

Name Code.....

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination : Semester I

Academic year : 2016

Date : 13 October, 2016

Time : 09.00 – 12.00 AM

Subject : 231-201 Material and Energy Balances

Room : S102

รายละเอียดการทำข้อสอบ

1. ห้ามนำข้อสอบบางส่วนหรือทั้งหมดออกจากห้องสอบ
2. นำหนังสือหรือเอกสารเข้าห้องสอบได้
3. ข้อสอบมีทั้งหมด 6 ข้อ มีจำนวนทั้งหมด 7 หน้า
4. อนุญาตให้ทำข้อสอบด้านหลังกระดาษคำตอบแต่ละข้อได้
5. กรอกชื่อและ Code นักศึกษาด้านหน้าข้อสอบและกรอก Code นักศึกษาทุกหน้าของกระดาษ

ข้อที่	คะแนนเต็ม	คะแนนที่ได้
1	10	
2	20	
3	20	
4	25	
5	25	
6	20	
รวม	120	

อ.จันทิมา ชั่งสิริพร
ผู้ออกข้อสอบ

ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น
และพักการเรียน 1 ภาคการศึกษา

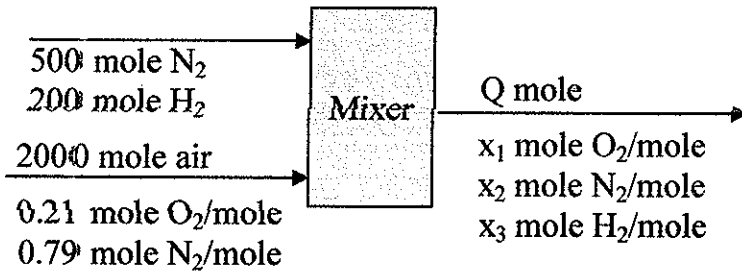
Code

1. (10 marks) 2 streams of HCl solution consisting of 120 kg/h (30.0 wt. % HCl) and Q_1 kg/h (12.0 wt. % HCl) are fed into a mixing tank. It is desired to produce the final product of 18.0% HCl solution.

- Determine**
1. Draw the diagram of this process.
 2. Calculate the flow rate of all streams.
 3. Flow rate of HCl in the final product solution.

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2. (20 marks) Scale the product of gas mixer unit as shown in flowchart below to 5,500 kmole/h and draw the new flowcharts of the scaled processes. How much of O₂ (kmole/h) containing in the product stream is produced from the scaled process?



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3. (20 marks) 2 input streams of 150 kg dry air/h and N_2 gas stream (flow rate of 1.5 time of the dry air) are fed into an evaporator. To produce humid gas stream containing 2.5 wt. % water, liquid water is introduced to the evaporator unit.

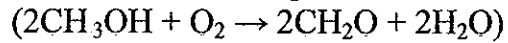
- Determine**
1. Draw and label a flowchart of the process.
 2. Calculate flow rate of liquid water that requires for humid air.
 3. Composition of the humid air product stream.

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4. (25 marks) Methane and air are continuously introduced to combustion chamber at the flow rate of 140 mole/h and 2000 mole/h, respectively. $f = 0.57$ (fractional conversion) of the limiting reactant reacts in combustion reaction. Flue gas is released out from the unit.

- 1) Draw the diagram of this process. ($\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$)
- 2) What is the theoretical air flow rate required if complete combustion occurs?
- 3) What is % excess air supplied to the system?
- 4) Molar flow rate of the flue gas using extended of reaction.
- 5) Composition of the flue gas on *dry basis*.

5. (25 marks) Methanol, oxygen, and nitrogen at flow rate of 200 kmole/h, 125 kmole/h, and 50 kmole/h, respectively, are fed to catalytic reactor to form formaldehyde. The reactor is to be designed for a conversion at 65% of limiting reactant. 75% of remaining methanol in reactor product is removed and sent out by separator unit.



- 1) Draw the diagram of this process
- 2) What reactant is limiting?
- 3) The percentage of the other reactants is in excess?
- 4) Calculate the flow rate of reactor product stream using extent of reaction.
- 5) Calculate the flow rate of final product from this process and CH_3OH in the final product stream.

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6. (20 marks) 800 mole N_2 /min ($T = 55^\circ C$ and $P_{\text{gauge}} = 0.5 \text{ atm}$) is continuously fed into an evaporator. Liquid hexane (C_6H_{14}) is also introduced to evaporate and mix with the N_2 in the evaporator unit. Gas leaving the chamber is compressed by compressor to produce the final product at $P_{\text{gauge}} = 5.5 \text{ atm}$ and $277^\circ C$. The percentage of hexane in this final product is 30% by mole.

- 1) Draw the flowchart of this process.
- 2) What is the flow rate of hexane feeding?
- 3) What is the partial pressure of hexane in the stream leaving the compressor?
- 4) What is the volumetric flow rate of the N_2 entering the evaporator?