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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2016/2017**

**TERBUKA**

COURSE NAME : PROCESS SAFETY ENGINEERING  
COURSE CODE : BNL 40403  
PROGRAMME : BNL  
EXAMINATION DATE : DECEMBER 2016/ JANUARY 2017  
DURATION : 3 HOURS  
INSTRUCTION : ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

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- Q1**
- (a) Safety often described as an attitude that includes careful planning, following safety rules, safe work practice and the use of personal protective equipment. List 5 important keys to improve the worker's safety.  
(5 marks)
  
  - (b) For higher-order organisms, the path of the chemical agent through the body can be well defined. After the toxicant enters the organism it moves into the bloodstream and will eventually be eliminated, or it is transported to the target organ. Briefly explain the entry routes for toxicants and methods to control the toxicants exposure.  
(5 marks)
  
  - (c) Exposure to hazardous chemicals commonly used in workplaces can lead to a variety of short and long term health effects such as poisoning, skin rashes and disorders of the lung, kidney and liver. Compare the effects of hazardous substances entering through inhalation and ingestion.  
(5 marks)
  
  - (d) Toxicologists often refer to a harmful reaction caused by a chemical as a toxic response. The relationship between dose and response can be visualized as a simple graph with dose on the x-axis and response on the y-axis. Analyse the characteristics of dose response curves critically.  
(5 marks)

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**Q2** (a) In the chemical process industry, accidents of varying degrees of severity continue to occur at a surprisingly high rate. Chemical process industry such as biodiesel is normally associated with high energy densities with great potential for fires and explosions. Explain briefly the accidents below:

- (i) Explosion
- (ii) Confined Explosion
- (iii) Detonation
- (iv) Deflagration
- (v) Blast Damage

(10 marks)

(b) Bhopal Disaster is claimed by many as the worst industrial disaster in history. It was caused by the accidental release 40 tonnes of highly toxic and heavier than air MIC gas from a Union Carbide pesticide plant located in the heart of the city of Bhopal, India. This disaster may be caused by the ignition energy in which could lead to dust explosion.

- (i) Define minimum ignition energy (MIE).
- (ii) How does ignition energy plays an important role in dust explosion?
- (iii) What are the various ignition sources likely to be present in industrial operation.

(10 marks)

**Q3** (a) Air contains 5 ppm of diethylamine (TLV-TWA of 20 ppm) , 20 ppm of cyclohexanol (TLV-TWA of 50 ppm), and 10 ppm of propylene oxide (TLV-TWA of 20 ppm).

- (i) Calculate the mixture TLV-TWA
- (ii) Based on result in (i), shows how the mixture level been exceeded or not.

(7 marks)

- (b) Determine the mixture TLV at 25 °C and 1 atm pressure of a mixture derived from the following liquid:

Component	Mole Percent	Species TLV (ppm)
Heptane	50	400
Toluene	50	50

(10 marks)

- (c) Several incidents are known to have occurred at biodiesel plants. Discuss several types of hazards in a biodiesel plant that may require the use of a Personal Protective Equipment (PPE).

(3 marks)

**Q4**

- (a) Hazard identification and risk assessment studies can be performed at any stage during the initial design or on-going operation of a process. Hazard process must be ongoing to ensure existing hazards are known. Many methods are available for performing hazard identification and risk assessment. The selection of the best method requires experience. Most companies use these methods or adaptations to suit their particular operation. Briefly explain the methods below, with its advantages, in hazard identification :

- (i) Process Hazard Checklist
- (ii) Hazard Surveys
- (iii) Hazards and operability (HAZOP) studies
- (iv) Safety review

(12 marks)

- (b) One of the most important references used during an industrial hygiene study involving toxic chemicals is the material safety data sheets (MSDS). List down the sections contain in MSDS.

(8 marks)

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**Q5** (a) An open toluene container in an enclosure is weighted as a function of time, and it is determined that the average evaporation rate is 0.1 g/min. The ventilation rate is 100 ft<sup>3</sup>/min. The temperature is 80°F and the pressure is 1 atm. Estimate the concentrations of toluene vapour in the enclosure, and compare your answer to the TLV for toluene of 50 ppm.

(6 marks)

(b) A toluene water wash process is shown in **Figure Q5(b)**. The separation is achieved with Podbielniak centrifuge, or Pod, because of a difference densities. The light phase (contaminated toluene) is fed to the periphery of the centrifugal and travels to the centers. The heavy phase (water) is fed to the center and travels countercurrent to the toluene to the periphery of the centrifuge. The extraction is conducted at 190 °F. Perform a formal safety review of this process.

(6 marks)

(c) A premixed fuel-air mixture will only burn as long as the fuel concentration is between the upper and lower flammability limits. Calculate the LFL and UFL of a gas mixture composed of 0.8% hexane, 2.0% methane, and 0.5% ethylene. **Table 1** shows mole fractions of mixture on fuel-only basics.

(8 marks)

- END OF QUESTION -

PROF. MARYAM DR. ABDUL MUTALIB BIN LEMAH  
SYDEB MASTORQ  
Fakulti Kejuruteraan  
Universiti Teknikal Malaysia Melaka

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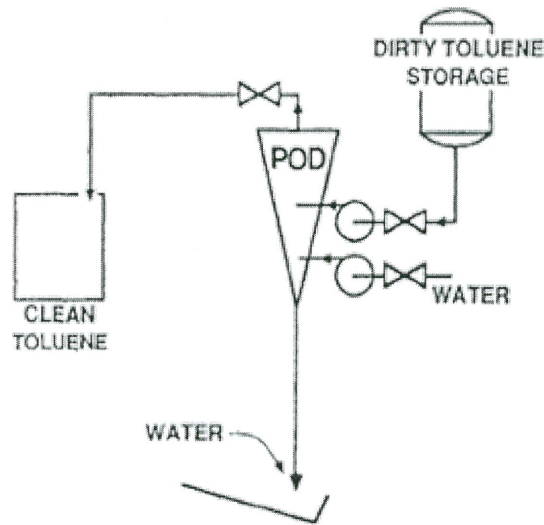


Figure Q5 (b): Toluene water wash process before formal safety review

Table 1: Mole fractions of mixture

	Volume %	Mole fraction on combustible basis	LFL <sub>i</sub> (vol.%)	UFL <sub>i</sub> (vol.%)
Hexane	0.8	0.24	1.2	7.5
Methane	2.0	0.61	5.0	15
Ethylene	0.5	0.15	2.7	36.0
Total combustibles	3.3			
Air	96.7			