PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Midterm Examination : Semester I   **Academic year : 2013**

Date : 1 August, 2013   **Time : 09.00 – 12.00**

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

รายละเอียดการทำข้อสอบ

1. ห้ามนำข้อสอบบางส่วนหรือทั้งหมดออกจากห้องสอบ

2. สามารถนำเครื่องคิดเลข Dictionary หนังสือหรือเอกสารทุกชนิดเข้าห้องสอบได้

3. ใช้ดินสอหรือปากกาในการทำข้อสอบได้ (เขียนให้อ่านได้ชัดเจน)

4. ข้อสอบมีทั้งหมด 6 ข้อ มีจำนวนทั้งหมด 7 หน้า

5. อนุญาตให้ทำข้อสอบด้านหลังกระดาษคำตอบแต่ละข้อได้

6. กรอกชื่อและรหัสนักศึกษาด้านหน้าข้อสอบและกรอกรหัสในข้อสอบทุกหน้าของกระดาษ

| ข้อที่	คะแนนเต็ม	คะแนนที่ได้
1	15	
2	25	
3	15	
4	25	
5	20	
6	20	
รวม	120	

อ.จันทิมา ชั่งสิริพร

ผู้ออกข้อสอบ

1. Two streams of H_2SO_2 acid solution containing 40.0% H_2SO_2 and 15% H_2SO_2 by mass are fed to mixer at flow rate of 20 kg/h and 30 kg/h, respectively. It is desired to produce 35.0% H_2SO_2 solution by mixing the feeds with pure water stream in the mixer for preparing the product. (15 marks)

    a) Basis and draw the diagram of this process.

    b) Calculate the ratios (kg water feed/kg product).

2. A labeled flowchart of a continuous steady state two-unit process is shown below. Each stream contains gas at different proportions. Three streams whose flow rates and/or compositions are not known as labeled (1), (2), and (3). **Calculate** the streams whose flow rates and/or compositions are not known. (25 marks)
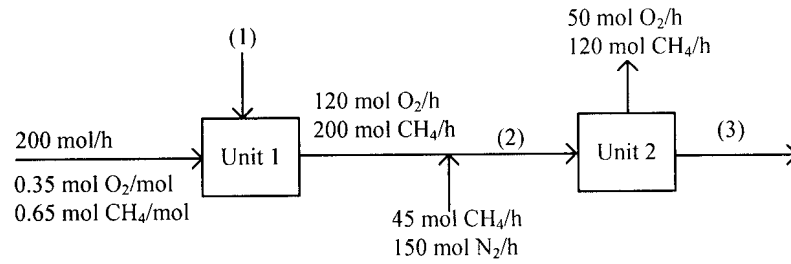
3. If you feed 280 grams/min of N_2 gas and 50 grams/min of H_2 into a reactor. Draw the diagram of this process and answer the following question: $(N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ (15 marks)

   a) What is the limiting reactant?

   b) What is the % excess of reactant?

   c) What is the maximum flow rate of NH_3 (grams/min) that can be produced?

4. Chemical reaction to produce ethylene (C_2H_4) from ethane (C_2H_6) can be shown as following: (25 marks)

$$C_2H_6 \rightarrow C_2H_4 + H_2 \qquad (1)$$
$$C_2H_4 + C_2H_6 \rightarrow C_3H_6 + CH_4 \quad (2)$$
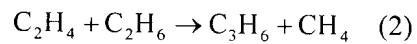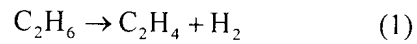
The reactions occur by feed gas at flow rate of 300 mol/h. The feed contains 75.0 mole% C_2H_6, 20.0 mole% H_2, and balance N_2. Fractional conversion of C_2H_6 is 0.75 and percentage yield of C_2H_4 (main product) is 65%.

a) Draw the process diagram of this reactor.

b) Calculate flow rate of each gas in the product stream by extent of reaction?

c) The selectivity of C_2H_4 to C_3H_6?

5. Ethane (C_2H_6) 140 mol/h and air (containing moisture 5 mole%, O_2 21%, and the balance N_2) at flow rate of 3000 mol/h are fed into combustion reactor. Percentage conversion of the ethane is 85%. (20 marks)

($C_2H_6 + \frac{7}{2} O_2 \rightarrow 2CO_2 + 3H_2O$)
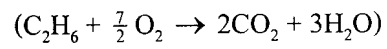
Calculate: a) Draw the process diagram of this combustion reactor.

b) The percent excess air.

c) Molar composition of the stack gas on the dry basis.

6. Propane gas (C_3H_8) and nitrogen stream (measured rate of 50 m^3 (STP)/min) are fed to the compressor. The combined gases are compressed to a total pressure P = 5.5 atm gauge at a temperature of 250°C. The partial pressure of propane in this outlet stream is p_a = 550 mmHg. Atmospheric pressure is 760 mmHg. (20 marks)

a) Draw the diagram of this gas compression process.

b) What is the molar composition of the stream leaving the compressor?

c) What is the propane feed flow rate to the compressor?