

Process Safety Incident of the Week

Waste Water Pit Explosion in Brazil

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On Sunday, July 26, 1998 at 2:40 AM, an explosion with a shock felt as far as 500 m away occurred in wastewater Pit No. 1 at a chemical plant manufacturing organic peroxides in Brazil. People in the nearby village were awakened and saw a big flash. There were only a few flames from the pit and from some drums around it. The flames were extinguished after 10 min following activation of the fixed fire protection system and action by the facility fire brigade. The main production cell was shut down for 20 days and some plant repairs were needed. Wastewater at the site was initially separated depending on the pH. Acidic wastewater had accumulated in Pit No. 1 from 1 week's production of organic peroxides, primarily methyl ethyl ketone peroxide (MEKP). As Pit No. 1 was not stirred over the weekend, a separation could develop over time with an upper organic layer containing peroxides. The exact initiation mechanism is unknown; however, non-phlegmatized MEKP is known to be extremely unstable. It may be that materials falling into the pit were sufficient to start the decomposition. Otherwise, the hot weather conditions on Saturday may have allowed a decomposition reaction to reach the point of self-accelerating reaction and explosion. There was only 2,000 L of wastewater in the pit, and the pit capacity is $\sim 12 \text{ m}^3$, so the level was low. The confinement effect of the pit walls focused the pressure waves upward and blew off the agitator support grill and angle irons. Damage included blowing out window frames, doorframes, glass, and fan blades. Some corrugated metal panels were deformed, concrete walls on production cells were spalled, and a drill stand was snapped off. Also, the fixed fire protection system was damaged and reduced the ability to passively fight the fire.

The energy released in the explosion was estimated from window breakage to be 16 kg of TNT. Window breakage usually provides the best evidence for setting explosion energy. Analysis of panel deformation on buildings provided 18–23 kg of TNT as a mean with 45 kg TNT as a high value. These estimates agree well with the 7.5–39 kg of TNT available energy estimated from vapor concentration calculations in the pit.



Lessons Learned

The incident emphasized the need to clarify written procedures and to respond actively to minor events. The significant hazards of non-diluted MEKP were well known to the facility; however, no connection was made between this and the change to remove agitation on the weekends. In fact, there was a warning in this case. On the previous Monday, water from one peroxide batch was sent by mistake to the wrong pit where decomposition occurred. This event was not reported to management as required in local systems. Additionally, for over 20 years, the plant sent all wastewater (after pretreatment) to an off-site facility in a local town. When a required change was made a year earlier to transport effluents away by trailer after neutralization, no clear procedure was written to cover wastewater. One consequence was that responsibilities for waste water and for what happened outside the production cells were not transparent. As a result of the explosion in Pit No. 1, the company built an appropriate safety-training program, renewed internal process safety systems, and strengthened local expertise.