Batch Sizes—Overdoing It

Carrie Ellis, Editor

Source: CSB

On an average workday, January 31, 2006, one chemical company tried to accomplish too much at once. You know how it is. A big order comes in with short turnaround times and even shorter deadlines. Some times, a company can get away with making these concessions, but you need the right equipment, the right process, the right expertise and the right follow-through. That being said, there's an awful lot to consider to perfect the equation, especially when your facility and employees' safety are at stake.

Other times, you can't get away with upping manufacturing capacity regardless of the conditions. This was the exact situation at the Synthron chemical-manufacturing facility in Morgantown, NC that fateful day. The decision to double the usual batch size was only part of the story.

A runaway chemical reaction sparked into an explosion in a 15,000-gallon process vessel that contained butyl acrylate, along with the flammable solvents toluene and cyclohexane. The tragic consequence of this long chain of events was 14 people sustaining injuries, of which two were critical, while one worker sustained fatal burns.

Additionally, according to the Chemical Safety Board (CSB), the blast destroyed the facility and broke windows up to one-third of a mile away. Two churches and a

home were damaged and later condemned, while Synthron filed for bankruptcy. The facility has not been rebuilt.

Judging from the CSB's investigative analysis, it's probably a good thing that the company decided to not rebuild. The board found that the facility's management was at fault for mismanaging reactive chemical hazards and being unprepared for chemical process emergencies.

Details of the Runaway

The Synthron facility processed acrylic polymers, routinely used in paints and coating additives. The CSB investigation notes that "The polymers were typically produced inside a batch reactor by chemically reacting a blend of acrylic monomers in a mixture of flammable solvents. The polymerization reaction produced significant heat, which was removed by condensing the solvent vapor in an overhead water-cooled condenser. The cooled, condensed solvent then flowed back into the reactor, keeping the temperature and the reaction under control."

However, as aforementioned, plant managers were trying to accomplish too much without the right equipment in place and without adequate maintenance procedures for the equipment involved. Rather than running two small batches to fulfill an order, workers ran one large batch, simply adding the extra requisite acrylic monomer during the first step.

Meanwhile, Synthron employees didn't account for the extra heat that may be created as a result of this addition. In fact, the CSB estimates that this mistake alone caused the usual heat generated by this process to escalate by a factor of at least 2.3. The cooling condenser was not designed to withstand this capacity of heat, thereby unleashing the subsequent runaway chemical reaction.

Source: CSB

After the chemical reaction was initiated, a group of machine operators noticed that some solvent vapor was escaping from the top of the reactor. But it was too late. The equipment was already in the process of overheating, and an excessive amount of pressure was mounting within the reactor. Luckily, the operators observing the vapor knew enough to flee the area, yet they gathered just outside of the production area, huddling near a doorway.

The CSB reports that is when “A flammable vapor cloud formed inside the building, and a short time later it ignited and exploded, destroying the production facility and fatally burning a maintenance supervisor who had remained inside. Personnel who gathered just outside the building were among the injured.”

Preventing the Runaway Reaction

It became apparent, through the CSB’s investigation, that safety was not necessarily top priority at the chemical-manufacturing plant, nor were the inexperienced workers properly trained. (Most employees had been on the job for less than a year.) The CSB cited ineffective corporate oversight, a lack of emergency planning and deficient reactive chemical process training and safeguards as contributing to the likelihood and severity of the accident.

Moreover, the CSB estimates that the flammable release occurred when the reactor reached a pressure of 23 PSIG, which was well below the reactor's maximum working pressure of 75 PSIG. Further, Synthron had a long-standing practice of improperly securing the reactor hatch, using only four of the 18 metal clamps recommended by the manufacturer. Once the condenser cooling capacity was exceeded during the runaway reaction, the failure to fully clamp down the hatchway compromised the performance of the hatchway gasket, which allowed flammable solvent vapors to be released into the building.

According to CSB Lead Investigator Jim Lay, “Synthron had apparently never documented the actual capacity of the cooling equipment, which was essential to keeping reactions from running out of control. The CSB also found no evidence that the company had ever cleaned or inspected the cooling water side of the condenser on the reactor for 30 years.”

In conclusion, here is a wrap-up of safety tips that could’ve prevented this catastrophe, which you may easily incorporate into your process safety:

- Know your equipment—or more importantly—know your equipment’s limitations.
- Know your process in detail, including what may happen if you must tweak certain steps.
- Keep regular cleaning and maintenance schedules for each piece of equipment in your plant.
- Be aware of all potential chemical reactive hazards.
- Implement, document and maintain appropriate safeguards to reactive hazards, including equipment, such as instrumentation that may automatically detect (high-pressure alarms), prevent (automatic emergency cooling systems) or lessen the severity (automatic systems to empty reactor contents to a safe place) of a runaway reaction.
- Manage changes to chemical recipes and their effect on equipment.
- Train personnel on emergency evacuation alarms and procedures, and conduct emergency drills.
- Train personnel on reactive hazards, safe operating limits, and the consequences of and responses to deviations.

Source URL (retrieved on *11/20/2014 - 10:01pm*):
http://www.chem.info/articles/2010/06/batch-sizes%E2%80%94overdoing-

it?cmpid=related_content