.004

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

$$Re = \frac{1000 \times 0.509 \times 0.1}{0.001136} = 44806$$

~~ecf~~ turbulent

$$h_f = \frac{K f L v^2}{2 g d}$$

$$= \frac{4 \times 0.0065 \times 30 \times (0.509^2)}{2 \times 9.81 \times 0.1}$$

$$h_f = 0.103 \text{ m}$$

$$\frac{K}{d} = \frac{0.15}{100}$$

$$= 1.5 \times 10^{-3}$$

$$= 0.0015$$

$$f = 0.0065$$

secondary losses 0.004

$$h_f = \sum K \left(\frac{v^2}{2g} \right)$$

$$= [(3 \times 0.2) + (4 \times 0.9) + 1.5] \left(\frac{v^2}{2g} \right)$$

$$= 5.7 \times \left(\frac{v^2}{2g} \right)$$

$$= 5.7 \times \left(\frac{0.004^2}{2 \times 9.81} \right)$$

$$= 4.65 \times 10^{-6} \text{ m}$$

①

②

②

③

④

⑤

Total losses 0.004

$$4.65 \times 10^{-6} + 0.103 = 0.103 \text{ m}$$

Total losses 0.008

$$\frac{h_1}{h_2} = \frac{Q_1^2}{Q_2^2}$$

$$h_2 = \frac{h_1 \times Q_2^2}{Q_1^2}$$

$$= \frac{0.103 \times (0.008^2)}{0.004^2}$$

$$h_2 = 0.412 \text{ m}$$

Total losses 0.012

$$h_2 = 0.927 \text{ m}$$

Total losses 0.014

$$h_2 = 1.262 \text{ m}$$

$$\frac{100}{1000} = 0.001$$

$$C_1 = \frac{0.001}{\pi \times (0.05)^2} = 0.088$$

$$C_2 = \frac{0.088}{\pi \times (0.05)^2} = 0.127$$

Examiner Only

Q2

$$Q = CA$$

$$C = \frac{Q}{A}$$

$$(a) \frac{P_1}{\rho g} + \frac{C_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{C_2^2}{2g} + Z_2 + h_f$$

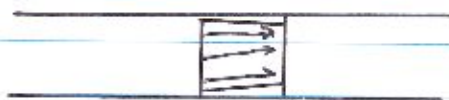
$$\frac{4 \times 10^5}{900 \times 9.81} + \frac{0.088^2}{2 \times 9.81} + 0 = \frac{P_2}{900} + \frac{0.127^2}{2 \times 9.81} + 12 + 1.2$$

$$45.3 + 3.95 \times 10^{-4} = \frac{P_2}{900} + 8.22 \times 10^{-4} + 13.2$$

$$45.3 = \frac{P_2}{900} + 13.2$$

$$(45.3 - 13.2) \times (900 \times 9.81) = P_2 = 283410.9 \text{ or } 2.83 \text{ bar}$$

(b) Reynolds carried out a test where he introduced a dye into water flowing through a pipe. By doing this he could see the type of flow. There are 2 types of flow which are laminar and turbulent. Turbulent flow has a velocity profile that looks like this:



And laminar looks like this:



The type of flow depends on, viscosity, density, velocity and diameter of the pipe. Reynolds created an equation to describe this.

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

The number you get from this is called the Reynolds number and is used to determine the type of flow. If it is under 2000 it is laminar. If it's over 4000 it's turbulent. If it's between it's in transition.