Notre Dame University. Department of Mechanical Engineering
Test #1-MEN210 (Thermodynamic I) *Closed book:50 minutes*
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Problem#1

Nitrogen enters a 0.1 diameter sprue to cool the molten metal during casting. It enters at 270 K and 101 kPa, and discharge at 280K and 106kPa. The rate of the volume at the exit is 0.12 m^3/s. Find the mass in kg/s at the inlet. Is this mass the same at the outlet? Explain. R = 0.2968 kj/kg. K

Problem#2

Ammonia at 4 atm and 50^0C is confined to an insulated solid rigid container that is divided by partition. One side is totally evacuated. Upon mixing the gas expands and fills the whole container. Find the final pressure in the container. Initial volume and final volume are 0.1 and 0.3 m^3.

Problem#3

a) If the thermometer outside reads 62^0F, what is the temperature in ^{0}C, in K? What does 0 K corresponds to?
b) Two identical houses on a hot day. The first house is naturally ventilated and the temperature inside is 85^0F and the second house is closed up and air conditioner keeps the inside temperature at 75^0F. Which house will have the greater amount of heat conduction into the house?
c) To reduce heat absorption from the sun, it is wise to paint the exterior of the house a light color with a low value of emissivity. What about the inside of the house? Explain if the color makes any difference?

Problem#4

a) Explain the process of water on a P-V and T-V diagrams in different states. Which P-T diagram should be used to trace the three phases of water at different pressure and temperature. Explain
b) What is the work in a polytropic process at n = 1. Show.
c) The specific volume of water at 200^0C is 0.22 m^3/kg. 0.2 is greater than v_g in the saturated table. Where do we go to find the pressure? If at 200^0C one pressure is 800kPa for 0.26 specific volume, and one is 1000 kPa at 0.205 specific volume, what is the final pressure?

Good Luck

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Zouk Mosbeh - Lebanon

Grade : 92

Name :

I.D. N° :

Course N°: MEN210 Section :

Date : 9-3-06

Problem 1

$PV_{air} = m_{air} R T$

$m_i = \frac{PV}{RT} = \frac{106 \times 0.12}{0.2968 \times 280 K} = 0.153$ Kg/s

$m_{inlet} = m_{outlet}$ because the mass doesn't change while the volume do.

Problem 2

before expanding $P_1 V_1 = m_1 R T$

$m_1 = \frac{P_1 V_1}{RT}$

after expanding $P_2 V_2 = m_2 R T$

$m_2 = \frac{P_2 V_2}{RT}$

mass doesn't change

$m_1 = m_2$

$\frac{P_1 V_1}{RT} = \frac{P_2 V_2}{RT}$ (RT are the same since T didn't change)

$P_2 = \frac{P_1 V_1}{V_2} = \frac{4 \times 0.1}{0.3} = 1.33$ atm

THE DEBATE CLUB

Problem 3

a) $T(C) = \frac{5}{9}(T(F) - 32)$

$T(c) = \frac{5}{9}(62 - 32) = 16.67°C$

$T(K) = 273.2 + T(C)$

$= 273.2 + 16.67$

$= 289.867° K$

(-3)

0K correspond to -273.2°C absolute Temp

b)

$Q = -KA \frac{dT}{dx}$

Because the first house has a temperature of 85°F but the second has 75°F, so dT of the first house is smaller than dT of the second house so the second house will have greater amount of heat conduction

$dT_1 < dT_2$

heat conduction in house 2 is larger that house 1

c) It make a difference around open windows because the walls will be subjected to radiation from the sun, because $Q = \sigma \varepsilon A T_s^4$ if ε is small Q is small but if in other place it don't makes a difference to, there won't be radiation, then there would be conduction, we shouldn't worry about the color of the material but on the type of it.

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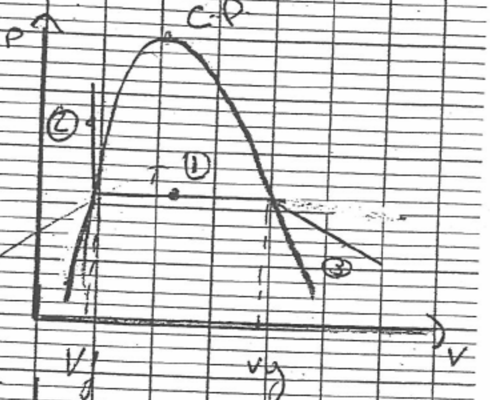
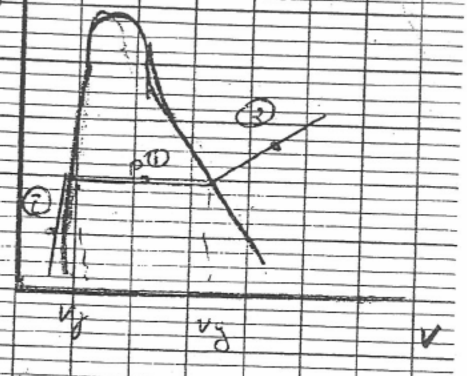
little more explanation

problem 4

a) (1) when water is saturated
$v_f \leq v \leq v_g$ we consider it inside the curve.

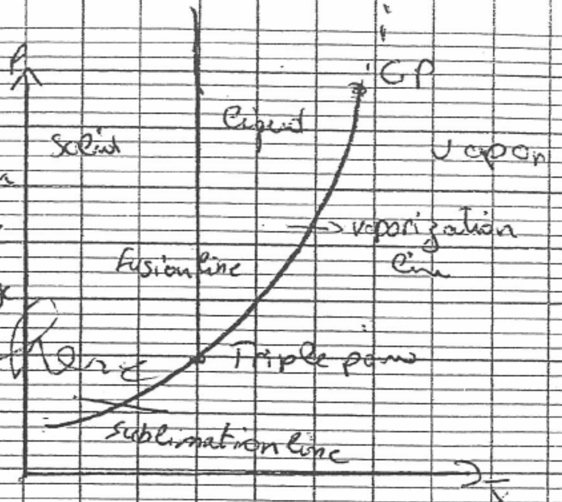


(2) when water is subcooled it's either
- $v < v_f$
- its Temperature < $T_{saturated}$, but $P = P_{sat}$
- it Pressure > $P_{saturated}$ but $T = T_{sat}$



(3) it is subcooled when:
- $v > v_g$
- $T > T_{saturated}$, $P = P_{sat}$
- $P < P_{saturated}$; $T = T_{sat}$

The P-T diagram shows the 3 phases of water: liquid - solid - vapor
sublimation line; is the change of solid water to vapor due to change of P & T
- the fusion line is the change of solid water to liquid
- the vaporization line is the change of liquid to vapor
- The tripple point is where water exist in 3 phases (solid, liquid, vapor)



show Temp line

b) polytropic process: $PV^n = \text{constant}$

$n=1$ $\quad PV = \text{constant}$

$P_1V_1 = P_2V_2 = PV = \text{constant}$

$P = \frac{\text{constant}}{V}$

$${}_1W_2 = \int_1^2 P\,dV = \int_1^2 \frac{\text{constant}}{V}\,dV$$

$$= \text{const} \ln V \Big]_1^2$$

$$= P_1V_1 \ln V_2 - P_1V_1 \ln V_1$$

$$\boxed{{}_1W_2 = P_1V_1 \ln \frac{V_2}{V_1}}$$

c) $V > V_g \Rightarrow$ we go to the superheated water @ $t = 200°C$, $v = 0.22\ m^3/kg$

P	V
1000	0.205
P	0.22
800	0.26

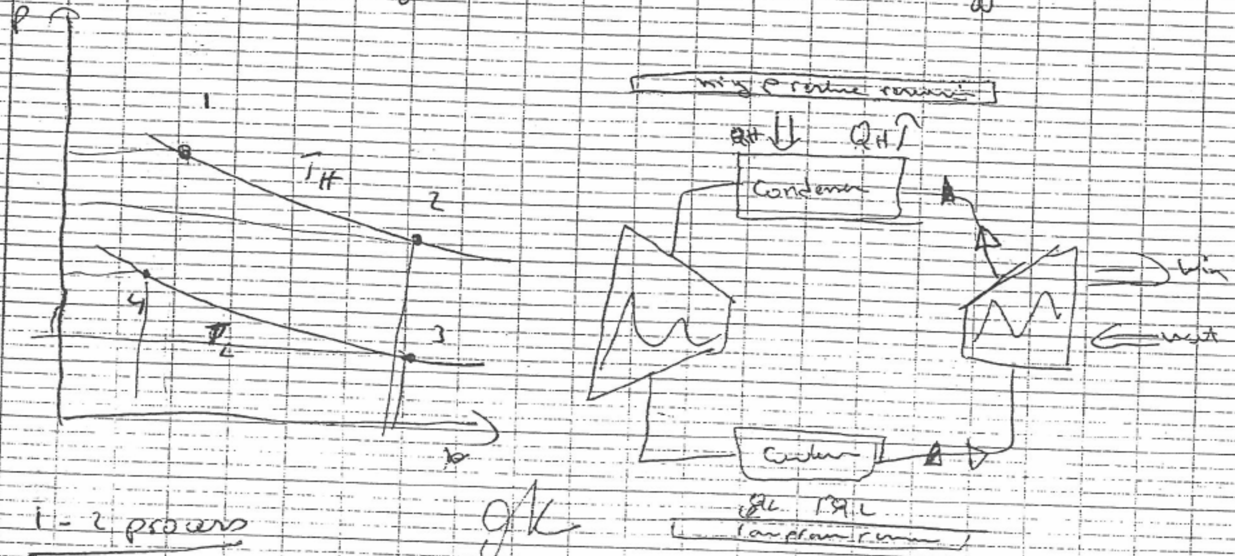
interpolate:

$$\frac{1000-P}{1000-800} = \frac{0.205-0.22}{0.205-0.26}$$

$$\boxed{P = 945.45\ kPa}$$

Joy Mianios Abdullah

Carnot cycle of ideal gases
specify all steps are the same piston cilinder explained in class
then why can't be 100% efficient justify



1-2 process

$$dq = Cvo\,dT + \frac{RT}{V}dV$$

$$q = 0 = \int_{T_{H_1}}^{T_{H_2}} Cvo\,dt + RT \ln\frac{V_2}{V_1}$$

2-3 process

$$q = 0 = \int_{T_L}^{T_H} Cvo\,dt + RT \ln\frac{V_3}{V_2}$$

$$dV = 0 \Rightarrow \frac{V_3}{V_2} = 1$$ no change in volume

$$Cvo(T_H - T_L) = 0$$

$$T_H = T_L$$

thats why carnot is not 100% efficient because we cant control T_H to be equal to T_L

process 3-4

$$q = 0 = \int_{T_{H4}}^{T_{H3}} C_{Vo}\, dT + RT \ln \frac{V_{21}}{V_3}$$

$$C_{Vo}(T_{H3} - T_{H4}) + RT \ln \frac{V_{21}}{V_3} = 0$$

$$C_{Vo}(T_{H4} - T_{H3}) = RT \ln \frac{V_4}{V_3}$$

process 4-1

$$q = 0 = \int_{T_{L4}}^{T_H} C_{Vo}\, dT + \int_{V_4}^{V_1} RT\, dV$$

$V_4 = V_1 \quad dV = 0$

$0 = C_{Vo}(T_{H_1} - T_{L_4})$

$T_H = T_L$ impossible to achieve

we cannot is not 100% efficient