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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2021/2022**

COURSE NAME : FUNDAMENTAL OF PLANT TECHNOLOGY

COURSE CODE : BNL 20103

PROGRAMME CODE : BNL

EXAMINATION DATE : JULY 2022

DURATION : 3 HOURS

INSTRUCTION : 1. ANSWERS ALL QUESTIONS

2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**.

3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

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- Q1** (a) Process engineering encompasses a vast range of industries.
- (i) Explain **FOUR (4)** examples of industries (4 marks)
  - (ii) A process plant is a complete set of process unit and direct supporting infrastructure required to provide a total operational function to produce the desired product. Based on your understanding, illustrate the necessary steps to design a process plant. (5 marks)
- (b) Ammonia is a compound of nitrogen and hydrogen. The absorber is fed at the bottom with ammonia-air mixture with a flow rate of 20 L/min. Water is then fed to the upper stream of the same absorber with desired flow rate of 10 L/min. The outputs from the absorber are insoluble ammonia gas at the upper stream while ammonia-water mixture at the bottom stream. The bottom stream is then fed to a distillation column which produce the ammonia gas that need to be condensed to produce liquid ammonia. Construct the Process Flow Diagram (PFD). (6 marks)
- (c) Calculate the energy/enthalpy required or consumed for the following reactions by using the bond energy as shown in **Table Q1 (c)**, and estimate either the reaction is exothermic or endothermic process.
- (i) Chlorination of methane,  $\text{CH}_4$  (5 marks)
  - (ii) Combustion of octane,  $\text{C}_8\text{H}_{18}$  (5 marks)
- Q2** (a) As an engineer working in a process plant, Process and Instrumentation Diagram (P&ID) is one of the important documents.
- (i) Compare **TWO (2)** differences between process flow diagram (PFD) and process & instrumentation diagram (P&ID). (4 marks)
  - (ii) Based on **Figure Q2 (a)**, explain the process in your own words. (4 marks)
- (b) Fresh air containing 4.00 mole% water vapor is to be cooled and dehumidified to a water content of 1.70 mole%  $\text{H}_2\text{O}$ . A stream of fresh air is combined with a recycle stream of previously dehumidified air and passed through the cooler. The blended stream entering the unit contains 2.30 mole %  $\text{H}_2\text{O}$ . In the air conditioner, some of the water in the feed stream is condensed and removed as liquid. A fraction of the dehumidified air leaving the cooler is recycled and the remainder is delivered to a room.

- (i) Illustrate the flowchart of the process including the mixing point and separation point  
(4 marks)
- (ii) Explain **FOUR (4)** reasons for using the recycle in a chemical process  
(4 marks)
- (iii) Taking 100 mol of dehumidified air delivered to the room as a basis of calculation, calculate the moles of fresh feed, moles of water condensed, and moles of dehumidified air recycled  
(9 marks)



The above equation showed a reaction of acetylene and hydrogen to produce ethane. The inlet conditions are 20 kmol/h  $\text{C}_2\text{H}_2$  and 50 kmol/h  $\text{H}_2$ . Calculate:

- (i) The limiting reactant  
(3 marks)
  - (ii) The percent excess reactant  
(3 marks)
- (b) Discuss the following:
- (i) The working principles of a shell and tube heat exchanger  
(3 marks)
  - (ii) The working principles of a cooling tower.  
(3 marks)
  - (iii) An engineer uninstalling a fail open valve controlling the flow of coolant entering an engine  
(3 marks)
- (c) **Table Q3 (c)** shows list of information on a refrigerator system. Based on the information,
- (i) Analyze the time required to cool down 5 watermelons.  
(6 marks)
  - (ii) Determine the COP, if the same time is required to cool down 10 watermelons.  
(4 marks)
- Q4 (a)** A house is heated by a 1200 kWh electric resistance heater during a winter month. The owner had studied the potential of a heat pump to replace the electric resistance heater usage. If the coefficient of performance (COP) of a heat pump is 2.4 and an electricity rate of 0.085 MYR/kWh.



- (i) Calculate the amount of money that could be saved if the heat pump is chosen. (6 marks)
- (ii) Estimate the savings if the coefficient of performance (COP) is doubled. (3 marks)
- (b) There are different categories of design solution for process safety of plant. Compare the differences of active and passive design solution with examples. (6 marks)
- (c) Industrial chiller is operated by three interrelated systems which are refrigerant circulation, water circulation and electric automatic control. A low-pressure fault in a chiller plant where the inlet pressure of the compressor is too low and affecting the low-pressure protection relay to be activated. Analyze the situation and point out:
- (i) **THREE (3)** possible causes of the situation. (6 marks)
- (ii) **TWO (2)** solutions for the problems. (4 marks)

**-END OF QUESTIONS -**

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Table Q1 (c)

Table of Bond Enthalpies (kJ/mole) at 25 °C					
Bond	Enthalpy	Bond	Enthalpy	Bond	Enthalpy
H-H	435	C-N	301	P≡P	490
H-F	569	C-O	352	Br-Br	193
H-Cl	431	C=O	532	Cl-Cl	243
H-Br	364	C-Br	234	H-Se	276
H-I	297	C-Cl	331	H-Te	243
H-C	414	C-F	440	S=S	427
H-N	460	N≡N	950	C-S	260
H-O	465	N-N	297	H-Si	393
H-S	377	O=O	498	H-P	318
C-C	368	O-O	213	C-Si	289
C=C	724	F-F	159	I-I	151
C≡C	963	Si-Si	339		

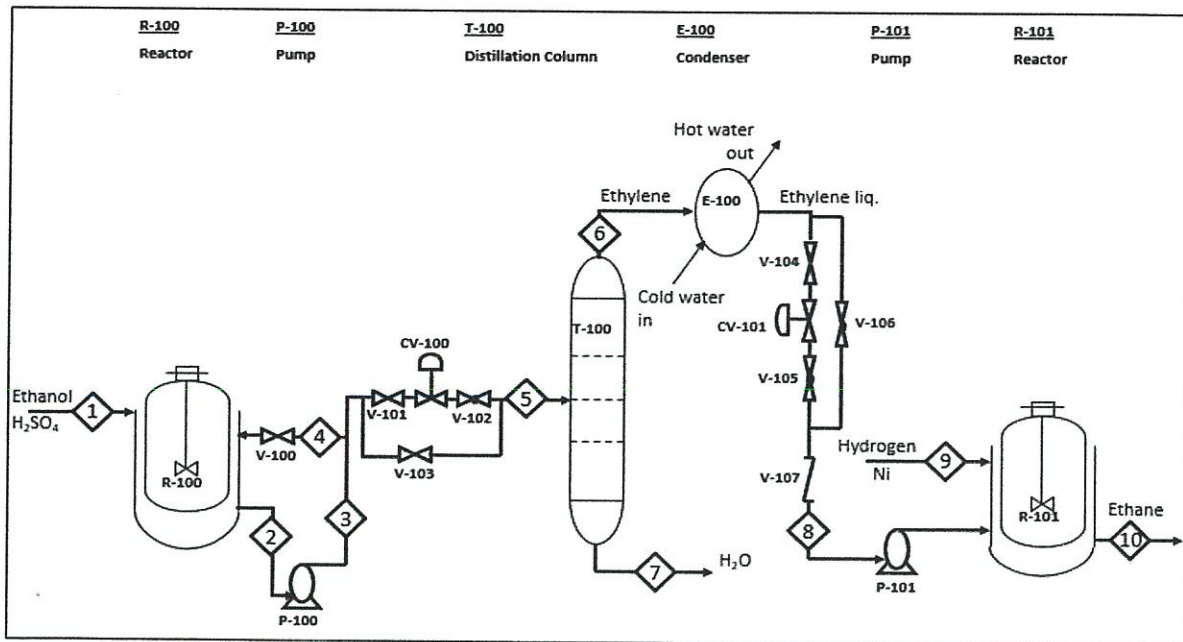


Figure Q2 (a)

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**Table Q3 (c)**

<b>Properties</b>	<b>Data</b>
Mass of watermelon (1pcs)	10kg
Initial temperature	20 °C
Final temperature	8 °C
Specific heat of watermelon	4.2 kJ/kg.°C
Refrigerator power input	450 Watt
Refrigerator COP	2.5

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