PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final Examination : Semester I — Academic Year : 2009

Date : 28 September 2009 — Time : 9.00 – 12.00

Subject : 230–466 Special Topic — Room : Com1

(Computer Applications for Chemical Engineers)

Paper Set : A B C

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

Number of questions : 3

Time : 3 hours

Total marks : 90

Notes are not allowed.

Storage devices and calculator are not allowed.

Perform simulation by Aspen Plus Program

Writing in pencil is allowed.

Question	Full Marks	Marks Received
1	35	
2	40	
3	15	
Total	90	

ทุจริตในการสอบโทษขั้นต่ำคือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

ห้ามนักศึกษาออกนอกหน้าจอ Aspen Plus, Excel และ VCR ตลอดช่วงเวลาการสอบ

การปฏิบัติผิดระเบียบข้อนี้ถือเป็นทุจริต

The folder with your answered files and this exam paper with answer sheets are used for grading.

Students are advised to save their answers on to their folder every 15 minutes in order to avoid problems of program interruptions and unexpected shutdown.

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

1. The feed stream at 200 K and 62.0 bar consists of carbon dioxide, hydrogen sulfide, methane, ethane and propane at flow rates 6, 24, 66, 3 and 1 kmol/hr, respectively. This feed is to be separated by going through a valve, a flash tank. A part of the flashed liquid is recycled.

   1a) Perform a simulation by using Aspen Plus Program according to the proposed PFD shown below. Set the program to calculate in General with Metric Units and the report options in mole fraction and TXPORT. The property method RK-SOAVE may be used. The simulation is aimed at removing hydrogen sulfide into stream number 6.

   Operation specifications for Valve B2 are :

   Calculation type: adiabatic flash for specified outlet pressure.

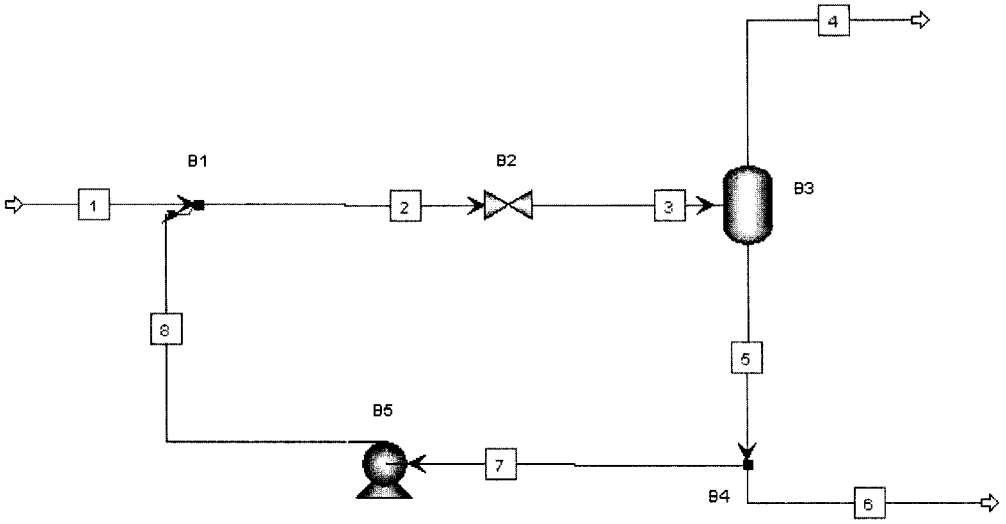
   Pressure drop 0 bar. (No pressure drop)

   Select your own process conditions for other unit operation models in order to obtain the best separation for hydrogen sulfide. You are not allowed to change the feed conditions and composition in stream number 1.

   After you have completed the simulation for this question, **save as** your file in the folder you have previously created as **Aspen Plus backup file** under the **file name xxQ1.bkp**. Note that xx is your computer number.

   1b) On your answer sheet, write down the phase and mole fraction composition for stream number 6.

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



Some details for unit operation models are given below.

Type	Model	Description	Type
Mixer/Splitter	Mixer	Stream mixer	DOT(black)
	FSplit	Stream splitter	DOT(black)
Separator	Flash2	Two-outlet flash	VDRUM1
Pressure Changers	Pump	Pump	Icon1
	Valve	Rigorous valve pressure drop	Valve2

(35 marks)

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

2. Benzene is to be produced from toluene and hydrogen according to the vapor-phase reaction:

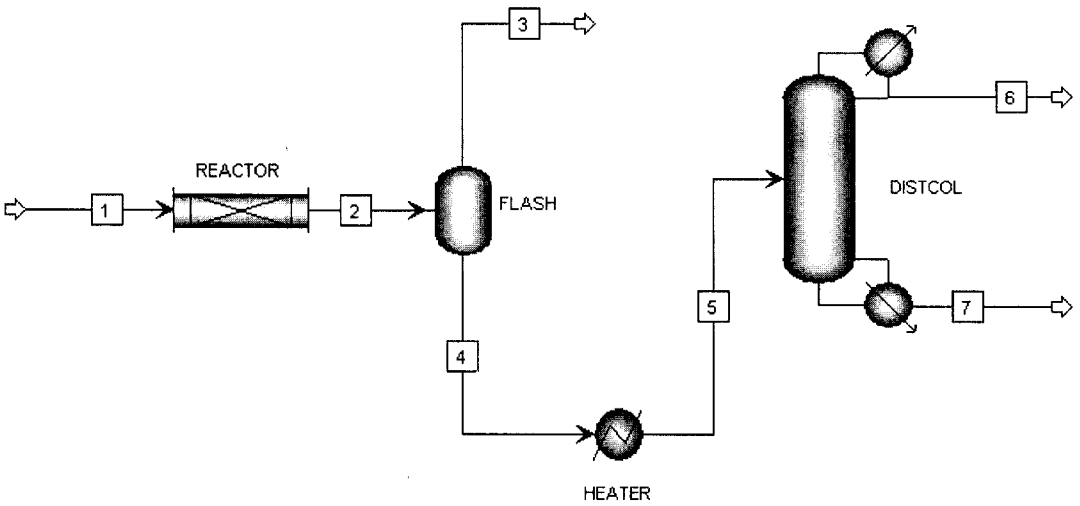
$$C_7H_8 + H_2 \text{ ------> } C_6H_6 + CH_4$$

toluene hydrogen benzene methane

Set up the Aspen Plus process flow sheet for this question as shown below. Enter simulation specifications from the provided information. Provide your own other specifications which you think necessary.

Set the program to calculate in General with English Units and the report options in mole fraction and TXPORT. The property method RK-SOAVE may be used.

The feed stream consists of toluene and hydrogen at flow rates 110 and 850 kmol/hr, respectively at 750 ^{o}C and 30 bar. Reaction is in vapor phase.



Some details for unit operation models are given below.

Type	Model	Type
Reactor	RPlug	Icon2
Separator	Flash2	Vdrum1
Heat Exchanger	Heater	Heater
Columns	RadFrac	Fract1

The RPlug specifications are:

Reactor type: Reactor with specified temperature.

Operating condition: Constant at inlet temperature.

The RPlug configurations are: length 10 feet, diameter 3 feet.

Reaction type: Power Law

Stoichiometry:

Component	coefficients	Exponent
Toluene	-1	1
Hydrogen	-1	0.5
Benzene	1	0
Methane	1	0

Kinetics:

Reacting phase: vapor

K = 6.3E+10 E = 52000 cal/mol

n = 0 T_O = optional

Flash outlet specifications: 40 ^{O}C, 3 bar

Provide your own specifications for the Heater and the RadFrac column in order to get best separation of benzene and toluene in streams 6 and 7. The Heater help increases temperature of stream number 5. The RadFract column calculation type is Equilibrium and consists of 30 trays.

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

Run the simulation program and answer the following questions.

After you have completed the simulation for this question, **save as** your file as **Aspen Plus backup file** in the folder you have previously created under the **file name xxQ2.bkp**. Note that xx is your computer number.

2a) Write down the flow rates and mole fraction compositions for streams 6 and 7 on your answer sheet.

2b) Calculate the reactor per cent conversion.

(40 marks)

Answers to Question 2

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

3. A mixture of air-ammonia vapor is absorbed (scrubbed) with water to remove ammonia in a gas absorber. The vapor feed stream is at 25°C and 25 psia and contains the following components and flow rates.

air	401.88 lbmol/hr
ammonia	54.33 lbmol/hr

The vapor feed enters at the bottom of the column and flows up. Water at 25°C and 14.7 psia enters the top of the column and flows down 52.76 lbmol/hr. Some part of ammonia dissolves in water and leaves the bottom of the column in LIQ-OUT stream. The GAS-OUT stream which leaves the top of the column contains air and the remaining ammonia.

This operation can be simulated with Aspen Plus program. **Do not perform simulation**.

Write **on your answer sheet** in details explaining the simulation steps. Provide all details for unit operation models and parameters used in the simulation. You may look for explanation in Help for Aspen Plus or User's guide.

Do not save any answer or file for this question.

(15 marks)