

Process Safety

Operational Necessity and Optimum Methodology

Swapnil S. Anekar

Abstract— For designing and maintaining various systems in many chemical industries, that involves the storage of hazardous chemicals or materials for its later use. The distinct unit processes and severe chemical reactions may involve erodible endothermic or exothermic reactions. The release of various toxic chemicals in industries may need proper safety precautions. Along with these vicinal conditions, industries also need to study the physical and Thermodynamic conditions of schematically and systematically for implementing corresponding safety parameters. The process safety is an analytical working of the system to take proper safety measures which are required for working of these processes and its proper maintenance at times. Technically a system needs to study the Energy Balance along with the Material Feasibility and proper Material of Construction with inherent obligations corresponding to the distinct systems.

Index Terms— Safety, Industries, Valves, Hazard, OSHA, Systems, Processes, etc.

1 INTRODUCTION

Process Safety briefly includes the idea that, how an appropriate safety precaution satisfactorily aids in working of any process smoothly by rendering the peril factors. This eventually involves the process management for certain ambient conditions or any unascertained activity that instantly creates the inappropriate conditions leading to the various accidents and unhealthy environment. Sometimes, we also need to take proper curative measures immediately to lower the risk and reduce the damage leading to economic and resource losses in the industries. The process safety is essential for working of any system that includes hazardous chemical storage and operating unit processes under critical conditions in Industry. The implementation of specified safety rules and measures at the time of design of processes is a very important step towards the safe working conditions for various chemical processes. In literature many authors have discussed about how improper safety had caused various problems in the industry. This boosts up the safety importance to the statement "Safety Dominates over the Profit". Hence Process Safety is must as an emphasized part to look upon by the industries.

2 PROCESS SAFETY

Process safety works with prevention of the fires, explosion and accidental chemical releases in chemical process industries. It deals with handling hazardous materials also including oils and gas refineries production and installation. The occupational safety and health primarily covers the management of personal safety. However, well developed

management systems also address proper safety issues. Sometimes the tools, techniques and programs are required to manage both the processes and occupational safety may be same (for e.g. Work permit systems)[2], which may have different approaches for various other cases.

3 PROCESS SAFETY MANAGEMENT (PSM)

The process safety is the proclaimed system by the U.S. *Occupational Safety and Health Administration (OSHA)* [2]. In many of the chemical industry the process involves the working with storage, developing and handling of tremendous hazardous chemicals within the unit processes. PSM is the interpretation as well as keen study for the management of this type of system to lower the risk efficiently. Thus, calibration of situational parametric outcomes of a system helps to determine the risks at successions. As a part certain standards are implemented in the working of the system[2]. These standards are composed by the organization, operational procedures design guides and audit programs.

3.1 Principles of process safety management

All tables and figures will be processed as images. According to the OSHA there are fourteen basic principles the process safety management is to be classified.

They are

- Process Safety information
- Process Hazard analysis
- Operating procedures
- Training
- Contractors
- Mechanical Integrity
- Hot Work
- Management of Change
- Incident investigation

• Swapnil Sunil Anekar currently pursuing Bachelors degree program in chemical engineering in Tatyasaheb Kore Institute of Engineering and Technology, India, PH- +918793192209. E-mail: s.s.anekar27@gmail.com

- Compliance audit
 - Trade secrets
 - Employee participation
 - Pre-startup safety review
 - Emergency planning response
- All these factors associate as tool of process safety.

4 INDUSTRIAL RELEVANCE TO PROCESS SAFETY

Industries entirely work on large scale processing either it may be oil refineries or storage of toxic chemicals and handling it. In early stages many of chemical processing industries worked only on the safety of the personnel through various safety equipments and proper training of them. Due to certain mishaps in past few decades the industries are bounded by the jurisdiction to follow the safety system management. To-day, it is mandatory for industries to work, not only on its safety but also to develop the sustainability accordingly by studying the surrounding environmental conduits. Even after taking certain preventive measures industries need to watch out for the unexpected problems.

4.1 Most Common Mistakes in Industries[3]

- The industrial personnel often assume that systems work as intended, despite of many warning signs.
- The good performance examples are cited utmost, while poor ones are overlooked which are soon neglected.
- Analysis of failure in many of the industries doesn't include organization and human resources with appropriate information and technological equipments for proper system management.

Today industries are working on process system management by implementing the systems to work at proper measures by detecting the threats and defects to overcome the problem even at elementary part of process. This modernization has lead to development of safe and fortified system finding the solution to economic and resource loses. They have also taken proper measure for protecting the surrounding environment in the case of any hazardous mishaps.

4.2 Industrial preference to the PSM principles

Most of the industries today mainly work on two key principles of PSM[4].

- 1) Process Hazard Analysis
- 2) Process Safety Information

4.3 Process Hazard Analysis (PHA)

The PHA should include the proper and systematic intention to identify, evaluate and control the hazards involved in any of the chemical process. The PHA should properly be measured by the complexity in any of the process. It is necessary to prepare a prerequisite design for processing system in case of emergency (process system failure) conditions.

4.4 Process Safety Information (PSI)

Process safety information is a keystone to the process safety management. It deals from the resource to process point of view. In order to maintain proper process safety regulations the PSI should include the relevance involving hazards of highly hazardous chemicals used or produced during the process and also the information of involved equipments in the process [4]. The information of technologies, their accessibility corresponding to process should definitely be included. This helps to deliver the necessary information relative to the process.

5 ACTUAL INCIDENTS DUE IMPROPER SAFETY MANAGEMENT

TABLE 1
MAJOR INCIDENTS IN PAST DUE TO IMPROPER PROCESS SAFETY

| Location(year) | Deaths | Injured | Cause |
|-----------------------|--------|---------|---------------------|
| Bhopal, India(1984) | 2000 | - | Isocyanides release |
| Pasadena, TX(1989) | 23 | 132 | Petroleum explosion |
| Cincinnati, OH(1990) | 2 | - | Explosion |
| Sterlington, LA(1991) | 8 | 128 | Chemical Release |

Considering Indian point of view, as informed in KPMG, India contributes 6.7% of gdp with revenue of USD 28billion. There have been many mishaps in India after the Bhopal. It includes[5], Sulfuric acid release, New Delhi (1985, 1 death, 340injured, >10 evacuated); Mumbai oil refinery fire (1988, 16 injured, 35 deaths); Ammonia leakage in Bhatinda (1989, 500 injured); Nagothane Ethane and Propane leakage (1990, 32 deaths and 22 injured); Kolkata chlorine leakage (1991, 200 injured);Vishakapattanam LPG leakage fire(1997, 60 deaths, 31 injured, 150000 evacuated);Vellore explosives explosion (2003,25 death, 3 injured); Toluene fire in Cochin (2004).

5.1 Statistical representation for Process Safety Management

According to the **Chemistry Industry Association of Canada (CIAC) member performance**,the workplace injuries and

illnesses as well as the lost time safety and health record have been actively decreased since the past few decades (1990-2008)[6].

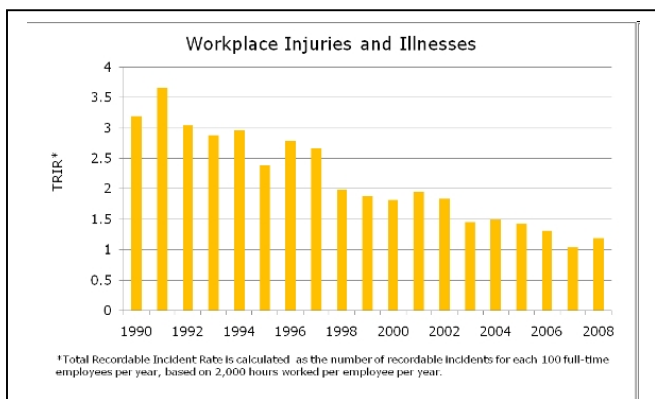


Fig. 1. Total recordable Incident Rate is calculated as the number of recordable incidents for each 100 full-time employees per year, based on 2000 hours worked per employee per year.

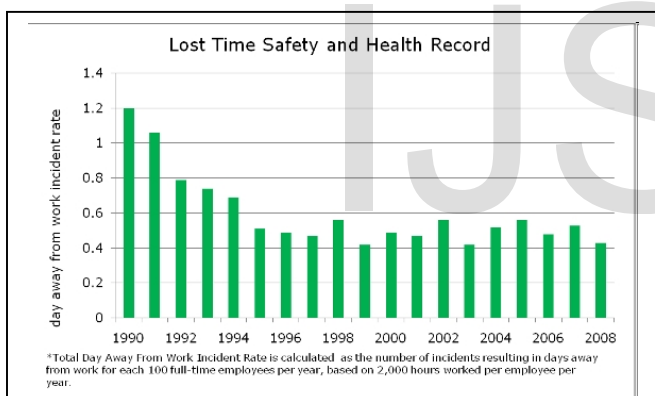


Fig. 1. Total day away from work Incident Rate is calculated as the number of incidents resulting in days away from work for each 100 full-time employees per year, based on 2,000 hours worked per employee per year.

The Process Safety Management has been effectively decreasing the incident rates since the development of proper assessment, empowerment and enhancement of processing systems.

6 PROCESS SAFETY APPLICATIONS FOR CHEMICAL INDUSTRIES

Safety Applications play a Major Role in many of the chemical industries. They need safety specifically on high risk areas

- Boiler units for safety
- Near the storage of toxic materials

- Areas including highly endothermic and exothermic reactions

For these purposes there is requirement of various industrial appliances for the system to manage and stabilize the processing units. Hence, the necessities of these appliances are satisfactorily managed by use of valves in boilers and use of proper safety tanks for hazardous chemical storage tanks that are developed by proper plant designing.

6.1 Process Safety Valve

Safety Valve is an automated valve system that works when the pressure or temperature exceeds its specified maximum limit value.

The valve is a type of pressure relief system that also includes safety relief valves; operated relief valve, low pressure safety valves, and vacuum pressure safety valves.

6.2 Types of Safety Valves

- **Vacuum Safety Valve (combined pressure/vacuum safety valve):** These valves are used to prevent a tank from collapsing while it is emptied or when cold rinse water is used after hot CIP (clean-in-place) or SIP (sterilization-in-place) procedures.
- **Pressure Relief Valve:** These valves work precisely on the liquid filled vessels and open with required increase in internal pressure at specified proportions. Some of the valves included in it are;
 - Safety relief valve
 - Pilot operated Safety Valves
 - Low pressure and Vacuum pressure safety Valves
 - Spring loaded safety valve
- **Thermal Relief Valve:** These types of valves are used generally for the liquid packed vessels. They work on the basis of pressure release in order to protect the system from thermal expansion.

6.3 Sizing, Selection and Setting of the Valves

To deal with the pressure inside the boilers, steam plants and refineries it is but obvious to deal with the proper sizing of valves with proper selection to the appropriate system and setting it at proper segment of the process.

As the valve handles the tremendous pressure and needs to vent it so as to maintain it properly and specifically in the boilers. It is must, to design a specified set point for its applications. In its application for the sectors having possibilities of more than single flow paths the proper sizing and setting of the valve becomes complicated. Hence an alternative method is by sizing it on maximum flow experienced in the flow path with the maximized number of flows[7]. It can also be sized to discharge the flow from combined flow paths. This choice works by determining the loss of two or more device failing at the same time. If there is a slightest chance that this may be occurred, the valve must be

set to allow the discharge from this devices. But, where the risk is very small cost advantages can project the valve through highest fault flow. This may improve its stability thermodynamically.

7.2 Applications

These types of valves have their applications in various industries including the chemical manufacturing, food and drinks, petroleum and petrochemical refineries, natural gas and power generation, pharmaceutical industries[7]. These valves serves as the solution for system with service apparent to the processing conditions.

8 CONCLUSION

- 1) The schematic and systematic analysis with proper safety parameters and various safety applications and instruments should be analyzed.
- 2) Effective methods and modes at hand to approach towards a system as a precaution and cure plays a vital role in safety and hazard analysis.
- 3) Statistics and applications of various safety valves and its detailing corresponding to specific flow conditions are analyzed.

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