

**BITS, PILANI-DUBAI**

Dubai International Academic City, Dubai, U.A.E.

IV Year Chemical Engineering, I Semester 2008-09

**Test 1**

**CHE C413 Process Plant Safety**

**Maximum Marks: 25**

**Duration: 50 min**

**(Closed Book)**

**Weightage: 25%**

**9-10-08**

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1. How the double block bleed valve works and reason behind its safety (3M)
  2. What are the objectives of industrial safety? (2M)
  3. Discuss in detail about modes of entry of chemicals in to the living beings. (6M)
  4. How ventilation system is classified in the process plant industries. (2M)
  5. Name the substances which produce health hazards from the following industries.  
i) plastic industry, ii) glass industry (3M)
  6. State the difference between extremely flammable and highly flammable with examples. (4M)
  7. Mention the requirements are needed while selecting the personal protective equipments. (3M)
  8. What is self contained breathing apparatus? (2M)

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**Test 2**

**CHE C413 Process Plant Safety**

Maximum Marks: 20

Weightage: 20%

Duration: 50 min

(Open Book)

9.11.2008

**Note: only prescribed txt book is allowed**

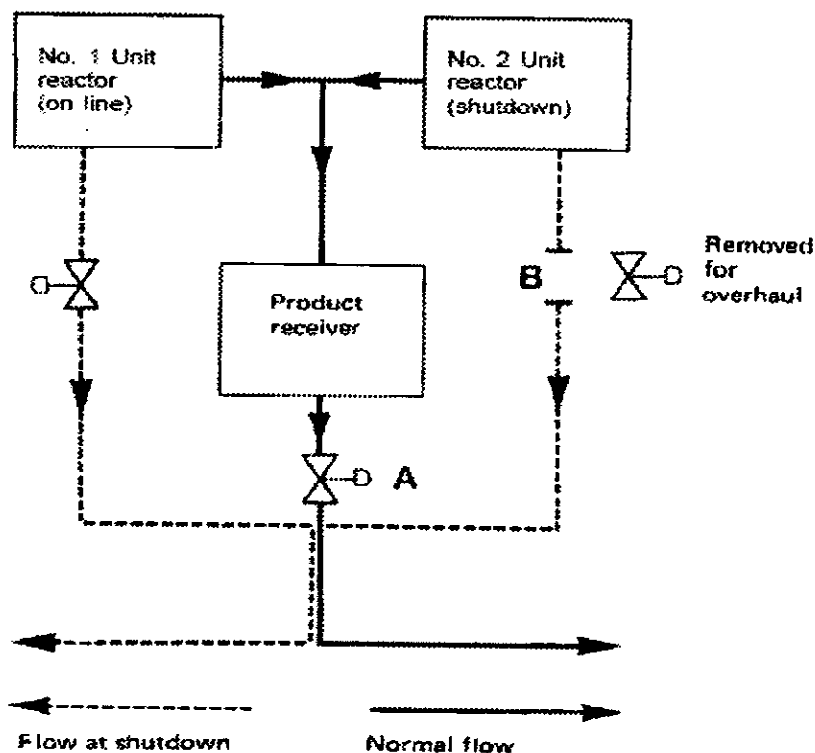
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1. Paper and pulp mills use large quantities of water, and the water is usually recycled. Buffer storage is needed, and at one paper mill, it took the form of a 740 m<sup>3</sup> tank. Experience showed that this was insufficient, and another tank of the same size was installed alongside. To simplify installation it was connected in series with the original tank. A week after the new tank was brought into use, welders were completing the handrails on the roof, an explosion occurred in the tank.  
(2 m)  
Explain why the explosion happened?
2. Mention any four incidents by which storage tanks have been sucked-in in the process plants.  
(4 m)
3. A pump had to be removed for repair. The bolts holding it to the connecting pipework were seized and it was decided to burn them off. As the plant handled flammable liquids, the pump was surrounded by temporary sheets of a flame-resistant material and a drain about a metre away was covered with a polyethylene sheet. Sparks burned a hole in this sheet and set fire to the drain. The fire was soon extinguished and no one was hurt. The atmosphere in the drain had been tested with a flammable gas detector before burning started but no gas was detected.  
State the reason why fire set in the drain  
(3 m)
4. Specify the types of sensors which are used in flammable gas detectors. Discuss any two in brief.  
(4 + 4 m)
5. The hydrocarbon processing plant consisted of two parallel units which shared some equipment in common (As shown in figure). Reaction product entered a common

product receiver and was then further processed in a common unit. The product receiver could be by-passed by the lines shown dotted in figure. These lines had been installed to make it easier to empty the reactors when they were being shut down and were used only occasionally.

One of the units was shut down for maintenance while the other continued on line. The unit under repair should have been isolated by slip-plates but unfortunately one of the interconnecting lines was overlooked. Valve B, in the by-pass line from the shutdown unit (No 2), had been removed for overhaul. A few hours later automated valve A was operated. Hot hydrocarbon boiling point about  $85^{\circ}\text{C}$ , temperature about  $150^{\circ}\text{C}$  and gauge pressure about 7 bar traveled in the wrong direction along No 2 unit by-pass line and came out of the open end. Someone sounded the evacuation alarm and the maintenance workers, who were on the plant at the time, working on No 2 unit, started to leave. Unfortunately hydrocarbon ignited after ninety seconds the leak started. The operator in the control room heard the evacuation alarm sound. His prompt action prevented a much more serious fire.

What sort of prompt action he would have taken to avoid the serious fire?  
(3 m)



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**Quiz No 1**

CHE C413 Process Plant Safety

Maximum Marks: 10

Weightage: 5%

Duration: 15 min

(Closed Book)

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1. Personal protective equipments may be divided into \_\_\_\_\_ (2M)
  2. What is color code for canister to protect against hydrogen cyanide gas? (1M)
  3. Mention the difference between gases and vapors with examples (1M)
  4. Match the following (3M)

a) Fumes	1 $\mu$
b) Dust	< 0.1 $\mu$
c) Smoke	0.1 $\mu$
	0.1 to 25 $\mu$
	0.01 $\mu$
	0.25 $\mu$
	> 0.1 $\mu$
  5. How the TLVs are derived? (2M)
  6. Discuss any one process plant incident briefly about the role of safety in the need for tagging. (1M)

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**Quiz No 2**

CHE C413 Process Plant Safety

Maximum Marks: 5

Weightage: 5%

Duration: 15 min

(Closed Book)

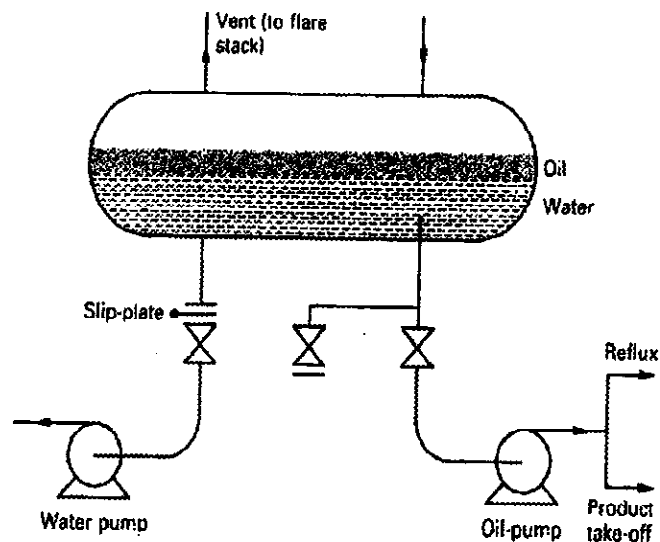
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A crude oil distillation unit was being started up after a major turnaround. It had taken longer than expected so the manager (fresh young graduate) therefore decided to be present throughout the night so that he could deal promptly with any problems that arose. The distillation column was warming up. It had been washed out with water before the shut-down and the water left in the column had distilled into the reflux drum and had half filled it. There was a layer of light oil containing some LPG on top of the water. Two pumps were connected to the reflux drum as shown in Figure. The water pump took suction from the bottom of the drum and sent the water to a sour water scrubber for purification and discharge to drain. The foreman asked an operator to start up the water pump. He found that a slip-plate had been left in the suction line to the pump on the drum side of the isolation valve. All the branches on the drum had been slip-plated during the turnaround to isolate the drum for entry. The other slip-plates had been removed but this one had been overlooked by the fitter who removed them and this was not noticed by the process foreman when he accepted back the permit-to-work.

The manager estimated that shutting down the reboiler furnace, allowing it to cool, fitting a hose to the spare branch on the reflux drum, draining the contents to a safe place, removing the slip-plate and warming up again would result in twenty-four hours delay. The maintenance foreman, a man of great experience, who was also present, offered to break the joint, remove the slip-plate and remake the joint while the water ran out of it. He could do it, he said, before all the water ran out and was followed by the oil; he had done such jobs before. After some hesitation the manager agreed to let the foreman go ahead. He dressed up in waterproof clothing and watched by the process team, unbolted the joint and removed the slip-plate while the water sprayed out. Unfortunately he tore

one of the compressed asbestos fibre gaskets, half of it sticking to one of the joint faces. Before he could remove it and replace it, all the water ran out and was followed by the oil. Some of the LPG flashed as the oil came out of the broken joint. This cooled the joint and some ice formed, making it impossible to remake the joint. The foreman abandoned the attempt to do so. The reboiler furnace was only 30 m away. As soon as the oil appeared, one of the process team pressed the button which should have shut down the burners. Nothing happened. The process team had to isolate the burners one by one while the oil and vapour were spreading across the level ground towards the furnace. Fortunately, they did so without the vapour igniting. Afterwards it was discovered that the protective system on the furnace had given trouble a day or two before the turnaround started. foreman on duty therefore took a considered decision to by-pass it until the turnaround, when it could be repaired. Unfortunately there was so much work to be done during the turnaround that this late addition to the job list was overlooked. Although there was no injury or damage, both could easily have occurred, and there was a day's loss of production. The incident was therefore thoroughly investigated, as all dangerous occurrences and near-misses should be. In the following we assume that each member of the five-man investigating panel wrote a separate report, each emphasising different causes and making different recommendations.

Write briefly about all five reports (each report should consist 2 recommendations) such that how to prevent such accidents in future for this system.



**Figure:** The reflux drum and connections, showing the position of the slip-plate

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**Quiz No 3**

CHE C413 Process Plant Safety

Maximum Marks: 5

Weightage: 5%

Duration: 15 min

(Closed Book)

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1. What are called study nodes in HAZOP studies? (1m)
  
  
  
  
  
  
  
  
  
  
2. Match the following (modes of gas measurement and its source) (2.5 m)

a) Ultrasonic sensor	-	i) ultraviolet lamp
b) Infrared	-	ii) electrical resistance
c) Photo ionization	-	iii) high pressure pipe line
d) Catalytic sensor	-	iv) anywhere in line of sight
e) Thermal conductivity	-	v) none
		vi) thermal resistance
  
  
  
  
  
  
  
3. Match the following (material of construction) (1.5 m)

i) Titanium	a) Wet chlorine
ii) Acid	b) Aluminum
iii) Caustic soda	c) Dry chlorine
	d) FRP
	e) Nitrile rubber
	f) None

4. Discuss any one process plant incident briefly due to modification. (1m)
5. What is called stress corrosion cracking? (1 m)
6. A small, new tank was installed with an unused branch blanked off. A month later the branch was leaking even though it was fully tight. What may be the reason? (1.5 m)
7. Two plates that have been bolted or riveted together. A month later a high pressure develops. This can force the plates apart or even break the bolts or rivets. What may be the reason? (1.5 m)



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**EndSem**

**CHE C413 Process Plant Safety**

Maximum Marks: 80

Weightage: 40%

Duration: 3 hr

(Closed Book)

24.12.2008

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1. (a) Discuss in brief about the substances producing health hazards in electroplating and leather good industries. (3 m)
- (b) Mention the basic requirements and its significance of any air sampling equipments. (3 m)
- (c) Recommend the personal protective equipments for the substances such as  
(i) Ammonia (ii) Hydrogen sulphide (3 m)
- (d) What all to be considered to achieve the ecological safety while siting up an industry. (2 m)
2. (a) Define explosives. (2 m)
- (b) What are the characteristics of low explosives? (2 m)
- (c) Discuss what went wrong in detail about the Chernobyl disaster. (7 m)
3. (a) What steps to be taken to avoid stress corrosion cracking in steel vessel used for storing anhydrous ammonia? (2 m)
- (b) How can wet carbon-di-oxide be responsible for a corrosion problem in iron containing metals? (3 m)
- (c) Sketch the chart for process of risk assessment for the chemical industries. (4 m)
- (d) Define the following terms which is used in HAZOP studies (4 m)
- (i) Intention (ii) Causes (iii) Study nodes (iv) Guide words

4. (a) How the dangerous goods are classified for the chemicals used in process industries. (4 m)
- (b) What are the necessary safety precautions to be taken in the storage of hazardous chemicals? (5 m)
- (c) Mention the causes of runaway reactions in reactors or in storage tanks? (5 m)
5. (a) What are the key points to be considered for the onsite emergency plan in the chemical industries? (4 m)
- (b) What are essentials of safety audit? (2 m)
- (c) How the auditing programs are classified in the process industry. (5 m)
- (d) Explain briefly an accident in process industry due to static electricity from powders. (2 m)
6. (a) Give your recommendations to protect a pressure vessel against fire. (4 m)
- (b) Discuss in detail about a major chemical disaster due to thermal runaway reaction (other than Chernobyl) which should include
- (i) the materials involved (2 m)
  - (ii) causes for runaway reaction (2 m)
  - (iii) what precautions should be considered in future to avoid such incidents (2 m)
  - (iv) examples of runaway reactions. (2 m)
- (c) Define the following terms: (i) Inhalable particles (ii) Atomic absorption (iii) Aerosol (2 x 3 = 6 m)