When Workarounds Backfire

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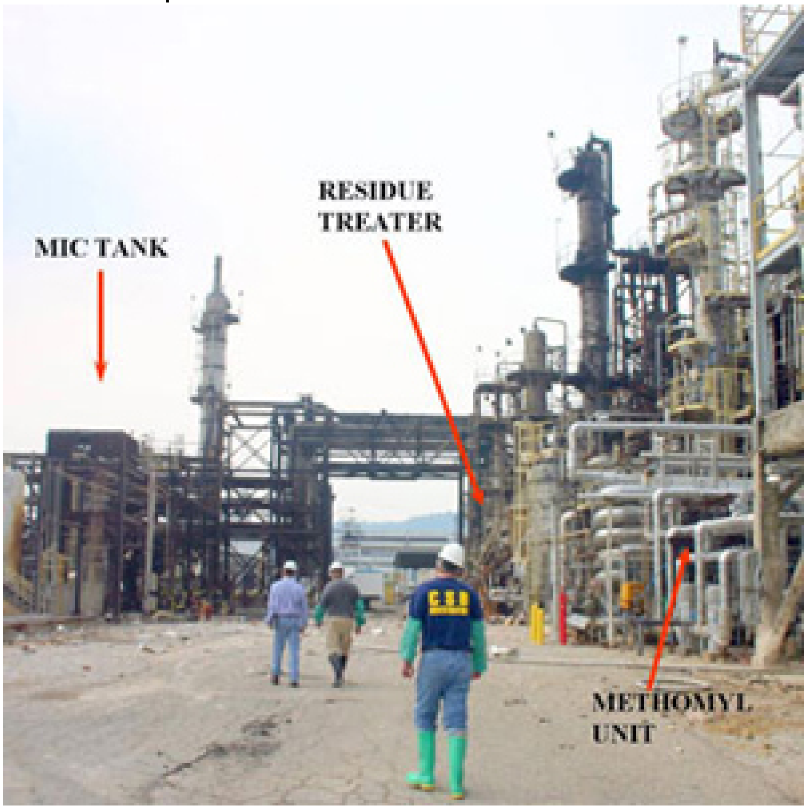

On August 28, 2008, a runaway reaction inside a pesticide residue treater at the Bayer CropScience facility in Institute, W.V., resulted in a violent explosion that propelled the treatment vessel 50 feet through the air and caused extensive damage to the surrounding infrastructure. Two operators were killed in the blast and eight others were sickened by the chemical exposure that followed. The Chemical Safety Board (CSB) identified four areas that could have contributed to the blast:

Equipment deficiencies — the residue treater was fitted with an undersized heater that required operators to break procedure and use a workaround solution. The safety interlocks controlling the flow of chemicals into the vessel were sidestepped, which resulted in a methomyl concentration 20 times the recommended maximum level. Workers attempted to check the unit's venting system when the internal pressure became elevated, but it is not clear why the system did not mitigate the pressure buildup.

Improper procedures — the workaround procedures mentioned above were never subject to the formal management-of-change safety reviews required by OSHA's process safety management standard.

Lack of training on new computerized control equipment — Bayer upgraded its computerized controls with a system that used a completely different user interface. The control screens looked completely different and a mouse was used instead of a keyboard. Operators were not fully trained to use the complex system, and written operating procedures were significantly out of date.

Operator fatigue — it was common for operators to work 20 hours of overtime a week, with 12- to 18-hour shifts regularly occurring.

This explosion also raised questions about the use and safe storage of the highly toxic pesticide additive methyl isocyanate (MIC) as a pressure vessel containing 13,000 pounds of the chemical was 80 feet away from the residue treater when it exploded. The devastating effects of an MIC leak were felt in Bhopal 26 years ago — the workers and residents surrounding the Bayer CropScience plant were extremely lucky the MIC vessel was not breached.

Although the CSB's safety recommendations for this incident will not be released until September 2010, there are a number of prevention strategies that can be adopted to reduce the chance of a runaway reaction at your facility.

Reduce Runaway Reactions

In 2004, the Center for Chemical Process Safety released a safety alert summarizing the chemical engineering principles necessary to safely design, scale up and operate chemical reaction processes. The first part of the document is a detailed checklist that can be used to identify chemical reaction hazards.

Source: CSB

Also included is a series of reaction process design considerations aimed at reducing the chance of a runaway reaction or other unintended reaction. More information on each point is available at www.aiche.org [1], but the underlying principles are:

- Rapid reactions are desirable.
- Avoid batch processes in which all of the potential chemical energy is present in the system at the start of the reaction step.
- Use gradual addition or semi-batch processes for exothermic reactions.
- Avoid using control of reaction mixture temperature as the only means for limiting the reaction rate.
- Account for the impact of vessel size on heat generation and heat removal capabilities of a reactor.
- Use multiple temperature sensors, in different locations in the reactor, for rapid exothermic reactions.
- Avoid feeding a material to a reactor at a higher temperature than the boiling point of the reactor contents.

Inherently Safer Technologies (ISTs) If a runaway reaction does occur, the resulting damage can be mitigated through the use of ISTs. The American Chemistry Council lists four strategies for using ISTs to reduce and manage risk:

- Minimize the amount of hazardous material in particular usages.
- Substitute a less hazardous material.
- Moderate the conditions in which hazardous chemicals are produced (less heat, lower pressures).
- Simplify the process to reduce opportunities for errors that can lead to unwanted exposure.
- In addition, safe storage methods, such as underground tanks, can protect hazardous materials from explosions, projectiles or any other element that could compromise the safe containment of materials.

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