ชื่อ.....รหัส.....

PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final Examination: Semester I **Academic year : 2011**

Date : 8 October, 2011 **Time : 13.30 – 16.30**

Subject : 231-201 Material and Energy Balances **Room : A401**

รายละเอียดการทำข้อสอบ

1. ห้ามนำข้อสอบบางส่วนหรือทั้งหมดออกจากห้องสอบ
2. สามารถนำหนังสือหรือเอกสารทุกชนิดเข้าห้องสอบได้
3. ใช้ดินสอหรือปากกาในการทำข้อสอบได้
4. ข้อสอบมีทั้งหมด 4 ข้อ มีจำนวนทั้งหมด 6 หน้า
5. อนุญาตให้ทำข้อสอบด้านหลังกระดาษคำตอบแต่ละข้อได้
6. กรอกชื่อและรหัสนักศึกษาด้านหน้าข้อสอบและกรอกรหัสในข้อสอบทุกหน้าของกระดาษ

ข้อที่	คะแนนเต็ม	คะแนนที่ได้
1	25	
2	25	
3	25	
4	50	
รวม	125	

อ.จันทิมา ชั่งสิริพร

ผู้ออกข้อสอบ

รหัส.....

1. Use the psychrometric chart for humid air flow to the room at wet-bulb temperature of 23°C and moisture content of 0.015 kg/kg Dry Air to estimate (25 marks)

(1) The dry bulb temperature, relative humidity, and enthalpy of humid air.

(2) The flow rate of water in 120 kg/h humid air at these conditions.

(3) If the air is heated up to 40°C. What is the relative humidity and wet bulb temperature? How much enthalpy is added?

(4) If the heated air is added up by water at constant temperature by a rate of 1.2 kg/h. What is the final relative humidity, moisture content, and enthalpy of humid air?

(5) Draw a sketch of the psychrometric chart to show for the given state of all process steps.

2. Two streams of water at atmospheric pressure (1 atm) are mixed and heated by other stream of superheated steam (300°C, 10 bar) in the heat exchanger to form the 300 kg/h superheated steam at 250°C 5 atm. Process data are given here. (25 marks)

Feed stream 1: 200 kg/h at 60°C Feed stream 2: Saturated steam at 90°C

(1) Draw flow diagram of the heat exchanger.

(2) Calculate the required heat input (kJ/h) to the heat exchanger to form the 300 kg/h superheated steam.

(3) Calculate flow rate of the superheated steam (300°C, 10 bar) to heat up the heat exchanger. The outlet condition of the superheated steam is 250°C, 10 bar.

Neglect the kinetic energies of the liquid inlet streams.

3. A stream of air in pressure vessel (20 m^3) at 85°C with total pressure of 5 atm contains water 6% by volume. (25 marks)

(1) Calculate partial pressure of water the air stream in the system.

(2) What is the condition (condensation, saturation, or superheated) of this air stream?

(3) What is the final temperature of the air stream if the system is cooled to saturation condition at constant pressure.

(4) If the air in pressure vessel (20 m^3) from (3) is more cooled down to get new temperature of 50°C. If the system gets the new saturation condition, how much water vapor is remained in the air stream?

4. Calculation for the following questions. (50 marks)

(4.1) The standard heat of the reaction of n-butane vapor is (10 marks)

$C_6H_{14}(g) + \frac{19}{2}O_2(g) \rightarrow 6CO_2(g) + 7H_2O(l)$: ΔH_r° = -4163 kJ/mol

Calculate the rate of enthalpy change, $\Delta\dot{H}$ (kJ/h), if 380 mol/h of O_2 is used in this reaction and the reactants and products are all at 25°C.

(4.2) Calculate the heat that must be removed from a nitrogen stream flowing at a rate of 50 mol/min for cooling down from 150°C to 70°C. (using integrates tabulated heat capacities.) (15 marks)

(4.3) A liquid containing 95 mole% ethanol and 5 mole% water is in equilibrium with its vapor at 25°C and 10 atm. What is the partial pressure and mole fraction of ethanol in the vapor? (15 marks)

(4.4) Superheated steam at 20 bar with 250°C is feed to a turbine at a rate $\dot{m} = 500\ \text{kg/h}$. The turbine operation is adiabatic, and the effluent is saturated steam at 2 bar. Calculate the work output of the turbine in kW, neglecting kinetic and potential energy changes. (10 marks)