ชื่อ.....รหัส.....

PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final Examination: Semester I **Academic year : 2015**

Date : 13 December, 2015 **Time : 13.30 – 16.30 AM**

Subject : 231-201 Material and Energy Balances **Room : R201**

รายละเอียดการทำข้อสอบ

1. ห้ามนำข้อสอบบางส่วนหรือทั้งหมดออกจากห้องสอบ
2. นำหนังสือหรือเอกสาร เครื่องคิดเลขเข้าห้องสอบได้
3. ห้ามหยิบยืมเอกสารใดๆ และพูดคุยกับนักศึกษาอื่นขณะทำข้อสอบ
4. ข้อสอบมีทั้งหมด 6 ข้อ มีจำนวนทั้งหมด 7 หน้า
5. อนุญาตให้ทำข้อสอบด้านหลังกระดาษคำตอบแต่ละข้อได้
6. กรอกชื่อและรหัสนักศึกษาด้านหน้าข้อสอบและกรอกรหัสนักศึกษาทุกหน้าของกระดาษ

ทุจริตในการสอบโทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทุจริตและพักการเรียน 1 ภาคการศึกษา

ข้อที่	คะแนนเต็ม	คะแนนที่ได้
1	20	
2	20	
3	20	
4	20	
5	20	
6	20	
รวม	120	

รศ.ดร.จันทิมา ชั่งสิริพร

ผู้ออกข้อสอบ

Code .....

1. (20 marks) Air stream (350 m^3/h) flows in a pipe at saturation condition (70°C, and 5.6 atm abs).

a) What is the partial pressure of the water in the humid air?

b) Percentage and volumetric flow rate of water in the air stream?

c) If pressure and temperature of the air is decreased to 2,000 mmHg gauge and 30°C, respectively? What is the condition of this humid air?

d) After the gas system from question c) getting to the new saturation, explain for the final condition (% water) of the air stream?

2. (20 marks) Humid air flow to the process system at 100 kg/h and 40°C (T_{db}) has 30% relative humidity (RH). Draw the process of all following condition in Psychrometric chart.
Calculate and explanation:
a) Saturation temperature, enthalpy at saturation, and moisture content of the humid air?
b) If the humid air is cooled down until the temperature 30°C (at constant moisture content), what is new saturation temperature and amount of heat is removed from this air (kJ/h)?
c) If moisture content of the humid air from b) is decreased to 0.010 kg/kg DA at constant temperature. What is the new relative humidity, T_{wb} of the air, and quantity of condensed water?

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3. (20 marks) Factory wants to reduce water (500 kg/h) temperature to 35°C using cooling tower unit. Air at flow rate of 1,300 m^3/h is introduced to the cooling tower at 30°C (T_{wb}= 20°C) and discharged at 33°C (T_{wb}= 25°C). Draw the diagram of this cooling tower and calculate the inlet temperature of water feeding to this cooling tower.

4. (20 marks) Engineers want to heat up water (100 kg/h) from 30°C to saturated steam at 100°C by heat exchanger. Superheated steam at 200°C, 5.0 atm is used as a source of heat to the heat exchanger and exiting stream of 150°C saturated steam is discharged. Draw the diagram of this exchanger and calculate flow rate of the superheated steam required for this unit. **(Neglect:** The kinetic and potential energies of the all streams.)

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5. (20 marks) Calculate the following question.

5.1 H_2SO_4 solution at concentration of molarity of 2.5 (Density of this solution 1.645 g/cm^3)

a) Molality of the H_2SO_4 solution

b) Mole fraction of the solution

5.2 Standard Heat of reaction of the reaction between NaOH and H_2SO_4

5.3 Water flow from reservoir through pipe and pump at a flow rate of 20 m^3/h.
Estimate the pump work (kW) require for sending the water to 5th floor of building (4 m/1 floor). Assuming friction losses is neglected.

6. (20 marks) Propane (C_3H_8) 20 mole/h at 450°C is fed to combustion chamber with pure O_2 at 200°C, 1 atm. Excess O_2 of 120% is introduced to the furnace to get the flue gas product at 600°C. Assuming the fractional conversion of the combustion reaction is at 60%.

Determine: $(C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O)$

a) Diagram of the combustion chamber.
b) Flow rate and composition of all stream feeding and product of the chamber.
c) Heat from the combustion reaction of C_3H_8.