PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final Examination : Semester I — Academic Year : 2007

Date : 3 October 2007 — Time : 13.30 – 16.30

Subject : 230 - 351 Computer Applications for Chemical Engineers — Room : R300

Student Name: ..... ID no. : .....

Number of questions : 3

Time : 3 hours

Total marks : 100

Notes are not allowed. One diskette A is provided.

Calculators are not allowed.

Perform simulation by Aspen Plus Program

Writing in pencil is allowed.

Question	Full Marks	Marks Received
1	35	
2	35	
3	30	
Total	100	

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

ห้ามนักศึกษาออกนอกหน้าจอ Aspen Plus, Excel และ VCR ตลอดช่วงเวลาการสอบ การปฏิบัติผิดระเบียบข้อนี้ถือเป็นทุจริต

One drive-A diskette and this paper with answer sheet are used for grading.

Student Name: ..... ID no. : .....

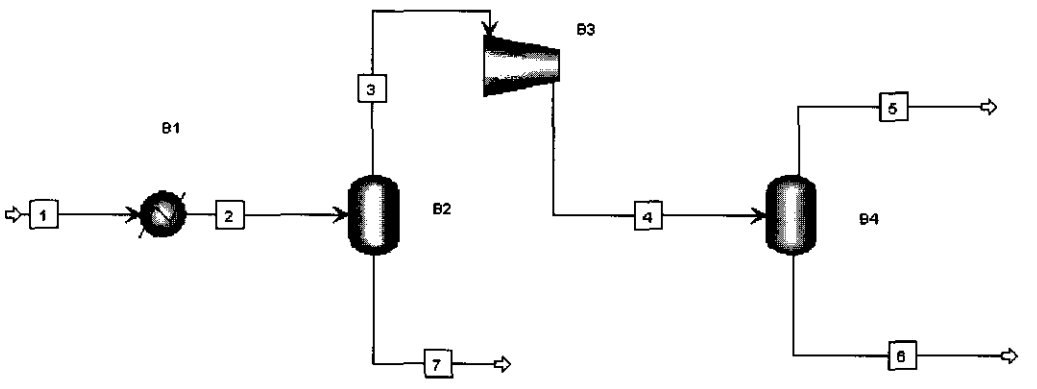
1. The feed stream at -20 °F and 210 psi consists of ethane, propane, iso-butane and n-butane at flow rates 1,000, 1,000, 1,000 and 2,000 lbmol/hr, respectively. This feed is to be separated by going through a heater, a flash tank, recompressed in a compressor and re-flashed in a second flash tank.

   The heater and flash tanks are specified for their outlet temperatures and pressures. The compressor is specified as positive displacement type, with specified discharge pressure and default values for efficiencies.

   1a) Perform a simulation by using Aspen Plus Program according to the proposed PFD shown below. Set the program to calculate in General English Units and the report options in mole fraction and TXPORT. The property method NRTL may be used. Select your own process conditions in order to obtain the best product separation for streams 5 and 6.

   After you have completed the simulation for this question, **save as** your file on to your diskette in drive A as **Aspen Plus backup file** under the **file name xxQ1.bkp**. Note that xx is your computer number.

   1b) Perform heat balance calculation around the second flash tank (Block B4) on the answer sheet.



(35 marks)

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2. Acetic anhydride is to be produced from acetone and acetic acid. In the first stage of the process, acetone is decomposed at 1035 K and 1.6 atm to ketene via the gas-phase reaction:

Reaction 1:

$$CH_3COCH_3 \quad \text{------>} \quad CH_2CO + CH_4$$

acetone ketene methane

The second stage of the process requires the ketene to be reacted with acetic acid to produce acetic anhydride via the gas-phase reaction:

Reaction 2:

$$CH_2CO + CH_3COOH \quad \text{------>} \quad CH_3COOCOCH_3$$

ketene acetic acid acetic anhydride

Set up the Aspen Plus process flow sheet for this question. Use the Unit Operation Block type RPlug. Enter simulation specifications from the provided information. Provide your own other specifications which you think necessary.

Set the program to calculate in General English Units and the report options in mole fraction and TXPORT.

The feed stream consists of acetone and acetic acid at flow rates 8,000 and 6,500 kg/hr, respectively at 1035 K and 1.6 atm. Reaction is in vapor phase.

The RPlug reactor operates as an adiabatic reactor.

The RPlug reactor is multi-tube type with 1,000 tubes of 20 meter long and 1 inch diameter.

Unit Operation Block	RPlug			
Reacting Phase	Vapor		Vapor	
Reaction	Reaction 1		Reaction 2	
Type	LHHW		LHHW	
Type	Kinetic		Kinetic	
	k= 3.58		k= 8.72	
	n=0		n=0	
	E=34222 kJ/kmol		E= 34222 kJ/kmol	
	T_0=1035 K		T_0=80 °C	
Driving Force	Term1	Term 2	Term1	Term 2
Concentration Exponents	Acetone =1	0	Ketene = 1	0
	Ketene = 0	0	acetic acid =1	0
	Methane =0	0	acetic anhydride = 0	0
Coefficients for driving force constant	A = 0	-10000000	A = 0	-10000000
	B = 0	0	B = 0	0
	C = 0	0	C = 0	0
	D = 0	0	D = 0	0
Rate Basis	Reac(Vol)		Reac(Vol)	
Property Method	SYSOP0			
Property Sets	HXDESIGN			
	THERMAL			
	TXPORT			
	VLE			
	VLLE			

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The reaction is rate-controlled kinetic of the type Langmuir-Hinshelwood-Hougen-Watson (LHHW).

(Note that you need to go to the reactions subfolder and create a reaction by selecting "New" and give it a name. Then select type LHHW.)

In the reactions subfolder and on the kinetics tab provide other specifications by clicking on the "Driving Force" button. Use the appropriate values for concentration exponents and coefficients for driving force constant from the provided table.

Run the simulation program and answer the following questions.

After you have completed the simulation for this question, **save as** your file on to your diskette in drive A as **Aspen Plus backup file** under the **file name xxQ2.bkp**. Note that xx is your computer number.

2a) Write down the flow rates and compositions for streams 1 and 2 in your answer sheet.

2b) For the LHHW kinetic, explain the meaning of parameters k, K, n and write the driving force expression.

2c) Calculate the reactor per cent yield.

2d) What is SYSOP0 property method?

(35 marks)

contains the following components and flow rates:

propane	2,000	lbmol/hr
iso-butane	400	lbmol/hr
n-butane	600	lbmol/hr
iso-pentane	150.3	lbmol/hr
n-pentane	200	lbmol/hr
n-hexane	50.8	lbmol/hr
n-heptane	250	lbmol/hr

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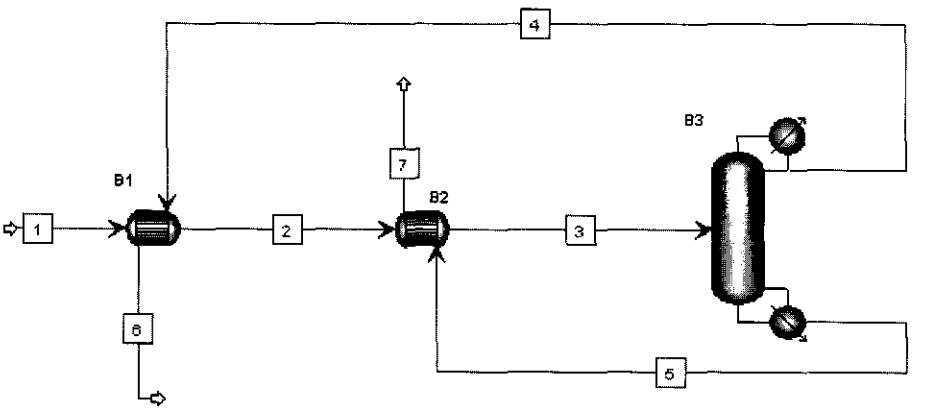
3. A mixture of petrochemical feed is to be separated in a process consisting of two pre-heaters and a distillation column. The feed (stream 1) is at 80°F, and 240 psi and contains the following components and flow rates.

propane	2,000	lbmol/hr
iso-butane	400	lbmol/hr
n-butane	600	lbmol/hr
iso-pentane	150.3	lbmol/hr
n-pentane	200	lbmol/hr
n-hexane	50.8	lbmol/hr
n-heptane	250	lbmol/hr



Specifications for Blocks B1 and B2

Unit Operation Model: HeatX, Type: GEN-HS

Calculation: Shortcut

Exchanger specification: Cold stream outlet temperature

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Specifications for Block B3 (Distillation Column)

Unit Operation Model: Distillation column type Distl

Column specifications:

Number of stages: 25, Feed stage: 9

Reflux ratio: 1.5, Distillate to feed mole ratio: 0.7

Condenser type: Total

Condenser pressure: 220 psi, Reboiler pressure: 410 psi

Draw an Aspen Plus process flow sheet for this question. Name all stream numbers as shown. Enter simulation specifications from the provided information. Set the program to calculate in General English Units and the report options in mole fraction and TXPORT. The property method Peng-Robinson may be used.
Provide your own other specifications which you think necessary and run the simulation program.

3a) After you have completed the simulation for this question, **save as** your file on to your diskette in drive A as **Aspen Plus backup file** under the **file name xxQ3.bkp**. Note that xx is your computer number.
Write down the flow rates and compositions for streams 6 and 7 in your answer sheet. Show the condenser duty and reboiler duty in Btu/hr.

3b) Change the number of stages for the distillation column to 35 stages. (do not change specifications for Blocks B1 and B2) and re-run the program. Write down the new flow rates and compositions for streams 6 and 7 in your answer sheet. Comment on the effects of increasing number of stages.

Do not save the conditions in question part 3b on to diskette drive A.

3c) What is the function or purpose of this distillation column? Suggest a name for this column relating to its function.

(30 marks)