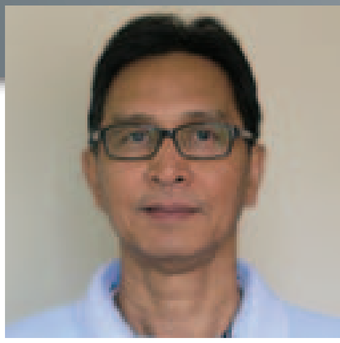

Difficult situations lead to lessons learned

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Thawing sulfur lines

Molten sulfur from nearby refineries is normally transported to the plant by trucks and unloaded directly into sulfur pits or aboveground storage tanks. If the plant is near a waterway, barge transport can be used more economically. The plant in this particular example uses both methods of transport.

Offloading from barges requires a pump and piping system. The pump draws molten sulfur from the storage tank in the barge and pushes it through a carbon steel pipeline to an elevated aboveground storage tank situated a considerable distance away. After emptying the barge, any remaining sulfur in the pipeline stays there until the next unloading batch. To keep the residual sulfur in its molten state and to prevent it from freezing during downtimes, it is important that all components of the pipeline, including the pump, be heat traced and properly insulated.

During one of the downtimes in this particular plant, the steam tracing encountered a problem and the molten sulfur that remained in the line froze. Steam tracing was eventually restored and thawing of the line started. After a few hours, a loud noise was heard and molten sulfur was seen spewing from a portion of the pipeline. What went wrong? The pipe experienced a thick-lip rupture as shown in Fig. 1. This rupture is indicative of over pressurization. Investigation revealed that only a section of the pipe was being thawed and the molten sulfur was blocked in. The inability of molten sulfur to thermally expand created over pressurization of the pipeline.

Lesson Learned:

Always start thawing frozen sulfur lines from one end to the other to allow free thermal expansion of molten sulfur. Procedures must be set in place and heat tracing must be designed to allow this.

Profiling is good practice

A pressure profile of the entire acid plant is one of the important metrics for gauging the current condition of a plant. It is an excellent tool for predicting the maximum attainable production capacity of the plant, troubleshooting equipment, scheduling much needed equipment inspection and maintenance, and planning for replacement of equipment.

Fig. 1: Thick-lip rupture of 8" sulfur pipe.

Pressure surveys should be religiously taken on every piece of equipment and the data gathered must be trended and reviewed regularly for the surveys to be effective. Failure to perform these steps will result in serious consequences. Such is the case for a plant that stopped gathering and trending data on some equipment because the pressure points were plugged with sulfate due to lack of maintenance. This continued for a long time and the drying tower and absorber tower packing were allowed to operate beyond their operational limits. The result was loss of absorption efficiency, as evidenced in Fig. 2, and serious acid entrainment, which in turn caused the following effects: damage to downstream ducting, the sulfur furnace windbox and catalyst, as well as higher than normal acid condensation in the cold end of the cold-reheat exchanger. It should be noted that loss of absorption efficiency in drying and absorbing towers can also be the result of plugged trough distributor orifices and/or down comer tubes.

The packing in the towers was found partially plugged with sulfate. This required separate shutdowns months apart to repack the towers. Much repair was needed because the ducting and catalyst-screening loss was higher than expected.

On a similar note, ignoring the data and continuing to run with higher than allowed pressure drop would also result in serious consequences. Such is the case for another plant that ran converter bed 1 pressure drop up to 52" WC. The plant shut down on account of higher than normal bed 2 exit temperatures and an increase in stack SO_2 emissions. On inspection, it was found that the pie-shaped catalyst bed support separated at the seams and at the core tube by at least 2" allowing catalyst to fall off. The core tube also had vertical cracks that propagated by at least 3" above the catalyst bed support.

Fig. 2: Drying tower mesh pad corrosion due to loss of absorption efficiency.

Lesson Learned:

Pressure profiles must be taken at least during each operational shift and the data gathered should be trended and reviewed on a regular basis to be able to identify potential problem areas.

Pressure points must be maintained and kept open and clear of sulfate at all times.

Never exceed the operating limits of the equipment.

Lower pressure drop is not always good

One of the most effective and economical strategies employed by designers to increase the capacity of an existing acid plant is to reduce equipment pressure drop wherever it may arise. In addition to increasing the plant throughput, this strategy also decreases power consumption.

The absorption section of an acid plant is a potential area for reducing equipment pressure drop. Some plant's drying and absorbing towers to date still use cast iron trough-, pipe- and even pan-type distributors. The pipe-type distributor is normally buried in the packing to minimize acid mist formation; the pan-type and sometimes the trough-type are laid just above the saddles. These placements block a good portion of the tower cross-section, thus contributing to pressure drop.

The use of cast iron distributors and piping also contribute to pressure drop as the ferrous sulfate, which is a product of corrosion, gets deposited in the packing, complicating things further. Designers have been pushing for and now most plants are moving towards alloy distributors to eliminate ferrous sulfate formation.

Use of low-pressure drop packing is also increasing. Some designers have been replacing the traditional 3" + 2" Intalox saddle-packing combination with all 3" Intalox or Super Intalox saddles. All this for reducing pressure drop; which is good, but not always!

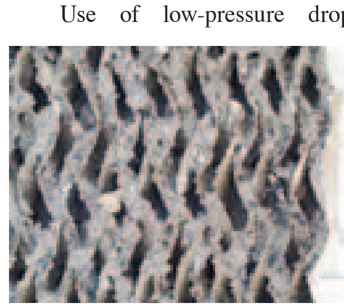

Fig. 3: Clogged bottom section of heat transfer fill.

A case in point is an acid plant that repacked a brick-lined absorber tower with structured packing. This job included replacing the cast iron pan-type distributor with an alloy pipe-type distributor. The design change was done at the plant using in-house engineering support. The placement of the distributor was above the 2" saddles that are atop the structured packing. The realized pressure recovery was tremendous, but absorption efficiency suffered significantly. The plant had to perform emergency measures to put back some pressure drop at the distributor level.

Another case in point is an acid plant that used all 3" Super Intalox saddles to replace the 3" + 2" saddle-packing combination in drying and absorbing towers in order to decrease pressure drop. Some pressure loss was gained, however higher moisture off of the drying tower was measured and a hazy stack occurred after the repacks.

Lesson Learned:

Always perform a proper technical review with the help of an external consultant before proceeding with design changes. All modifications should be properly vetted to minimize risks.

Don't ignore the cooling tower

Cooling towers provide heat removal through evaporation of the plant's process water. Most plants use induced draft, cross- or counter-flow type, with or without heat transfer fills. They are usually constructed out of redwood or Douglas fir lumber. They are reliable pieces of equipment. Except for maintenance of water chemistry and rotating equipment, plants normally don't pay attention to maintenance of structure, especially when new. During turnarounds, work is mostly focused on cleaning the basin, but inspections to check for structural integrity are not normally scheduled. Such is the case for an acid plant in North America. The heat transfer fills were ignored and no inspection was performed for many years. It was only when the water outlet temperature crept up to 10 degrees that Operations was prompted to schedule an inspection. It was found that the heat transfer fill was almost plugged up with silt at the bottom section, as shown in Fig. 3. The top section was fouled but not clogged as shown in Fig. 4. Clogged heat transfer fills add load to the supporting structure. In this particular case, the increased weight of the fill was found to be six times the original installed weight. Luckily, the supporting structure did not collapse.

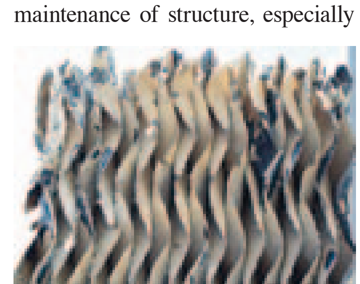

Fig. 4: Fouled top section of heat transfer fill.

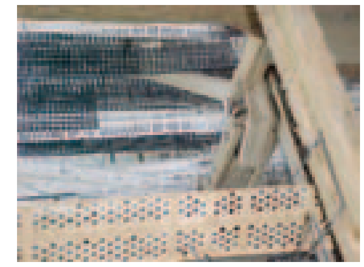

Fig. 5: Broken wooden column inside a cooling tower

In another North American acid plant, a worker who was climbing down the stairs of a cooling tower broke one of the treads and sprained an ankle. This prompted inspection of the cooling tower's structural components. The inspection revealed that the wooden components had deteriorated so badly that even some of the posts inside the cooling tower were broken, as shown in Fig. 5. Corrosion was so bad that the cooling tower was at critical risk of collapsing. Emergency measures were set in place to stabilize and prevent the tower from collapsing under high wind conditions.

Lessons Learned:

Cooling towers require regular inspections for corrosion, fouling, and mechanical/structural integrity of their components, just like any equipment in direct contact with acid, SO_2 or SO_3.

Heat transfer fills can easily get fouled, especially when water chemistry is not under control, and can easily get clogged in dusty environments. Deposits can add a few hundred pounds to the heat transfer fill's own weight.

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