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Optimize Control Systems with Preventive Maintenance

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Ensuring equipment integrity by conducting thorough maintenance provides multiple benefits for your operation, from maximizing machine uptime and minimizing process shutdowns, to prolonged equipment lifespan and safety. This is true and well understood in the industry when it comes to mechanical equipment. Yet, when it comes to controls and monitoring systems, opportunities to improve abound.

Maintenance approach

A plant's equipment maintenance approach typically falls into one of two categories: reactive maintenance and preventive maintenance.

Reactive maintenance refers to repairs made upon equipment failure. Reactive maintenance takes place when a business chooses to wait for a pipe to burst or a part to fail before taking action. It is waiting for a compressor's performance to degrade so far that it's no longer able to support its downstream companions before studying the cause of the degradation. Thus, reactive maintenance doesn't prevent subsequent safety and monetary consequences — it's simply waiting for a negative consequence before taking action.

Reactive maintenance comes with a number of negative consequences — scrambling to find a replacement from spare stock, or ordering a replacement from a supplier, which can result in long lead times or exorbitant expediting fees, all headaches compounded by the fact that as you wait, losses are stacking up quickly due to lack of production. Reactive maintenance really isn't maintenance at all; rather, it is constantly living on the verge of a potential catastrophe.

Preventive maintenance (PM) goes above and beyond reactive maintenance by involving intelligent monitoring of process variables and mechanical conditions to identify potential causes of failure before they become actual causes of failure. Preventive maintenance involves using past failure data to put into place measures that ensure ongoing product performance versus awaiting potential failures.

The Link between maintenance and system optimization

An important step in preventive maintenance is monitoring ongoing machine operation and performance for irregularities. This includes monitoring the mechanical condition of rotating equipment and performing scheduled inspections of pipework, valves, pressure vessels, and other components. A major element of preventive maintenance is empowering personnel with the knowledge and expertise necessary to intelligently interpret this gathered data so they are capable of recommending the proper course of action based on the reports.

Too often, control systems known for their reliability become victim of the "set it and forget" syndrome. While they perform as originally designed, processes around them change, creating the real yet unrecognized need for life cycle optimization. Regular audits by qualified personnel of suction and discharge pressures and temperatures, process gas flow rates, machine vibration, and steam flow, motor power, or turbine power, can reveal significant details about a machine's health long before the overall process suffers. Correctly applied, a preventive maintenance plan means that a drop in com- pressor performance caused by seal and bearing degradation is properly identified before it causes a process upset or shutdown.

Preventive maintenance means valves are regularly stroked to ensure behavior remains fast, accurate, and smooth. This is especially critical for recycle or blow-off valves performing antisurge functions, as these control elements may remain fully closed for months at a time, but must be able to open immediately in order to protect their machine.

Fig.1 An Important step in preventive maintenance is monitoring ongoing machine operation and performance for irregularities. This includes monitoring the mechanical condition of rotating equipment and per- forming scheduled inspections of pipework, valves, pressure vessels and other components.

Example 1

Compressor Controls Corporation (CCC) was recently asked to assist in troubleshooting the cause of several trips and a subsequent inability to restart a turbo-expander recompressor unit at a gas production facility in Northern Africa. As CCC's representative inspected the process layout, piping, control elements, and fast trend data taken during the trip events for the turbo-expander recompressor, it became clear that during a time when the turbo-expander recompressor was operating at more than 20,000 rpm, a trip in the downstream ex- port compressors caused an upset in the process. The turbo-expander recompressor's control system recognized the upset and immediately called for the antisurge valve to open, but the valve did not respond for more than two seconds. During those two seconds, the re-compressor experienced a surge event, suffered a hard landing against its magnetic bearings, and tripped. After this happened for the third time within three weeks, the unit had experienced such significant damage that once restarted, it would not come up to speed at all.

The resulting damage required installation of an entirely new rotor within the turbo-expander — a costly replacement for the facility in terms of parts and downtime. After determining the root cause of the failure, the CCC representative assisted in retuning the antisurge valve to ensure proper response of the valve to its control signal.

Had the facility performed regular performance tests of their control elements, a poorly-functioning valve would have been identified before its behavior caused the damage it did, and the valve could have been retuned during a convenient shutdown or turnaround. When preventive maintenance is in place, upon discovering a point of concern or irregularity, a facility has time on its side and is able to contact vendors for materials and support well in advance of a significant equipment degradation or costly adverse consequence. Once preparations have been made, the repairs can be completed at a convenient time, with a much smaller impact on production — and the facility's revenue stream.

Balancing Controls with Current Process Parameters

Another important aspect of preventive maintenance that goes beyond preventing equipment failure is ensuring controls are operating based on current process parameters. If the process or equipment have undergone significant (or even rather insignificant) modifications since commissioning, the controls may not react properly, resulting in process instability, wasted energy, and reduced operator faith in the controls themselves.

If the general throughput of a plant has come down over time, it's possible that an antisurge controller will demand recycling for the safety of the machine, where there previously was none. For in- stance, at the time of commissioning, because the actual flow rate through a machine was predicted to be high, it may have been decided not to perform testing to determine the actual location of the ma- chine's surge line, choosing instead to abide by predicted surge curves. But, because plant conditions now require constant recycling, taking the time to perform actual surge testing may allow for minimizing of surge control margins and appropriate tuning of the control response to maximize the allowed envelope of operation, and reducing unnecessary re- cycling.

When changes have been made to a machine's throughput capabilities by means of alterations to piping, rebundling the machine, process gas composition changes, or driver upgrades, the control strategy and response should be closely evaluated to ensure that the control configuration is still applicable to the machine's operation, and that no energy is being wasted due to improper parameters.
Changes in the machine's throughput capabilities can affect a multitude of machine parameters, including where the machine experiences surge and choke, where the driver encounters high power or speed restrictions, and more. If a compressor has been rebundled to alter its performance profile and the antisurge controls haven't been adjusted to compensate, the controls may not recognize surge when it occurs and operators may not be alerted to the events, leading to short term process instability and long term equipment damage. On the other hand, if the performance envelope of the machine has been increased but the controls are not updated, they may inadvertently hinder the machine from performing to its full potential by incorrectly limiting pressures or speeds, or by unnecessarily increasing the recycle or blow off rate.

Always address change

Changes in control elements' performance (for better or worse) can also alter the necessary control action. If a controller is tuned for a fast-responding control element that has slowed down over time, its fast-moving output command can end up causing process swings and increased instability. Alternatively, if a control element has been rebuilt, retrimmed, or upgraded for a faster and more accurate performance, but the controls have not been adjusted to compensate, the controls may continue operating with the lethargic tuning parameters and unnecessarily large safety margins required by the slower control elements.

Controls that have not been adjusted to take into account all present operating conditions can — and often do — lead to decreased operator faith in the control system. If the controls are believed to be inadequate in providing smooth, reliable operation, operators will often assume manual control over the system, defeating the purpose of having electronic controls in the first place. Safety of the process and equipment may be reduced, and any and all adaptations required for changing process conditions now require human intervention. In time, valves, piping, machinery, and the process all experience change for a variety of reasons. Ensuring that the control strategy is continually adapted to those changes is vital to maximizing a plant's capabilities.

Fig.2 Regular audits by qualified personnel of suction and discharge pressures and temperatures, process gas flow rates, machine vibration, and steam flow, motor power, or turbine, power, can reveal significant details about a machine's health long before the overall process suffers.

Example 2

A refinery in the Southeast United
States asked CCC to assist in retuning the suction pressure control response after refurbishing a suction throttling valve. While observing the controllers' operation, the CCC field representative noticed the suction-throttling valve spent most of its time sitting on its software low clamp of 25 percent. This prevented the valve from adequately controlling suction pressure, and caused the antisurge controller to modulate its recycle valve at 10-20 percent open in order to keep suction pressure at the required lev- el. This was unsatisfactory to operators, so the anti- surge valve was manually opened and held steady at 30-40 percent, which raised suction pressure enough that the suction throttling valve would rise off of its clamp and begin modulating pressure.
After much discussion and a minor feat of archaeology, it was determined that the suction throttle valve's

software low clamp had been put in place based on process conditions that were no longer applicable. The low clamp was necessary for startup conditions seen during the original commissioning, and because the throttling valve typically operated in the upper half of its stroke, the clamp never inhibited normal operation. However, due to a change in startup procedure that no longer used the original startup gas, as well as a reduction in plant throughput that saw the throttling valve operating near or at the clamp, it was determined that the clamp could safely be lowered. Based on observed conditions and an evaluation of the startup procedure, the running process, and the control element, the CCC field representative reduced the software low clamp to 18 percent, at which point the recycling was eliminated and the throttling valve was able to properly modulate pressure. The reduction in recycling resulted in a significant reduction in steam consumption (and subsequent cost savings), and allowed the antisurge controller to operate in its automatic mode, ensuring maximum safety of the machine and stability of the process. Active is better. A thorough preventive maintenance plan that encompasses constant monitoring and examination of process and equipment parameters, regular testing and inspection of equipment, and accounts for changes in equipment, instruments, and process conditions is critical to minimizing downtime due to failure and maximizing the capabilities of installed machinery. Reliable equipment operating at the highest possible levels of efficiency means many years of safe and profitable operation

About The Author:

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