

ชื่อ..... รหัส.....

มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

การสอบกลางภาค ประจำปีการศึกษาที่ 1

ประจำปีการศึกษา 2547

วันที่ : 31 กรกฎาคม 2547

เวลา : 13:30 – 16:30

วิชา : Advance Chemical Engineering Thermodynamics I (230-610)

ห้อง : R300

ทฤษฎีในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทฤษฎี และพักการเรียน 1 ภาคการศึกษา

- อนุญาตให้นำหนังสือและเอกสารอื่นๆ เข้าห้องสอบได้
- อนุญาตให้นำเครื่องคิดเลขทุกรุ่นเข้าห้องสอบได้
- ข้อสอบมีทั้งหมด 7 ข้อ (10 หน้า) ให้ทำทุกข้อ
- กระดาษไม่พอให้ทำต่อด้านหลัง
- ใช้ดินสอทำข้อสอบได้

หน้าที่	ข้อที่	คะแนนเต็ม	คะแนนที่ได้
2	1	10	
3	2	15	
4	3	10	
5	4	15	
6	5	15	
7	6	20	
9	7	15	
	คะแนนรวม	100	

ดร. ผกามาศ เจษฎ์พัฒนานนท์

21 กรกฎาคม 2547

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1. Determine the specific volume of superheated water vapor at 1.6 MPa and 225°C based on (a) the ideal-gas equation, (b) the generalized compressibility chart, and (c) the steam table. Determine the error involved in the first two cases. (10 points)

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2. The radiator of a steam heating system has a volume of 20 L and is filled with superheated vapor at 300 kPa and 250°C. At this moment both the inlet and exit valves to the radiator are closed. Determine the amount of heat that will be transferred to the room when the steam pressure drops to 100 kPa. Also, show the process on a P-v diagram with respect to saturation lines. (15 points)

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3. Air at 600 kPa and 500 K enters an adiabatic nozzle that has an inlet-to-exit area ratio of 2:1 with a velocity of 120 m/s and leaves with a velocity of 380 m/s. Determine (a) the exit temperature and (b) the exit pressure of the air. (10 points)

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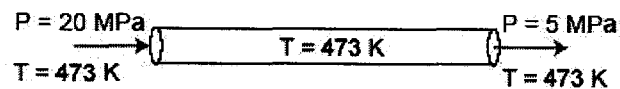
4. A 0.2-m^3 rigid tank initially contains saturated vapor at 300 kPa. Now steam at 1 MPa and 300°C is allowed to enter the tank from a supply line until the pressure in the tank is 1 MPa. Determine the amount of mass of steam that has entered the tank. (15 points)

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5. Answer these questions. (15 points)

5.1 An inventor claims to have invented a refrigerator that maintains the refrigerated space at -20°C while operating in a room where the temperature is 20°C and has a COP of 7.999. Is there any truth to his claim? What do you think if he claims that his refrigerator has a COP of 6.325? And what is the minimum work required to drive this refrigerator if 1,000 kJ of heat is transferred to the room? (8 points)

5.2 Engineer is designing a pipe for high pressure water. Here is the process.



How much entropy is this process generating?

(7 points)

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6. Answer these questions (20 points)

6.1 For the acetone (1)/ acetonitrile (2)/ nitromethane (3) system, we have the following

Antoine equations:

$$\ln P_1^{sat} = 14.5463 - \frac{2,940.46}{t + 237.22}$$

$$\ln P_2^{sat} = 14.2724 - \frac{2,945.47}{t + 224.00}$$

$$\ln P_3^{sat} = 14.2043 - \frac{2,972.64}{t + 209.00}$$

where t is in °C and the vapor pressures are in kPa. Assuming that Raoult's law is appropriate to this system, calculate

(a) P and $\{y_i\}$, given that $t = 70^\circ\text{C}$, $x_1 = 0.45$, $x_2 = 0.35$, $x_3 = 0.20$

(b) P and $\{x_i\}$, given that $t = 80^\circ\text{C}$, $y_1 = 0.45$, $y_2 = 0.35$, $y_3 = 0.20$

(15 points)

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(กระดาษสำรองสำหรับข้อ 6.1)

6.2 I need to know the activity coefficient of ethanol in benzene, describe an experiment that would measure it. Indicate what properties to measure and how the activity coefficient is determined from the data. (5 points)

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7. For the following systems, finish all calculations. (15 points)

7.1 A multiple-effect evaporator concentrates a 20% (**by mole**) aqueous solution of H_2SO_4 to 75% (**by weight**) aqueous solution of H_2SO_4 . The feed rate is 100 lb/s, and the feed temperature is 32°F . The evaporator operates at an absolute pressure of 1 psia, and under these conditions the boiling point of a 75% solution of H_2SO_4 is 200°F . What is the heat-transfer rate in the evaporator? (9 points)

Note: Enthalpy of superheated steam at 200°F and 1 psia = 1150.2 Btu/lb.

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7.2 A 25% aqueous solution of H_2SO_4 at 32°F is mixed with a 75% aqueous solution of H_2SO_4 at 100°F to form a solution containing 65% H_2SO_4 .

- (a) If the mixing is done adiabatically, what is the final temperature of the solution?
- (b) If the final temperature is brought to 80°F , how much heat must be removed during the process?

(6 points)