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Messages for Manufacturing Personnel

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…but the temperature was below the flash point!

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In 1986, there was an explosion in a 10 gallon (~38 l) agitated vessel in a pilot plant. An oxidation reaction was being done in a pure oxygen atmosphere at 250 psig (1825 kPa). It was thought that the vessel atmosphere was safe from ignition since the vessel was operating 50°C below the flash point of the contents in the oxygen atmosphere, and the fuel vapor concentration was below the Lower Explosive Limit (LEL). Processing conditions were stable for 41 minutes when suddenly the explosion occurred. It ruptured the 750 psig (~5200 kPa) reactor, did significant damage to the facility (Fig. 1), and started several small fires. Fortunately, nobody was injured.

Fig. 1: Damage to the facility

Because the vessel was operating below the flash point of the contents, the concentration of ***fuel vapor*** in the vessel atmosphere was too low for ignition. There should not have been an explosion hazard. But the fuel may not only be present as a vapor (remember dust explosions). The investigation determined that the vessel agitator created a fine mist of liquid droplets (Fig. 2). The tiny droplets were estimated to have an average size of about 1 micron. In comparison, the diameter of a human hair is 40-50 times larger than the mist droplets. Flammability testing demonstrated that the mist could be ignited at room temperature in air – and the mist would be ignited even more easily in a pure oxygen atmosphere. The vessel contained both fuel and oxygen – but what was the ignition source? Although it is often difficult to identify an ignition source for an explosion, the investigation determined that the most likely ignition source was a contaminant, left over from a previous experiment in the vessel, which decomposed and generated enough heat to ignite the mist.

[Reference: Kohlbrand, H. T., *Plant/Operations Progress* **10** (1), pp. 52-54 (1991).]

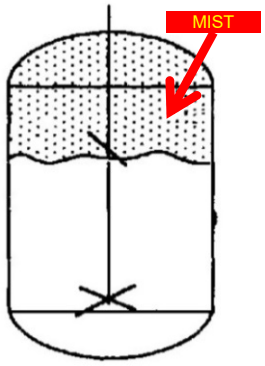

Fig. 2.: What happened? The agitator created a mist of very small combustible liquid droplets

Did you know?

- A mist of combustible liquid drops at temperatures below the flash point of the liquid can be as explosive as a fuel vapor-air mixture. The explosion mechanism is similar to a dust explosion, except that the fuel is present as small drops of liquid rather than small, solid particles.
- A mist can be formed in many ways. In this incident, vigorous stirring by an agitator blade near the liquid surface generated the mist. A mist can also be created by a liquid leak from a pressurized pipe, vessel, or other equipment – for example, a flange leak, a hole in a pressurized pipe or vessel, or a leak from a pump seal.
- Don't forget that a leak from a utility or maintenance system can create an ignitable mist. For example, there have been incidents of ignition of mist from a leak of lubricating, heat transfer, or fuel oil.

What can you do?

- Be aware of the potential for fire or explosion of a mist of flammable or combustible liquid when responding to a leak or spill. If there is a mist present, don't assume that there is no hazard because the temperature is below the flash point. Take the same precautions that you would to prevent ignition and protect people if the leak had resulted in a flammable vapor cloud.
- If you observe a mist or fog inside any process equipment inform your management so they can ensure that proper protective measures are in place.
- Promptly report any leaks of flammable or combustible materials, including utility fluids, if you see them in your plant.

Remember that combustible liquid mists can burn or explode!

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