Course Handout (Part-II)

Date: 14/01/2021

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No. : **CHE F413**
Course Title : **Process Plant Safety**
Instructor-in-Charge : **P C Sande**

1. Course Description:

Role of safety in society; Engineering aspects of process plant safety; Chemical hazards and worker safety; Hazardous properties of chemicals; Safety aspects in site selection and plant layout; Design and inspection of pressure vessels; Storage, handling and transportation of hazardous chemicals; Risk assessment methods; Toxic release; Fire and Explosions; Safety audit; Emergency planning and disaster management; Case studies.

2. Scope and Objective:

- This course deals with various safety aspects encountered in the chemical process industries.
- The primary objective of this course is teach important technical fundamentals for proper assessment of the risks posed by hazardous chemicals and continuous care during their manufacturing, processing, treatment, packaging, storage, transportation, use and sale.
- We will apply the concepts and principles learned in the course to analyze numerous cases of 'real world' chemical process incidents/accidents.
- This course provides guidance for developing industrial safety procedures and equipment designs.

3. Prescribed Text Book:

T1 Crawl D.A., and J.F. Louvar, "Chemical Process Safety: Fundamentals with Applications", Prentice Hall PTR, Englewood Cliffs, New Jersey, 3rd ed., 2012.

4. Reference Book:

R1 Trevor Kletz, "What went wrong? Case Histories of Process Plant Disasters", 4th edition, Gulf Professional Publishing, 1999.

R2 Sanders R.E., "Chemical Process Safety: Learning from case Histories", Butterworth-Heinemann, Boston, 1999.

5. Course Plan

Module	Lecture Session	Reference	Learning Outcomes
1. Introduction to chemical process safety	L1.1 Introduction and discussion of the course content; Recent and historical cases of process accidents; role of safety programs in industry; engineering ethics and professional standards;	1.8 (T1) Examples from R1, R2 and news articles. 1.1 - 1.2 (T1)	• Understand the importance of safety standards in chemical process industries. • Internalize the professional ethics and standards in chemical industry.
	L1.2 Accident and loss statistics, acceptable risk; public perceptions about safety; Natural of accident process and inherent safety;	1.3 - 1.7 (T1)	
2. Toxicology	L2.1 Introduction to Toxicology; Toxicological studies, Dose versus response	2.1-2.4 (T1)	• Understanding the toxicology in biological organisms and toxicology studies. • Understand the dose versus response models for toxicants.
	L2.2 Models of does: response curves, relative toxicity; Threshold limit values	2.5- 2.8 (T1)	
3. Industrial hygiene and personnel safety	L3.1 Introduction to government regulations for worker safety Industrial Hygiene: anticipation and identification	http://labour.gov.in/industrial-safety-health 3.1 (T1)	• Recognize government regulations. • Identify, anticipation, and evaluation of various safety
	L3.2 Industrial Hygiene: Evaluation	3.3 (T1)	

	L3.3 Industrial Hygiene: Control	3.4 (T1)	aspects of industrial hygiene.
4. Source models	L4.1 Introduction to source models; Flow of liquid through a hole; Flow of liquid through a hole in a tank	4.1-4.3 (T1); Read Cases from : 13.1-13.2 (R1); Chapter 2 (R2)	• Understand various aspects of source models for cause of accidents. • Understand the safety aspects in flowing liquid, gas/vapor through holes from tanks, and in pipes. • Identify the causes of pipe and tank failures, and methods to mitigate those failures.
	L4.2 Flow of liquid through pipes; Pipe failures	4.4 (T1); 9.1 (R1)	
	L4.3 Flow of gases or vapors through holes	4.5 (T1)	
	L4.4 Flow of gases or vapors through pipes; Pipe failures	4.6 (T1); 9.1 (R1)	
	L4.5 Flash liquids; liquid pool evaporation or boiling; Realistic and worst-case releases; conservative analysis	4.7-4.10 (T1)	
	L4.6 Review and discussion of source models	L4.1-L4.5	
5. Toxic Release and Dispersion Models	L5.1 Introduction to toxic release and dispersion models; Parameters affecting dispersion	5.1-5.2 (case 10) (T1)	• Understanding the release and dispersion of toxic material. • Study various dispersion models and parameters affecting dispersion.
	L5.2 Pasquill-Gifford Model, (Cases 11-15); dense gas dispersion	5.2 (case 11)-5.4 (T1); 5.3 (T1)	

	L5.3 Dense gas transition to neutrally buoyant gas; Toxic effect criteria; effect of release momentum and buoyancy, release mitigation	5.5-5.7 (T1)	• Apply the toxic release models to mitigate consequences.
	L5.4 Review and discussion of Dispersion Models	L5.1-L5.3	
6. Fires & Explosions	L6.1 Introduction to fires and explosions; Flammability characteristics;	6.1-6.12 (T1),	• Distinguish between fires and explosions • Understand the flammability characteristics of liquids and vapors, gas mixtures and the dependence on temperature and pressure. • Understand various factors effecting the fires • Understand the details of explosions; their causes, methods to measure the resulting damage.
	L6.2 LOC and inerting, Flammability diagram, ignition energy, autoignition, adiabatic compression, ignition sources, sprays, and mists	6.5-6.12 (T1)	
	L6.3 Explosions—Detonation and deflagration, confined explosions, Blast from overpressure, TNT equivalency, TNO Multi-Energy Method	6.13 (T1)	
	L6.4 Explosions –Energy of chemical explosions, Energy of mechanical explosions, missile damage, blast damage to people, Vapor cloud explosions, Boiling-liquid expanding vapor explosions	6.13 (T1)	
	L6.5 Review and discussion of Fires and Explosions	L6.1-L6.4	
	L7.1 Inerting: Purging	7.1 (T1)	

7. Designs to prevent fires and explosions	L7.2 Static Electricity	7.2 (T1)	• Understanding various concepts and strategies to prevent fires and explosions.
	L7.3 Controlling static electricity	7.3 (T1)	
	L7.4 Explosion-proof equipment and instruments; ventilation; sprinkler systems; other concepts for prevention of fires and explosions.	7.4-7.7 (T1)	
8. Chemical reactivity	L8.1 Background of chemical reactivity; Reactive chemical hazards identification and awareness	8.1-8.2 (T1)	• Understand the background and case histories of chemical reactivity hazards • Understand the characterization of reactive chemical hazards, and study the design principles for controlling these hazards.
	L8.2 Characterization of reactive chemical hazards; controlling reactive hazards	8.3-8.4 (T1)	
9. Introduction to reliefs	L9.1 Relief concepts and Definitions; Location of reliefs; Relief types and characteristics	9.1-9.4 (T1)	• Understand the concepts of pressure relief systems and their installation and design criteria to prevent or mitigate hazards
	L9.2 Relief scenarios; Data for reliefs sizing; Relief systems	9.5-9.7 (T1)	
	L10.1 Hazards Checklists, Hazard Surveys; Fire & Explosion Index,	11.1-11.2 (T1)	• Understand the methods of hazard

10. Hazard Identification	L10.2 Hazard and Operability (HAZOP) studies; Safety Reviews; Other methods for hazard identification such as Human Error, FMECA	11.3-11.5 (T1)	identification using checklists and surveys. • Understand the HAZOP studies, safety reviews in a chemical process • Familiarity with concepts of human error and FMECA methods for hazard identification.
11. Risk assessment	L11.1 Review of Probability Theory	12.1 (T1)	• Review the probability mathematics and its use in safety • Understand two probabilistic methods: event trees and fault trees • Understand the concepts of QRA and LOPA
	L11.2 Event Trees	12.2 (T1)	
	L11.3 Fault trees: Theory	12.3 (T1)	
	L11.4 Fault trees: case study	12.3 (T1)	
	L11.5 QRA and LOPA: Theory	12.4 (T1)	
	L11.6 QRA and LOPA: case study	12.4 (T1)	
	L11.7 Review and discussion of Risk Assessment	L11.1-L11.6	
12. Self-Study: Case histories and Major accidents	Static electricity, Chemical reactivity, System designs, procedures, List of Major accidents (1970-1998)	14.1 -14.4 (T1), cases studies from reference R1	• Study major accidents and case histories, apply knowledge gained from the course to analyze the cases.

6. Evaluation Scheme:

EC No.	Component	Duration (Minutes)	Weightage (%)	Date & Time	Remarks
1.	Class activities	TBA	10%	-	In class
2.	Project paper with class presentations	TBA	20%	-	In class and take home
3.	Mid-Semester Test	90	30%	TBA by AUGSD	CB + OB
4.	Comprehensive Exam	120	40%	TBA by AUGSD	CB

*date will be announced in the class

Course Policy:

- Mid Semester Test and Comprehensive Examination are according to the Evaluation Scheme given in the Course Handout.
- If the student is unable to appear for the Regular Test/Examination due to genuine exigencies, the student must refer to the procedure for applying for Make-up Test/Examination (see Academic Regulations-2015). Final decision rests with IC.

Project reports and Presentation:

- The deadline for the report and date of presentations: to be announced in the class.
- Further guidance will be provided during the lectures.

Pedagogy: mode is adapted for online platform and might include film or video clips/ role play or dialogue/ case studies/ breakout sessions etc.

Instructor-in-charge
CHE F413