CCPS An AIChE Technology Alliance
Center for Chemical Process Safety
www.aiche.org/ccps

Process Safety Beacon

http://www.aiche.org/CCPS/Publications/Beacon/index.aspx

Messages for Manufacturing Personnel

This issue sponsored by
ioMosaic
www.iomosaic.com

Runaway reactions caused by contamination

February 2018

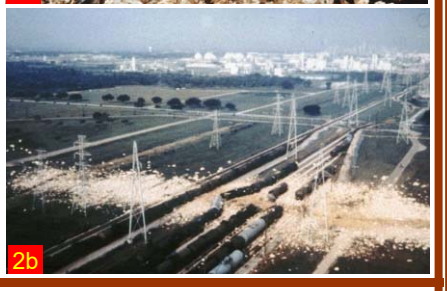
Incident 1: A pipe containing an organic residue from distillation processes and liquid drained from process vent systems was isolated by closed valves. The pipe was steam-traced to keep the residue from solidifying. During a weekend shutdown, the pipe exploded (Figures 1a and 1b). Nobody was injured because the building was not occupied, and damage was minimal.

Incident 2: A railroad tank car containing crude methacrylic acid (MAA) was observed to be hot and venting material from its relief valve. The area was evacuated, and after some time the rail car exploded, destroying the car and causing significant damage in the area (Figures 2a and 2b) Because people had evacuated, there were no injuries.


1a


2a


1b


2b

What Happened?

Most incidents have multiple causes. For each of these incidents, contamination was a contributing cause.

Incident 1: The temperature control system on the steam tracing for the pipe had failed, resulting in high temperature. This should not have resulted in decomposition and explosion, but the residue had been contaminated with about 1% water. Water vapor from process vessels condensed in the vent system and drained into the residue tank. Laboratory tests confirmed that this amount of water reduced the decomposition temperature of the residue by about 100°C. The temperature resulting from the steam temperature control failure was high enough to initiate decomposition.

Incident 2: Crude MAA contains strong mineral acids from the manufacturing process which corrode stainless steel. The dissolved metal from corrosion increases the tendency of MAA to polymerize. Crude MAA is supposed to be stored in lined tank cars, but, in this incident, an unlined stainless steel tank car was used. Also, the plant did not add the specified amount of polymerization inhibitor to the crude MAA. The inhibitor stabilizes MAA by stopping slow polymerization that occurs, even in pure material. The metal contamination from corrosion of the tank car may have induced the polymerization, and the reduced inhibitor concentration diminished the stability of MAA, ultimately leading to the runaway polymerization and explosion.

References: Incident 1 – Hendershot, et al., *Process Safety Progress* **22** (1), pp. 48-56 (2003). Incident 2 – Anderson and Skloss, *Process Safety Progress* **11** (3), pp. 151-156 (1992).

What can you do?

- When you check safety information (Safety Data Sheets, operating procedures, etc.) for materials in your plant, pay attention to possible hazardous reactions such as decomposition and polymerization as a result of contamination. Be aware of any specific contaminants of concern which are present in your plant.
- Some contaminants are common – rust, water, heat transfer fluids, lubricants, metals and other products from corrosion of pipes and equipment. Know if any of these common contaminants are of concern for your process.
- Recognize that even a small amount of contaminant can be enough to cause a dangerous reaction.
- Follow all procedures for avoiding contamination in your plant and equipment. Take special care to verify the identity of materials before unloading into storage tanks or other plant equipment.
- Always use the correct material of construction for all components when doing maintenance in your plant.
- Confirm that containers you fill (pails, drums, tank trucks, rail cars, etc.) are the correct material of construction.
- Make sure that pipes, vessels, and portable containers that you use are clean. "Clean" means free from deposits, residue, rust, or other contamination as appropriate and defined by your plant procedures for the specific service.

A small amount of contamination can cause a big problem!

The Beacon is usually available in Afrikaans, Arabic, Catalan, Chinese, Czech, Danish, Dutch, English, Filipino, French, German, Greek, Gujarati, Hebrew, Hindi, Hungarian, Indonesian, Italian, Japanese, Korean, Malay, Marathi, Mongolian, Persian (Farsi), Polish, Portuguese, Romanian, Russian, Spanish, Swedish, Telugu, Thai, Turkish, Urdu, and Vietnamese.