ROTATING EQUIPMENT

STEAM TURBINE CONTROL

Background: Steam turbines can be found in almost any processing plant or power generation facility. In processing plants, steam turbines are used as the driver for other rotating equipment, converting thermal energy to rotational energy ultimately to control input speed of a driven device. Common driven devices in processing plants are compressors, fans, blowers, and pumps. Precise control of these turbines is vital to the optimization of the plant process, and availability of these turbines is critical to overall plant profitability.

In power generation facilities, steam turbines can be found as the driver for boiler feed pump turbines, as well as for turbine generator sets to generate electricity. Any detrimental impact on performance of these turbines can affect boiler control, ramp rate, and/or the ability to synchronize to the grid. Steam turbine downtime in power generation facilities ultimately prevents the plant to generate power and revenue.

There are thousands of steam turbines in use across the spectrum of industrial applications, and many are antiquated having been installed for decades. In an effort to improve operations and boost production, many plants have quantified an immediate return through the modernization of controls and upgrade of actuation of these turbines.

Depending upon the turbine design, there are different opportunities for actuator upgrades. 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

ELECTRAULIC™ ACTUATION

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 actuator upgrade.

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:

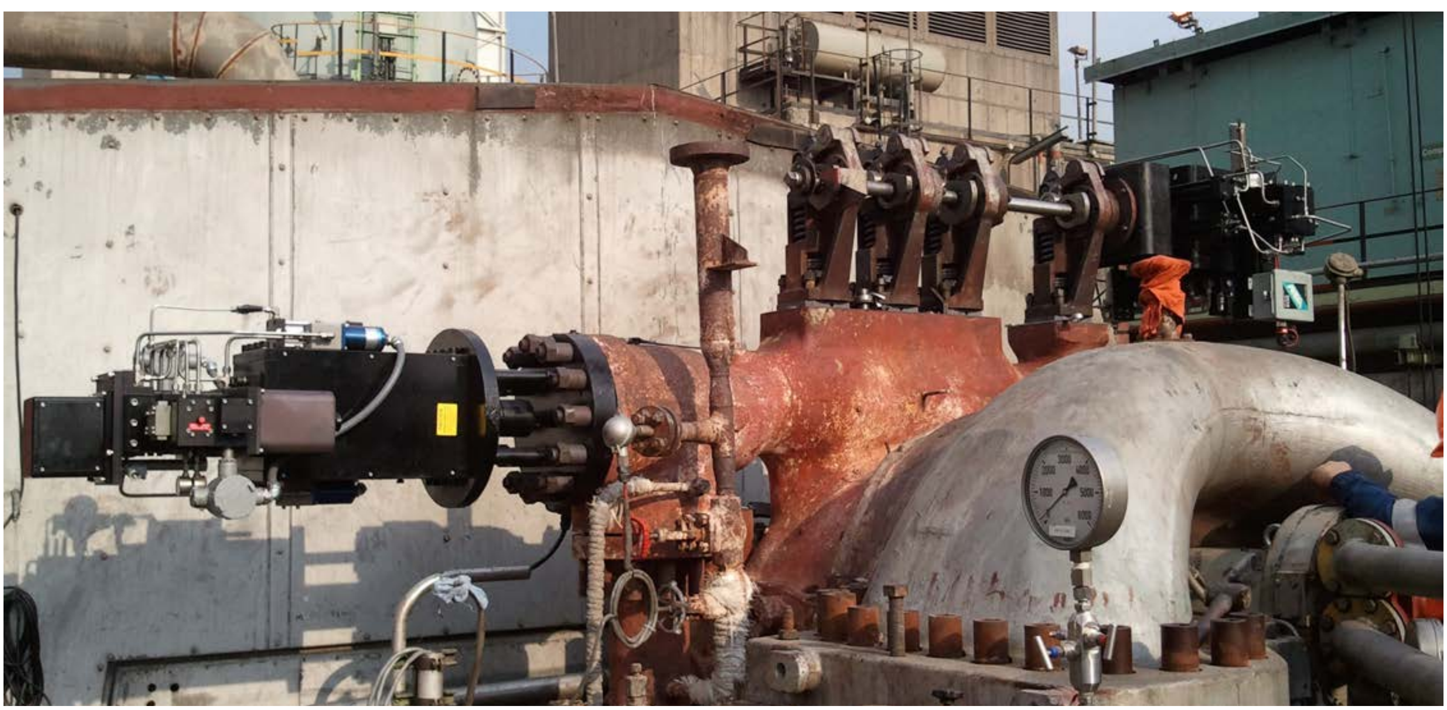
- 0.1% repeatability
- 100% duty cycle
- <100mSec dead time
- Fail safe capability
- Ability to withstand high ambient temperatures
- Fast Stroking Speed (<1-2 seconds for full stroke)

The majority of existing steam turbine designs utilize a hydraulic system comprised of a hydraulic power unit (HPU) and servo or proportional valves for control. Hydraulic systems are proven to meet and exceed turbine control requirements, as previously defined, when operating in good condition and as designed. After some time in real-world operation, however, the challenge becomes more with maintaining the systems to work properly than the inherent benefits of the actuator technology.

Problem: Although hydraulic systems are preferred over all other technologies for control, the systems are universally difficult to maintain and are generally unreliable. The battle faced by the system owner is primarily based around the requirement for extensive oil maintenance for proper operation. Traditional hydraulic systems are open-loop, utilizing an HPU, a gravity fed reservoir, and a series of servo and/or proportional valves for control. 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 actuator cylinders and 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.



Electric actuation in the form of servo motors driving mechanical planetary gears or ball screws can also be found for control of steam turbines, but are far less common than hydraulic systems. These actuators are capable of fast stroking speeds and relatively high frequency response, and have been positioned as a solution to the problems associated with hydraulics. These actuators, however, have different limitations than their hydraulic counterparts. They are not easily made fail safe while maintaining the high level of resolution. Most steam turbine governors are required to have fail safe capability as a secondary means of protecting the turbine, following the primary turbine trip valve or trip and throttle valve functionality. Electrically driven ball screw actuators are limited by this requirement. Vibration sensitivity, temperature limitation, and reliability in a harsh environment are all drawbacks to utilizing this technology on a wide scale basis.

SOLUTION: Steam turbine operators have turned to REXA's Electraulic™ Actuators, which offer a rugged, responsive, and repeatable solution for turbine control applications. These 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.

RESULT

Upgrading to REXA's Electraulic™ Actuators on turbine control valves provides immediate benefits for any power plant or chemical processing facility. Maintenance savings can be immediately realized through the cost of replacing faulty servo valves and reducing labor required for the upkeep of antiquated hydraulic systems.

An upgrade to REXA Electraulic™ Actuators will yield the following operational improvements:

- Reduced Downtime
- Improved speed control
- Increased ramp rate (BFPTs & TGs)
- Improvement in unit turn-down (minimum load operation)

In most plants, the ROI for upgrading to a REXA Electraulic™ Actuator on turbine control can be measured in weeks.

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