

King Mongkut's University of Technology Thonburi
 Mid-term Examination Semester 1/2012
 MEE 224 Thermal Engineering Credits 3
 Department of Control system and Instrumentation Engineering
 11 October 2012 Time allowed 3 hours

- Note:** 1. You are not allowed to bring lecture notes and any other texts to the examination room except a dictionary.
 2. Calculators are permitted.
 3. Answer all five questions.
 4. If you have any doubt that the given information does not clarify, you may assume.
 5. Tables of thermodynamic properties are provided.

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Basic Principle Formulations

Simple Compressible Closed System:

Conservation of mass: $m_1 = m_2$
 Conservation of energy: $Q = U_2 - U_1 + W$
 Mechanical work of simple compressible system: $W = \int p \, dV$

Open system, Steady Flow: one inlet, one outlet

Conservation of mass: $\dot{m}_i = \dot{m}_e = \rho_i A_i \bar{v}_i = \rho_e A_e \bar{v}_e$
 Conservation of energy: $q - w = h_e - h_i + \left(\frac{v_e^2 - v_i^2}{2} \right) + g(z_e - z_i)$

Properties of pure substances:

Specific heats: $c_v = \left(\frac{\partial u}{\partial T} \right)_v$ and $c_p = \left(\frac{\partial h}{\partial T} \right)_p$

for ideal gases: $c_p - c_v = R$ and $k = \frac{c_p}{c_v}$

An ideal gas law: $pV = mRT$

The specific volume of the mixture (liquid and vapor): $v = v_f + x(v_g - v_f)$

An ideal gas equation of state: $\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$

Polytropic processes of an ideal gas: $pv^n = \text{constant}$

Enthalpy $h = u + p v$
 $du = c_v \, dT$, $dh = c_p \, dT$

The gas constant of air is $R = 0.287 \, \text{kJ/kg} \cdot \text{K}$

Water at room temperature is $c_p = 4.18 \, \text{kJ/kg} \cdot \text{K}$

Name: Student ID.

1.1 What is a system in thermodynamics? (4 marks)

Answer:

1.2 What is the zeroth law of thermodynamics? (4 marks)

Answer:

1.3 It is claimed that fruits and vegetables are cooled by 6°C for each percentage point of weight loss as moisture during vacuum cooling. Using calculations, demonstrate if this claim is reasonable. (4 marks)

Answer:

1.4 What is an isothermal process? (4 marks)

Answer:

1.5 What is a steady-flow process? (4 marks)

Answer:

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2.1 Complete the following table for water: (10 marks)

T, °C	P, kPa	h, kJ / kg	v, m³ / kg	x	Phase description
	200	2706.3			
130				0.65	
400		3277.0			
30	800				
147.90	450				

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2.2 What is a compressed liquid phase of water? (5 marks)

Answer:

2.3 What is a saturated liquid phase of water? (5 marks)

Answer:

2.4 What is a saturated vapor phase of water? (5 marks)

Answer:

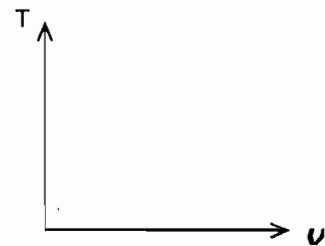
2.5 What is a superheated vapor phase of water? (5 marks)

Answer:

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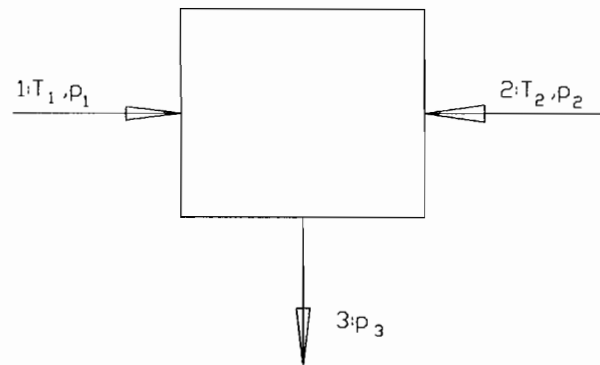
3 A rigid tank with a volume of 2.5 m^3 contains 15 kg of saturated liquid–vapor mixture of water at 75°C . Now the water is slowly heated. Determine the temperature at which the liquid in the tank is completely vaporized. Also, show the process on a T - v diagram with respect to saturation lines. (20 marks)

H ₂ O
75°C



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4. A feedwater heater operate at a steady state with liquid entering at inlet 1 with $T_1 = 40^\circ \text{C}$ and $p_1 = 0.7 \text{ MPa}$. Water vapor at $T_2 = 200^\circ \text{C}$ and $p_2 = 0.7 \text{ MPa}$ enters at inlet 2. Saturated liquid water exits with a pressure of $p_3 = 0.7 \text{ MPa}$. Ignoring heat transfer with surroundings and all kinetic and potential energy effect, determine the ratio of mass flow rates, \dot{m}_1 / \dot{m}_2 . (20 Marks)



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5. One of the facilities that use in Thailand recently for Flood Drainage improvement is water pushing machine (เครื่องดันน้ำ). Use your knowledge of Thermodynamics principles to comment on how it works. Does a canal cross sectional area affect the flow of water or machine efficiency? (20 Marks)