

HAZARDOUS PROCESS SERIES (u/s 2(cb) of Factories Act, First Schedule and Schedule-4 of 68-J)

This series has been specifically designed considering the hazardous processes described u/s 2(cb) of Factories Act. Each letter covers ONE such hazardous process out of total. The content of this series has been designed in such a way that any company having any of the hazardous process can get basic guidelines about the nature of reaction and basic safety features which should be taken into consideration while designing such process installations. Detailed safety features can be identified after Process Hazards Analysis by any adequate tool like HAZOP.

ALKYLATION

Alkylation is the transfer of an alkyl group from one molecule to another. The alkyl group may be transferred as an alkyl carbocation, a free radical, a carbanion or a carbene (or their equivalent). This process is used by petroleum and petrochemical refining industries.

Alkylation units are considered the most dangerous in a refinery because a release of hydrofluoric acid from an explosion or fire could spread a possibly lethal vapor cloud across surrounding communities.

GENERAL CHEMICALS INVOLVED IN THIS PROCESS

- Hydrocarbon that has double bonds, such as propylene or butylenes.
- Isobutane
- Sulphuric Acid,
- Hydrofluoric Acid.

PROCESS HAZARDS

- Fire
- Explosion
- Corrosion

NATURE OF REACTION

- The reaction is highly exothermic. Also run-away reaction is possible.
- The unit process large volumes of light hydrocarbons which are highly flammable and potentially explosive.
- The acid catalyst is corrosive and toxic.

MINIMUM SAFETY MEASURES REQUIRED:

- Redundant supply of cooling media to absorb heat of reaction.
- Automated feed cut mechanism in case of abnormal temperature rise.
- Dumping facility of adequate capacity for reaction contents.
- Appropriate size and MOC of pressure relief devices (safety valve & rupture disc)
- Measure to ensure mechanical integrity of reaction equipments.

Some industrial incidents having similar hazardous process:

- **Giant Industries' Ciniza oil refinery in Jamestown, New Mexico, east of Gallup.**

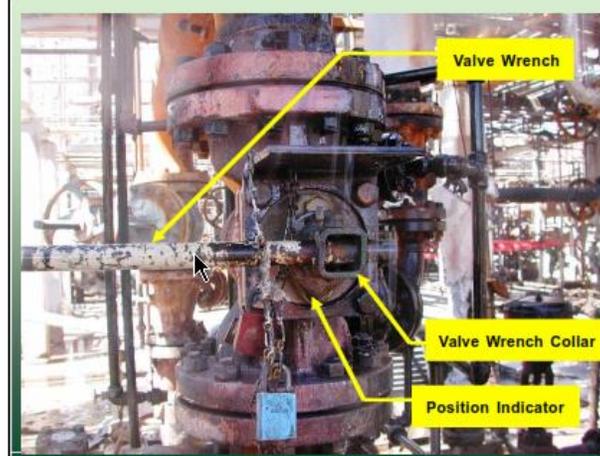
➤ Incident:

When operators attempted to put the spare pump in service, they discovered that it had a leaking mechanical seal and that it would not rotate.

The spare pump was scheduled for maintenance. To isolate the pump for work, plant personnel, using a valve wrench, turned a shut-off valve connecting the pump to a distillation column to what they believed was the "closed" position. Investigators determined that the valve was actually open. An operator disconnected the pump's vent hose to verify that no pressure was in the pump, and witnessed some alkylate flow through the hose. After the flow subsided, he believed that the pump had been de-pressurized and was ready for removal.

The study concluded that the vent line was plugged, not de-pressurized. As the mechanics were removing the pump alkylate was suddenly released at high pressure and temperature, producing a loud roar that was audible throughout the refinery.

Suction Valve and Position Indicator as Found After Incident



One of the mechanics was blown over an adjacent pump and broke his ribs. About 30 to 45 seconds after the initial release, the first of several explosions occurred.

➤ Loss:

The plant operator was covered in alkylate that quickly ignited and seriously burned him. Other personnel suffered burns and eye injuries.

• **BP Texas City Refinery.**

➤ Incident:

The raffinate splitter tower in the refinery's ISOM unit was restarted after a maintenance outage. During the startup, operations personnel pumped flammable liquid hydrocarbons into the tower for over three hours without any liquid being removed, which was contrary to startup procedure instructions. Critical alarms and control instrumentation provided false indications that failed to alert the operators of the high level in the tower. Consequently, unknown to the operations crew, the 170-foot (52-m) tall tower was overfilled and liquid overflowed into the overhead pipe at the top of the tower.



The overhead pipe ran down the side of the tower to pressure relief valves located 148 feet (45 m) below. As the pipe filled with liquid, the pressure at the bottom rose rapidly from about 21 pounds per square inch (psi) to about 64 psi. The three pressure relief valves opened for six minutes, discharging a large quantity of flammable liquid to a blow down drum with a vent stack open to the atmosphere. The blow down drum and stack overflowed with flammable liquid, which led to a geyser-like release out the 113-foot (34 m) tall stack. This blow down system was an antiquated and unsafe design; it was originally installed in the 1950s, and had never been connected to a flare system to safely contain liquids and combust flammable vapor released from the process.

The released volatile liquid evaporated as it fell to the ground and formed a flammable vapor cloud. The most likely source of ignition for the vapor cloud was backfire from an idling diesel pickup truck located about 25 feet (7.6 m) from the blow down drum. The 15 employees killed in the explosion were contractors working in and around temporary trailers that had been previously sited by BP as close as 121 feet (37 m) from the blow down drum.

➤ Loss:

In the explosion, 15 contract employees working in or near the trailers sited between the ISOM and the NDU unit were killed. Autopsy reports revealed that the cause of death for all 15 was blunt force trauma, probably resulting from being struck by structural components of the trailers. Three occupants in the Quality Assurance/Quality Control (QA/QC) trailer perished, and 12 of 20 workers inside the double-wide trailer were killed; the others were seriously injured.

A total of 180 workers at the refinery were injured, 66 seriously enough that they had days away from work, restricted work activity, or medical treatment. The majority of these suffered multiple injuries, typically combinations of: fractures, lacerations, punctures, strains, sprains, and/or second- and third-degree burns. Of the seriously injured, 14 were BP employees; the rest were contractor employees from 13 different firms. Of the 114 workers given first aid, 35 were BP employees; 79 were contract employees from 14 different contracting firms. None of the contract workers in the area surrounding the ISOM were personnel essential to the startup of the unit. The satellite control room was severely damaged and the catalyst warehouse was destroyed. Many of the approximately 70 vehicles in the vicinity of the ISOM unit were damaged and a number were destroyed. More than 40 trailers were damaged; 13 were destroyed. Windows were shattered in homes and businesses located north of the refinery, up to a distance of three-quarters of a mile away from the ISOM unit.

Bringing to you the "Act-Now" solutions of process safety...

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