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An early bird saves in costs

Proactive maintenance helps bring down expenses

For the better of all

The story of social innovation

Driving toward actuation success

Despite initial costs, upgrading hydraulic actuators can bring significant savings

Looking back with nostalgia on early driving days as a teenager and young adult in the 1970s and 1980s, the first cars were generally used cars and relatively inexpensive. As such, they required a lot of maintenance. It was not uncommon in those days to see drivers and their broken-down cars on the side of the road in need of rescue. Engine overheating, carburetor problems, broken V-belts, and flat tires were common causes of the breakdowns.

Nowadays, it is rare to pass a car with even a headlight out. About the only time you see cars on the side of the road is when they are accompanied by police vehicles with flashing lights when users test the vehicles max governor rpm. The technology used in the automotive field 30 to 40 years ago seems primitive by today's standards, as electronic governing systems are standard equipment in cars today, and have been for several years.

In industrial processing plants and refineries, however, decades-old, low-tech mechanical and hydro-mechanical governor equipment continue to operate still, controlling steam turbines and compressor trains in many refineries and process plants. This equipment, like the automobile technology of 30 to 40 years ago, can present maintenance and operational challenges, and can lead to reduced efficiency and reliability in the production process.

The turbine speed governor's job is to provide accurate speed control, thus preventing process oscillations. To achieve this goal and prevent unplanned process shutdowns, upgrading governor valve actuation to a more precise and dependable operator becomes necessary. Higher performance expectations of the governor valve actuator may go against the traditional thinking that such expectations lead to greater expense. But the economic advantages are significant enough that an upgrade should be considered.

The return on investment of a new governor valve actuator is realized immediately after retrofit due to significantly improved process throughput. Two of the main advantages of high precision actuation are stabilizing equipment speed with tighter rpm control and avoiding nuisance process and equipment trips. Thus, the new technology that comes with modern turbine actuation control systems can now operate the turbine at its maximum potential without interruptions. The reliability of the turbine is increased tremendously, and many of the mechanical governor challenges are removed from the unit.

Problem at a refinery

Recently, Compressor Controls Corp. (CCC) implemented a mechanical retrofit for a mid-Continent refinery that was experiencing large swings (100-200 rpm) in the speed control of its steam turbine. The speed instability was caused by a subpar steam turbine governor valve actuation system. The sticking actuator could not maintain the setpoint target and had recently caused a process trip of the main air blower (MAB).

Speed control of the turbine had become so difficult that it had to be operated manually and at a higher target speed than desired. In addition, load sharing with a secondary air blower could not be implemented, and the customer had to use the blow-off valve to make adjustments to the air flow. Finally, the steam turbine could not utilise the existing CCC automatic start-up sequence because of the sticking actuator. These challenges not only took time away from the operator's priorities but also created an inefficient process, ultimately wasting a great deal of energy.

Understanding the impact of actuation technology

Controlling compressor efficiency starts with precision control of the steam turbine driver in order to regulate the speed of the compressor. Depending upon the turbine design, there are different opportunities for actuator upgrades to improve performance. For turbines with shell-mounted control valves, the actuators may individually drive multiple control valves, or there may be a single "power piston" arrangement that drives a bar or rack, allowing multiple steam valves that are mechanically coupled together to be opened sequentially.

For turbines with chest-mounted control valves, it may be a globe-style valve external to the turbine that is providing the control. In some configurations, a pilot valve assembly with a small stroke and a low thrust requirement may be used to port lube oil to the power piston. This is also a good candidate for an actuator upgrade. The key to success for optimal steam turbine actuation upgrade is selecting a technology that offers high frequency response and precise resolution in a highly reliable package.

Typical steam turbine control requirements include:
- 0.1% repeatability
- 100% duty cycle
- <100ms dead time
- Fail safe capability
- Ability to withstand high ambient temperatures
- Fast stroking speed (less than 1-2 seconds for full stroke).

Drawbacks with existing technology

The existing steam turbine designs at this mid-Continent refinery utilised a hydraulic system comprised of a hydraulic power unit (HPU) and servo or proportional valves for control. These hydraulic systems had proven to meet and exceed turbine control requirements at first, when they were

An actuator in a turbine governor application

operating in the condition as they were designed. After some time in real-world operation, however, the challenge with the existing hydraulics was primarily with maintaining the systems to work properly, as they required extensive oil maintenance for proper operation. These systems have a large quantity of oil and basically all utilize the same principal of operation.

Hydraulic fluid is drawn from the reservoir by motors and pumps to facilitate movement of the actuator cylinder and then is drained back to the reservoir when the cylinder moves to position. The oil is continually circulated at high frequency to accomplish the high resolution control performance required for the application. Since the system is not sealed, as it is open to atmosphere at the reservoir, the oil is subject to breakdown. Communication with the atmosphere adds moisture that causes degradation to the oil system due to moisture ingress, oxidation, and corresponding acid build-up. The continuous circulation of hydraulic fluid adds heat to the oil, which accelerates and exacerbates the breakdown of the hydraulic fluid.

In order to combat the effects of oil breakdown, system owners are required to perform a high level of maintenance on these systems. Extensive filtration systems are used, demanding high maintenance intervals coupled with flushing and replacement of hydraulic fluid. Ultimately, the hydraulic fluid degrades to the point where the servo and proportional valves get stuck, resulting in loss of control and system downtime.

A new solution provides big results

Finally, after the refinery had consulted with CCC, the decision was made to retrofit the antiquated governor valve actuator with newer actuation technology. The actuation system specified was a Rexa Electraulic self-contained unit. Electraulic actuation uses a position-controlled power module, driven by a 4-20ma signal, to build pressure with an internal oil gear pump that displaces hydraulic fluid from one side of cylinder piston to the other. A rod extending from the cylinder is then mechanically connected to the steam valve rack and able to precisely position the rack from a fully closed to fully open position.

Electraulic actuators are designed for continuous modulating service with an adjustable dead-band as tight as 0.05% of stroke. The virtual incompressibility of hydraulics provides repeatable, stiff, and accurate control performance as is required in this demanding application. The drawbacks associated with HPU-based hydraulics are eliminated by design.

The system utilizes Rexa's patented "flow match valve" (FMV) technology. The FMVs are used in conjunction with a bi-directional gear pump in a positive pressure sealed hydraulic system, eliminating the need for a hydraulic reservoir and the problematic servo and proportional valves. The Rexa hydraulic circuit design completely removes the need for filtration and requires no oil maintenance as part of a preventive maintenance plan. The system design lends itself to minimal oil requirements, as a typical Rexa actuator requires anywhere from 2-5% of the oil of a comparable HPU-based hydraulic system.

Electraulic actuators are also simple to make fail-safe without any detriment to the control precision. With both spring- and accumulator-based fail-safe technology, these actuators achieve trip speeds as fast at 200ms, meeting the requirements for turbine control.

Taking it to the bank

The mechanical actuation upgrade to Rexa's Electraulic actuators on turbine control valves and successful tuning with the CCC controller provided immediate benefits for this refinery.

- Maintenance savings were immediately realized through the cost of replacing faulty servo valves and reducing labor required for the upkeep of antiquated hydraulic systems.
- Improved speed control with high responsive Rexa electro-hydraulic actuation, allowing the turbomachinery train to match its performance with the desired process setpoint more accurately and reliably.
- Removal of the existing control oil and piping, thus eliminating the hassle of oil maintenance and filtration requirements associated with this system.
- Reduced insurance rates for the turbine deck by de-rating the risk of fire through the removal of existing control oil supply.
- Automatic start-up sequencing and load sharing features of the CCC control system could now be utilized, improving the overall process control stability of the process unit.
- A single turbine trip lasting mere 20min – an incident that the customer experienced recently before the actuator retrofit – would cost the refinery more in throughput than the cost of the new Rexa actuator and commissioning.

Customer feedback

The improvements in performance are described in the words of several plant employees:

"The REXA actuator has allowed proper speed control. The previous hydraulic servo with multiple mechanical linkages often bound up causing FCC upsets. We have not seen these issues since the install."

"With the better speed control, the load sharing controller can optimize the load between the auxiliary and main air blowers. This resulted in an approximate air capacity increase of 15% on the overall air system."

"Prior to the installation, the lube oil system and the hydraulic oil for the servo were on the same system. We were experiencing borderline low lube oil pressures before the install. The install decoupled the system and eliminated the need for hydraulic control oil. This eliminated the need to upgrade the lube oil system to increase the lube oil pressure to OEM specifications."

"The installation also eliminated pneumatic hand controls that were primarily used during start-ups and shutdowns. The system can now be solely controlled by the console operator. This simplified many procedures for start-up."

For more information:

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Questions to consider for your plant

- Do you have turbomachinery that has experienced nuisance trips resulting in loss of production?
- Do you have to live with larger than expected rpm swings resulting in poor control and increased steam expense?
- Does smoothing out your control line, to significantly improved process throughput up to 25%, sound like cost savings to you?
- Would you like to be able to have automatic start-up sequencing through all control ranges of idle speeds, critical speeds and governor ranges, and have the capability to operate the turbine more effectively from the control room?