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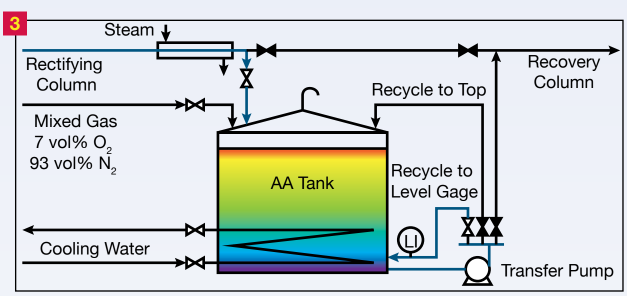
Several Small Changes Can Add Up to a Big Problem

A 70-m^3 (18,500-U.S. gal) fixed-roof acrylic acid (AA) tank exploded, causing a fire at an industrial site in Himeji, Japan, in September 2012, destroying the tank and damaging nearby facilities (Image 1 and Image 2). A firefighter was killed and 36 people were injured, including two police officers, 24 firefighters, and 10 plant workers. The surrounding neighborhood and environment were not impacted.

The tank provided intermediate storage between two distillation columns that purified AA. Originally, the tank had been used at full capacity. The contents were cooled and mixed by being pumped from the bottom of the tank to the top. Later, the normal operating level was reduced to a level below the cooling coil. The contents were not recirculated to the top of the tank, but instead to a nozzle near the bottom that was also used to connect a level gage (Image 3).

At the time of the explosion, the plant was conducting a test of the downstream distillation column, which required stopping the feed from the AA tank. The level of the tank gradually increased to its original operating level. Because the recycle to the top of the tank had been stopped, the AA above the cooling coils was not mixed and cooled. The temperature of the incoming AA was believed to be below the onset temperature for polymerization, and it contained polymerization inhibitor. However, the temperature in the tank increased, particularly at the top, and the tank eventually overpressurized and exploded.

Reference: Accident Investigation Committee, "Nippon Shokubai Co., Ltd., Himeji Plant Explosion and Fire at Acrylic Acid Production Facility Investigation Report," Nippon Shokubai Co., Osaka, Japan (Mar. 2013).



What happened?

- Originally the pipe feeding the tank was jacketed with hot water to prevent it from freezing, but later the jacketing was changed to steam.
- Removal of a steam trap made temperature control unreliable.
- Once the recirculation was turned off, the top layer was no longer mixed with cooler AA from the bottom, and the incoming AA maintained the warm temperature.
- AA undergoes two exothermic self-reactions — dimerization and polymerization. Polymerization inhibitor does not stop the dimerization reaction. Experiments showed that heat from dimerization raised the temperature sufficiently to start a runaway polymerization reaction.
- The hazard of heat from dimerization was not recognized, so recirculation to the top of the tank was not resumed.
- The tank had no temperature indicator. The first indication of a problem was observation of AA vapors escaping from the top vent of the tank.

What can you do?

- Never make any changes to your plant, even changes you think are small, without following a management of change (MOC) procedure.
- When you see any change in your plant, ask if there has been a MOC review. If there has been, and you were not informed of the change, tell management. You should always be informed of changes to the plant that impact your job.
- If something is different from normal operation, confirm operating procedures or ask your supervisor what to do.
- Accumulation of small changes can cause an incident with a big consequence. All small changes must be identified and the risk to the total system analyzed and adequately managed.

Small changes can have big consequences!