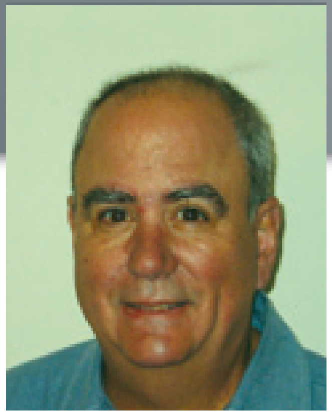

GUEST COLUMN

Process monitoring

By: Rick Davis, Davis & Associates Consulting Inc.

It is commonly accepted that preventive maintenance will reduce maintenance costs and increase equipment reliability. Normally, this would include vibration measurements and trending, lubrication and oil samplings. In the sulfuric acid process, moving air through the process equipment is key to maintaining plant performance. Routine gas pressure drop profiles are recommended by all plant designers. In addition, steam conditions over time should be monitored. The history of profiles is extremely useful during troubleshooting after plant situations. Pressure profiles, like vibration readings, provide trends to maintenance requirements. The profiles must be reviewed and evaluated regularly.

The evaluation of the plant parameters and trends in recent years has been transferred to a computer or historian data storage device and many plants do not review this data until a problem has occurred. Preventive maintenance is about preventing incidents, but the current trend is using historian data after an incident or a problem. Although the data is normally not used for preventive or predicted maintenance purposes, it can be very useful in foretelling future events.

An example where plant data provided a clear history but was not observed is as follows: A sulfur burning acid plant had an issue concerning steam purity but did not identify the problem for over ten months, even though the data was there.

The steam superheater following the steam drum cooled the converter gases leaving the first catalyst bed. The temperature to the second bed was controlled by by-passing steam around the superheater. After an operational upset, the steam by-pass valve position trended closed, which caused loss of control of the inlet temperature to the second bed of the converter. This was the first indication of a steam purity problem.

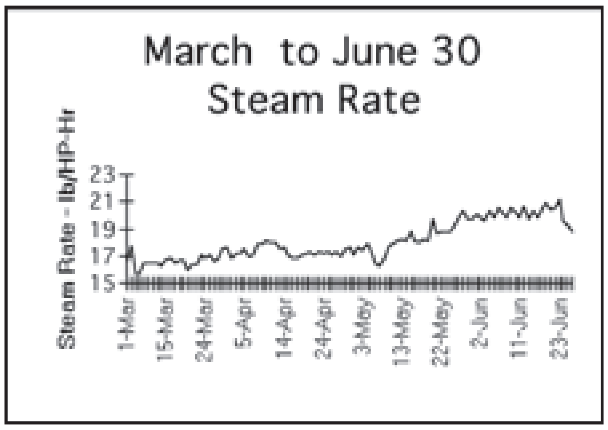

Fig. 1: Increasing steam rate in air turbine indicates thermal inefficiencies.

The main air blower steam turbine began having axial position problems caused by the build-up of solids from boiler water carryover. The review of the turbine thermodynamics showed a clear trend of reduced efficiency caused by the build-up, but it was not observed. This was the second indication of a steam purity problem. Fig. 1 shows the main air blower steam rate.

The trend is clear. There was a 20-25 percent loss of thermal efficiency in a three-month period.

The turbine was cleaned and the efficiency improved, but the steam purity problem continued. The boiler carryover became so severe that the temperature to the second catalyst bed was dropping, causing the loss of reaction temperature. The plant went down to investigate the problem and plant personnel found the failure of an internal steam drum baffle associated with the steam separator. This was the third and final indicator of a steam purity problem.

When the main air blower turbine requires more steam, less steam is available for power generation. Over this 10-month period, the loss of power generation caused increased power purchases of almost $200,000. Fig. 2 shows the monthly losses. The plant shut down in early December to correct the steam purity problem.

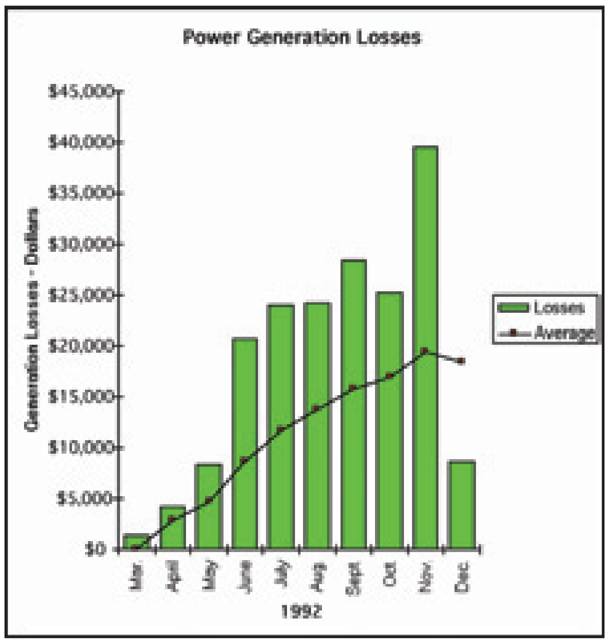

Fig. 2: Losses from increased power needs of main air blower turbine.

As an example, the power generation losses shown in the graph are just one situation where the plant data was giving information, but was not used as guidance to interpret bigger impending problems, which ultimately increased operational and maintenance costs. With today's digital collection of plant data, it becomes easier to trend and calculate various parameters like the earlier example of steam to horsepower ratio. It is advised that part of your preventive/predictive maintenance program should include a review of process parameters in combination with the more traditional methods, like vibration analysis.

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LESSONS LEARNED

Corrosion or erosion in sulfuric acid piping?

Sulfuric acid has the potential to be very corrosive, depending on its concentration. When strong sulfuric acid piping fails or shows high metal loss and corrosion, the blame instinctively falls on a poor choice for the pipe's materials of construction (MOC) or acid concentration excursions, but this is not necessarily the source of the problem.

The picture below shows ductile iron piping damaged by strong sulfuric metal loss on one side of the pipe, but not the other side. If the mechanism for pipe degradation is corrosion, why does the pipe corrode in only one isolated section, as shown in Picture 1? This picture shows a high degree of metal degradation only near the inlet on one side and then diminishes with distance from this point.

Picture 1: Localized metal loss caused by eddy currents in a ductile iron pipe.

The pipe's corrosion prevention mechanism is a thin protective film that forms in its initial contact with strong sulfuric acid. This film is designed to work with streamline or laminar flow. With this protective film intact the pipe does not corrode or oxidize.

Most likely the pipe's gasket extended past the inside wall of the pipe causing eddy currents and turbulence. The eddy currents, vortexes and high velocities can cause a mechanical sheering or removal of the pipe's protective film layer. Removal of the protective coating produces pocketed perforations. Multiple sheering of this layer causes metal loss and corrosion in the pipe.

Figure 1: Acid flow profile with a disturbance and eddy currents.

LESSON LEARNED

Metal erosion is an important consideration in the design and operation of strong sulfuric acid systems. Flow disturbance, internal to the acid pipe, may cause high velocities, turbulent flows and eddy currents (Fig. 1). These disturbances can wipe off protective film layers and be potentially damaging to the long and successful operation of the sulfuric acid plant.

The above Lessons Learned submission was provided by DuPont MECS. For more information, please contact Nathan Porter at (314) 275-5700 or at nathan.j.porter@mecsglobal.com. ❑