A USER'S GUIDE

Valve and Damper Actuation for the Power Industry

rotork®

Valve and Damper Actuation
for the
Power Industry

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INTRODUCTION

Today, power plants face many tough challenges.

For example, there are increasing demands for them to improve operating efficiencies, increase productivity, and become better environmental stewards. Other important goals include enhancing worker safety, maximizing bottom-line profitability, and attaining higher levels of maintenance proficiency.

Whether a power plant uses coal, natural gas, oil, hydropower, nuclear energy, or even waste by-products as the energy source for its process, it has a need for effective valve and damper actuation throughout the plant.

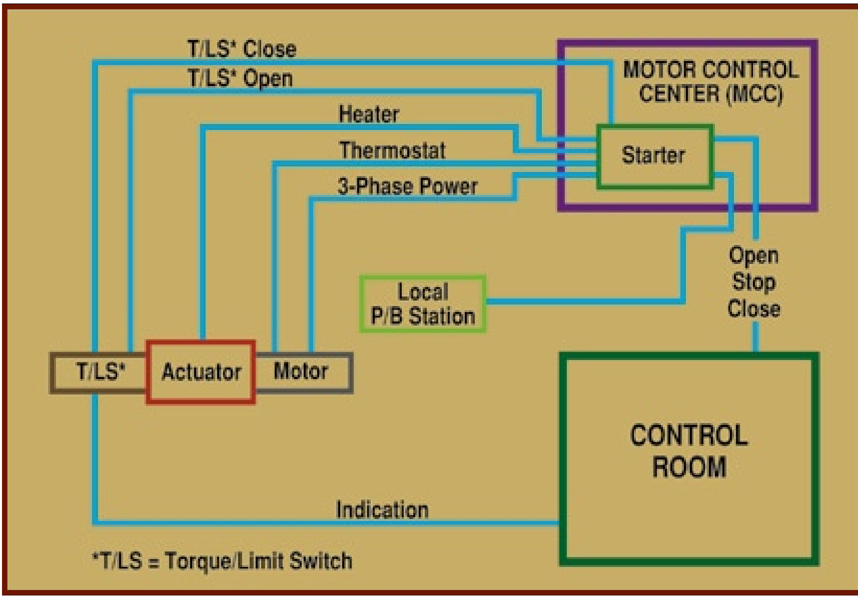
By wisely choosing and upgrading to the new actuator technology that is available today, power plants can make substantial progress toward accomplishing many of the important operational, business, environmental, and safety challenges they face.

Today's power plants use a wide range of devices to actuate many different types of valves, gates, and dampers. There are a number of different processes throughout the plant that have their own unique actuation needs.

The basic, underlying requirement, however, is that the type of actuator chosen can survive in the environment. Some typical environmental challenges include: outdoor service, high vibration, extreme temperature, dust, and a severe duty cycle.

Because of the rugged demands found throughout the plant, the power industry in the past has tended to stay with traditional actuators that do not have integral controls. But, today, that is changing.

Proper selection of valve and damper actuators can help today's power plants solve many of the performance, maintenance, environmental, and safety challenges they face.



A schematic of a traditional remote motor starter system.

THE EVOLUTION OF ELECTRIC ACTUATOR CONTROLS

The use of electric actuators in power plants has a rich, evolving history.

When motors were first adapted to gearing, some of the early actuators were designed for power industry applications.

In fact, power plants always had the need for automation as well as electric interlocks to provide adequate safety. Therefore, early motor and gear sets with external limit switches once were considered state-of-the-art technology.

Through the 1970s, coal-fired plants were built with electric actuators which included motors, gears, hand wheels, limit switches, and torque protection.

Traditionally, the motor starter equipment was located in a central motor control center of the plant known as an MCC. In such plants, a limited amount of extra space was allocated in the MCC for future growth.

In the 1980s, many existing plants found the necessity for such safety upgrades as turbine water induction protection. At that time, engineers started to evaluate actuators that had integral starters for the following reasons:

1) They were running out of available space in the MCCs;

2) They recognized that there was a substantial cost savings that could be realized related to wiring savings;

3) They saw other benefits of integral controls such

as monitoring relay, phase rotation protection, and 24-volt DC control.

During the 1980s and 1990s, there was a resurgence in the construction of gas-fired power plants. Certain designers used the advantages of integral motor controls and incorporated them extensively throughout their plant configurations.

Another important change in power plant design happened during this time. Distributed control systems (DCS) became the standard in most cases and interlocks could be accomplished via software. This eliminated the need for numerous switches inside the electric actuator. It also enabled a way to eliminate much of the wiring required inside the actuator itself, which results in a more reliable and maintenance-friendly actuator.

The surge in building of power plants during the past ten years has stimulated power plant designers to re-evaluate their core designs.

RECENT DEVELOPMENTS

Integral motor starters have become the standard in many of the latest generation of power stations that are currently in design or under construction. In fact, the vast majority of plant designers have eagerly embraced the world of digital control.

The many challenges faced by the next generation power plants have caused new-plant designers to look for ways to include efficiencies gained by using modern distributed control systems with intelligent field devices.

For example, today's power plant designers are integrating asset management technology into their plant designs as a focal point for improved operational performance. In doing so, they are introducing sophisticated electronic controls found in such devices as the latest generation of valve actuators to provide vital diagnostic and performance information to the control room.

While the benefits of diagnostic monitoring and automated control are impressive, many seasoned plant engineers may ask: "Can these devices survive in a power plant environment?"

In short, the answer for many applications is "Yes." However, there are exceptions, and this booklet will help give insights to clarify specific situations.

Another pressing question arises with existing power plants that are under mandate to increase efficiency both operationally and environmentally.

Many retrofit projects involve re-automating existing valves, gates, and dampers. The question is, "Do you replace like with like," or "Do you look at new technology?"

In fact, there are significant advantages to using new technology in an older plant environment to improve the performance of a single process. This booklet will provide useful information on some of the available options.

ASSET MANAGEMENT

Today's modern power plant needs to run as efficiently as possible with minimal downtime. Asset management is strategically important and requires data from all instrumentation and field devices to function as a system.

More megawatts are being produced with less staff in every type of plant, regardless of the fuel used. The theory is that with more automation less manpower will be needed during normal operation, at plant start-up as well as during outages.

In fact, many utilities today outsource their outages to specialists, who may not be familiar with the specific equipment in their plant. This requires an even greater need to plan ahead and to have relevant valve operating and historical data on hand.

Distributed control systems are very sophisticated and have the ability to gather large streams of data and send them to planners and engineers for analysis.

VALUABLE DATA FROM SMART ACTUATORS

Below is a description of some of the information today's smart actuators can provide.

A supervisor at a combined-cycle natural gas plant uses a hand setting tool to check configuration, troubleshooting, and predictive maintenance data.

First, it is important to understand what type of information is available at the actuator, how to access it, and how to manage it.

Generally, we can break down the type of information that can be captured in sophisticated actuators into three main categories: predictive maintenance, configuration, and trouble-shooting data. This information can relate to the valves, actuators, and control room requirements.

For example, we can obtain torque profiling information by capturing the torque characteristics of an individual valve and storing it in the asset management system. Then, it can be compared with additional profiles throughout the valve's life history. This can help predict valve performance and assist in the scheduling of normal maintenance tasks, such as packing replacement. We can also monitor seat wear.

Another example of predictive maintenance is that the actuator data logger can give us alarm logs that are date and time stamped. Details such as the number of times a contactor has been energized can be analyzed. Also, last operations and historical operations logs are of great use to planners.

From an operations point of view, information like phase loss monitoring can pinpoint areas of the power system that need attention. Over-torque trips can mean operational problems such as over pressure in a particular line or material clogging in a valve. One might find that a loss of a maintained signal could indicate an error in software programming under certain conditions.

Furthermore, control room operators would be interested in interlock failures related to faulty wiring issues. Anything that could possibly stop a system from getting through its process can be monitored and adjusted with this type of diagnostic information.

There are several different ways that the smart actuator's information can be accessed.

The most basic way is that a lot of information can be accessed locally at the actuator via its help screens;

Data from today's electronic actuators, such as the Rotork IQ Pro, can be accessed locally via the actuator's display screen; downloaded locally via a hand setting tool, PDA, or laptop computer; and accessed remotely via the plant's network and/or a secure Ethernet web browser.

Actuators, such as the Rotork IQ Pro, can be easily and economically connected to the plant's network via a two-wire Pakscan communication system and master station (inset).

however, that does not automatically get the data into the asset management system. Nonetheless, the diagnostic information displayed on the help screens provide exact data on the conditions inside the actuator.

In the past, the traditional way to get such information was with multi-core cables. But, the abundance of available information has made that method impractical.

Therefore, today's smart actuator have evolved so that they can be accessed locally using a PDA or laptop computer. This way, large amounts of valuable information can be quickly downloaded from the actuator for easy transfer into the asset management system.

In addition to accessing data locally, most modern plants that use asset management tools have their electric actuators connected on their network, so that much of the actuator's data is available at the control room.

NETWORKED VALVES

Configuration of smart valve actuators on a network is simple. The actuators on the network can be configured remotely, including the setting of the electric actuator network baud rates and addresses. Network maps can be seen and adjusted from the human-machine interface (HMI).

Also, many items within the motor operator can be adjusted remotely, including dead bands and spans on modulating operators. Torque values can be monitored and adjusted over today's networks.

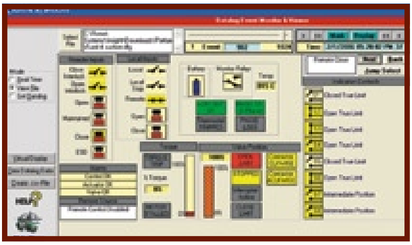
Troubleshooting is another area which has been enhanced by the use of networks. From the actuator, we can now download profiles and transmit them electronically to remote service centers for assistance. The profiles can be analyzed with selected computer programs, which allow end-users to troubleshoot their equipment without opening the covers.

The negative side of this is that the large amounts of data can load up the highway. So, some end-users are looking at ways to get the information off-line.

One very practical solution is to use an Ethernet connection, which can provide secure Web access. Also, some manufacturers are looking at wireless as a method of extracting information for diagnostics purposes (but, NOT for control).

Managing the information is another challenge in today's plants. The DCS is one place to do it, but many are looking to third party suppliers to manage the data with prepackaged software. Web sites are another option as well as subcontracting plant maintenance all together.

A few things are worthy to note. Watch the network traffic. Many believe that a faster network speed will solve all problems. This is not necessarily true. Be sure to take advantage of all the



A major benefit of linking actuators on a network is that valve monitoring and troubleshooting can be done remotely without the need to open actuator covers.

information that's available and work with vendors you have confidence in.

ACTUATOR APPLICATIONS IN A TYPICAL POWER PLANT

Because coal-fired power plants generate about half of the world's electricity, this booklet will discuss the process of a typical coal-fired facility. However, many of the processes are applicable to other types of plants, so the information is relevant to a wide range of different power generating facilities.

This booklet describes how actuators are involved in the processes where coal is transported and stored at the facility, how it is moved through the system, and how it is processed with air and water in order to produce steam. Then, we'll discuss the role actuators play in how steam is used to produce power, and how the waste needs to be treated as a by product.

Please note: An illustration identifying valve and damper actuator locations in a typical coal-fired power plant is found on pages 12 and 13.

COAL PREPARATION

The process begins by getting coal from the rail car to the steam generator.

Coal is removed from rail cars and moved via conveyor systems. The coal is typically dropped through hoppers equipped with special hopper valves.

Steps include moving coal to storage silos, bulk handling, and conveyor isolation.

Most of the valves used in these areas are slide gates. They are shut-off gates, which do not require tight sealing and are typically operated by multi-turn actuators. The multi-turn operation can be accomplished by an electric motor operator, manual gear box, or pneumatic cylinder.

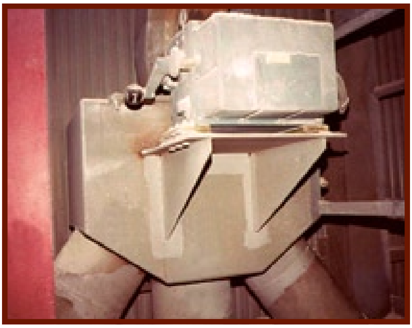
Often, if operation is infrequent, manual gearboxes are used. (For example, manual operation is common if the valve needs to be operated only during maintenance outages.)

However, if the gate valve is operated more frequently and needs automation, the decision of what type of power should be used is important. In northern climates, pneumatic power typically does not fare well outside, and electric power is preferred. In very high thrust conditions, hydraulic power can be considered.

Gate size and control requirements are other important considerations. Electric actuators can have an advantage with their integral limit switches, emergency manual hand wheels, and easily achieved torque protection. The advantages of pneumatic power include increased air pressure to overcome occasional clogging with increased forces from the cylinder. Also, the air cylinder can provide quicker operating times than the typical motor without increasing horsepower.

As coal is moved through the process, valves are used at several locations, including grinding mills and coal mill feeders, which prepare the coal for the boiler feed stage.

During the movement of the coal to these areas, there are many diverter applications for hoppers, basket diverters, and flapper gates. These often require quarter-turn operation, which can be achieved with a cylinder and exposed clevis arrangement, or quarter-turn electric motor actuators.



A Jordan SM-5000 electric actuator used in a coal diverter application.

All of these applications move coal in different directions per the requirements of the process. And, for today's efficient plant, that means the need for information being fed back to the control process.

In many of the more critical applications, heavy-duty lock gates are used. These are double gates that can isolate and measure flow. They actually have two actuation assemblies which can be linked and operated with one motor or cylinder. In some of these applications, temperatures can be quite high at relatively low pressures.

As coal is broken down and crushed, different devices are needed to keep the particles moving. The end result is so fine that the pulverized coal resembles talcum powder.

The equipment in the coal-handling and processing applications is difficult to keep clean, so sometimes self-cleaning valves are used.

The front-end of a coal-fired facility is an area where health and safety margins are high-priority considerations for system designers. It is also an area that is difficult to interlock, because the particulate can cause valves to have difficulty making the ends of travel limits.

The "front-ends" of other types of power plants have very different considerations. For example, natural gas plants are connected to pipelines where gas is brought to the plant in relatively high pressures.

A Rotork Fluid System P-Range spring-return pneumatic actuator operates a block valve in gas service.

The gas is moved through Teflon-seated ball valves, which are typically 300lb or 600lb ANSI pressure class valves. Usually, they are either flanged or weld-end valves and are motor operated for metering service.

Block valves are used, too, and are often fitted with spring-return pneumatic actuators. They require limit switches for indication.

STEAM GENERATOR

The steam generator, which is commonly called the boiler, is where the fuel is mixed with air.

The fuel is ignited, and the resulting heat is transferred to water-filled pipes in the walls of the boiler. The heat generated there is used to vaporize water,

A Jordan LA2000 modulating electric linear actuator operates a secondary damper.

and steam is produced. Superheated steam is introduced to the steam turbine.

Because a wide variety of temperature ranges must be accommodated in this stage of the process, many different types of actuators are used.

At the start of the process, pulverized coal is initially moved via an air stream, which is powered by fans. The fans often work with control dampers, which modulate constantly in continuous-duty mode.

These dampers are called "axial fan" dampers. While they can be controlled with close-coupled actuators, in most cases, they are controlled from floor-mounted drives with lever arms.

The duct work leading to the boiler usually has traditional louver dampers and close-coupled damper drives. While electric drives are now often used in many isolation applications, traditionally, the modulating applications relied on pneumatic drives. Now, however, electric drives are starting to be used in modulating applications as well, since their duty cycles have improved over the years. Modulating electric drives provide an important advantage, because they can be easily added to the network (such as a HART network) that controls vital aspects of boiler functionality.

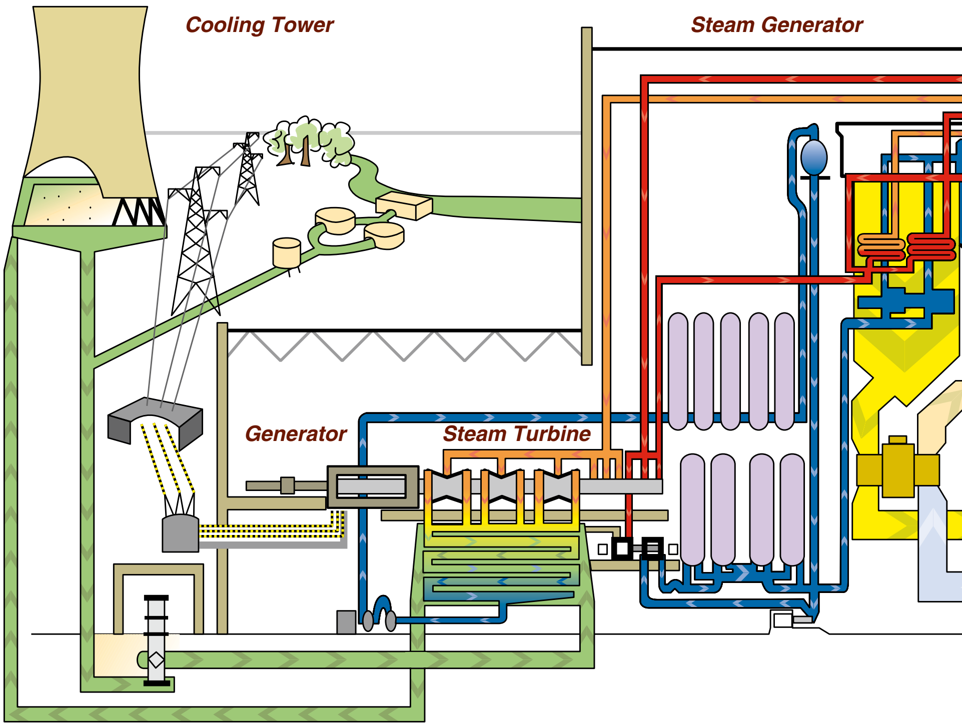
The firing of the boiler most often is regulated under strict codes and national safety regulations. Boiler firing is an integral part of the control system of the various boiler manufacturers.

One of the most critical phases of boiler operation is the start-up sequence. In super critical boilers that operate at very high pressures, the valves are often very large y-pattern globe valves for block valve service that require some of the biggest electric valve actuators in the plant.

Traditionally, the motor starter equipment for these valves is located in the central motor control center. These valves are heavy wall, high-

Jordan SM1700 electric actuators control over-fired air dampers.

Typical Coal-fired Power Plant

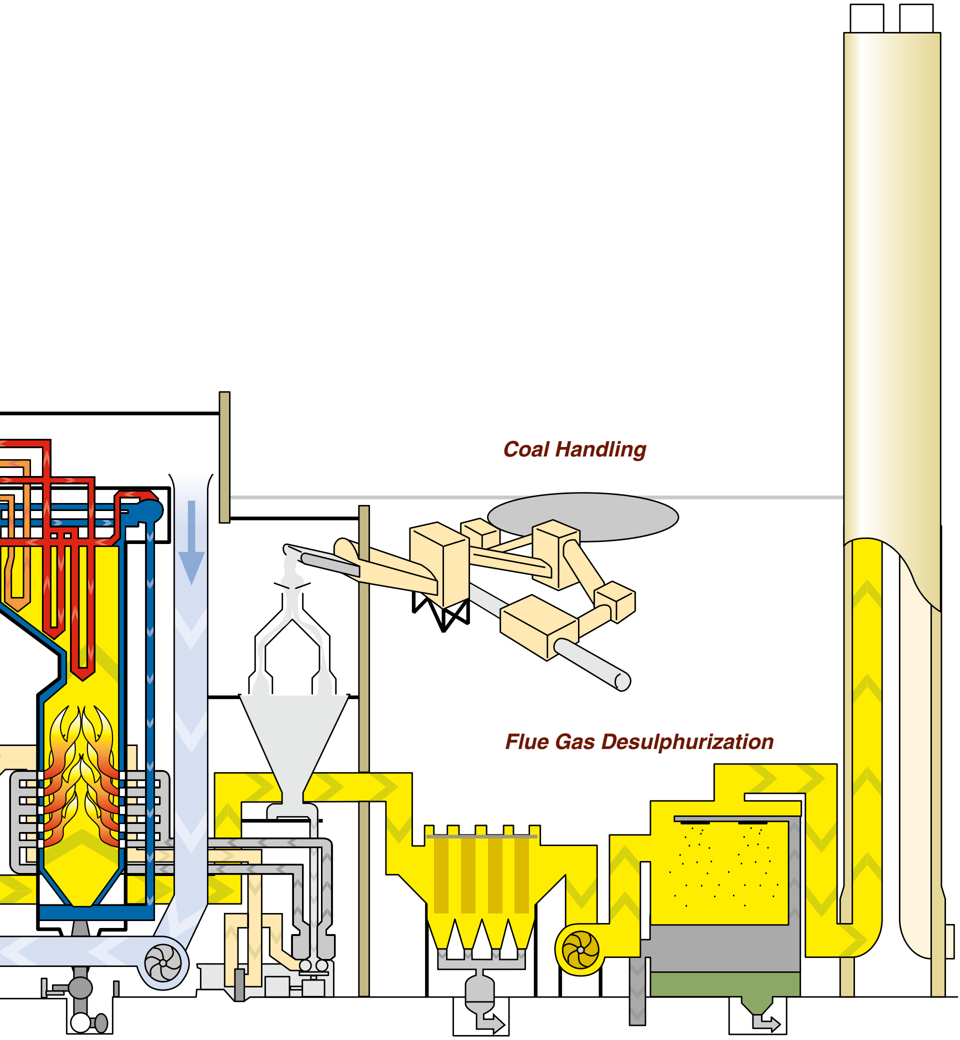


River Water
This is added to the feedwater to make up for losses from the steam/power generation process.

Feedwater
Boiler feedwater is recovered from the condenser and re-circulated through the system by the boiler feed pump. This is then pumped into the economizer and furnace walls to generate steam within the boiler drum.

Extraction Steam
Extraction steam that has had its pressure reduced to supply heating as part of the Rankin cycle.

Superheated Steam
Steam from the boiler drum goes through primary and secondary superheaters to produce dry superheated steam at a very high temperature to drive the turbine.



Reheated Steam

The high-pressure return steam passes through the reheater elements within the boiler, and this reheated steam drives the second-stage turbine (intermediate pressure). Then, this exhausts into the three stages of the low-pressure turbine, and subsequently to the condenser where it is cooled and becomes feedwater.

Exhaust Gases

Gases created and exhausted as a result of the combustion process.

Limestone Slurry

The exhaust gases are passed through a limestone slurry to remove sulphur oxides, thus reducing emissions. This process is known as flue gas desulphurization (FGD).

Gypsum Slurry

The by-product of passing the exhaust gases through the limestone slurry. After drying, gypsum slurry is used in various building materials, including breeze blocks and wallboard.

pressure valves that are either pneumatic or electric powered. Modern plants are tending to use electric actuators for ease of maintenance.

There are literally hundreds of actuators around the boiler. The boiler fronts have many drives that are part of the fuel-firing system. The system includes dampers that control the combustion air flow into the boiler. Typical applications include over-fired air and corner-fired air dampers. Customer preference dictates whether they are pneumatic or electric actuators.

Depending on the boiler design, dampers can be operated by either quarter-turn actuators or linear devices utilizing a drive arm with clevis pin. Most of these applications require high-rate modulating actuators.

A Jordan SM6000 electric actuator provides continuous modulating duty and 0.1% accuracy for precise damper control.

The applications that have high-duty cycle requirements include burner tilts, air shrouds, and over-fired dampers. Other applications near the boiler include auxiliary and pulverizer inlet air dampers.

The majority of these dampers are modulated using an incoming 4-20 MA control signal. They tend to be both single- and three-phase power actuated drives.

Today, many of these applications are utilizing network protocols for enhancing their diagnostic capability. The industry is also starting to use Foundation Fieldbus and Profibus communication in some areas to interface more directly with plant control systems. Most drive manufacturers are producing actuators that can support all of the major protocols.

Over-fired air dampers control the air at the top of the boiler and remove particulate. This is another common application that has a high-duty cycle within the 1200 start-per-hour range. It operates in the middle range of the traditional modulating actuator and the true high-duty cycle drive. Another application detail that must be taken into account in this area is temperature.

Certain areas can be extremely hot. The designer needs to look at both ambient temperature and heat transfer through the valve or damper shafts.

Careful analysis of temperature by application is required, because a “rubber stamp” approach can result in costly mistakes. Interestingly, many designers may think they are taking a conservative approach by over-estimating possible temperatures. However, a higher temperature requirement than that which is actually needed may not allow the use of standard electronics, which do not operate reliably at temperatures above 160 degrees F.

The unnecessary removal of electronics from a hot area often defeats the substantial benefits of wiring savings and simple control.

For these reasons, accurate assessments of each situation should be determined, since each application and boiler is different.

COOLING TOWER

The basic function of the cooling tower is to provide cooling for the steam cycle.

The most natural principle of cooling is by evaporation. However, since directing wind to cool the steam is usually not a realistic option, a flow of air over a large body of water is the most common cooling technique used by today’s power plant.

There are several different types of cooling towers. For example, atmospheric towers do not require fans to create air flow. Hyperbolic natural draft towers are distinctive in their shape. Mechanical draft towers use fans to provide a flow of air through the tower.

Fans can push air from the bottom or draw air from the top. The use of FD (forced) or ID (induced) fans require modulating drives. The velocities of these fans can be quite high, so the actuators tend to be rigidly mounted with output shafts.

The air flow can approximate wind speeds equal to 5 mph within the tower. The interior of the tower is both windy and saturated with moisture. It is a difficult application for electrical equipment, so totally sealed actuation is a must. It is best to specify submersible equipment in this area.

Towers often include cross-flow and counter-flow designs. The technologies include moving the water and air in different patterns to affect the differing results intended.

Therefore, there are numerous valve applications in a typical tower. For example, blow down applications are used to eliminate impurities in the water. Collection basins are located in vessels below and integral to the tower. There, water is collected and redirected to the sump or pump suction line. As in all applications with pumps, there are suction, discharge, and bypass lines with electric actuated valves. These valves are either rubber-lined butterfly valves or knife gates, depending on the preference of the designer. The automation of the quarter-turn butterfly valve offers a significant cost advantage. It also allows for a better sealed package.

If a knife gate is used, there is a higher chance that moisture can enter the center column area of the multi-turn electric actuator that is used to operate it. Adequate moisture protection can usually be accomplished if one starts with a properly sealed actuator and also takes special care in how the stem cover is sealed.

The distribution system of the cooling tower has many automated applications. There are also many areas that require flow regulation or throttling valves. These are not true modulating applications such as those required for the fan drives, but they do require that the valves move to mid-travel positions.

Headers, laterals, branch arms, and other applications help to distribute the water where required. Also, there is often a need for fail-safe operation in this area, where actuators fail on loss of main power.

There are many different piping arrangements throughout the tower where water comes in and out. Some of the valves will be outside the tower, and are best operated by electric actuators mounted at ground level with readily

Actuated valves are often located in hard-to-access places. Here, Rotork IQ electric actuators linked to the plant's network provide remote montioring and control.

available three-phase power as the power of choice.

Towers are excellent examples of how today's actuators can provide operational, maintenance, and safety benefits. Specifically, modern, network-compatible actuation enables remote monitoring of tower valves that are located in hard-to-access and potentially dangerous areas of the facility. Because of their difficult locations, tower valves and their actuators are ideal candidates for network control and monitoring.

PLANT CIRCULATING WATER

In addition to cooling towers, there are many other applications that require moving and directing water within the plant.

Water is typically drawn from a nearby source through a pipeline, and the flow is controlled via rubber-seated butterfly valves.

The valves can be anywhere from two-to-five feet in diameter. If the water is heated, then the valves often require metal rather than rubber seats. The metal seats necessitate higher actuation forces and require more torque for the same line size of non-heated water.

Either electric or pneumatic quarter-turn actuators are used for rubber- or metal-seated butterfly valves. The main advantage of a pneumatic

Rotork IQ electric actuators operate 48-inch butterfly valves located about 20 feet above floor level.

actuator at this point would be to easily accomplish fail-safe operation.

However, if there is a need for manual back-up operation, then pneumatic actuators may not be the best choice for large-size valves. Specifically, large quarter-turn valves with pneumatic actuators that need manual back up most often require clumsy declutchable gearboxes or hydraulic hand pumps.

For that reason, electric actuators usually make more sense on large quarter-turn valves.

TURBINE ISLAND

The turbine is the key to the generation of electricity. It is an area that has need for valve automation.

For example, there are multiple drain valves that are required to remove moisture from the system.

The drain valves tend to require motor-operated valves on small line sizes with high pressures. In most cases, drain valves are one or two inches in line size. The control system of the turbine itself will control these, so they are considered an integral part of the steam turbine. Because of this, they are usually not on a broader valve network.

There are also applications for turbine water induction to protect the turbine. The induction system provides critical safety features to protect the turbine and insure that water is not allowed to be introduced to the turbine blades.

The valves here are typically in the range of 6-18 inches, ranging from the 150lb through to the 900lb class. The turbine stop valve can be quite large and might have an electro-hydraulic operator.

FLUE GAS

Flue gas desulphurization (FGD) is the name given to the highly automated process used to clean the effluent gas that results from the burning of coal.

There are many different, evolving technologies used in the FGD process. However, in general, the initial flue gas is typically sent to a precipitator, which statically charges the particulate and removes it. The gas then undergoes a chemical neutralization process and is sent through a slurry and drying process. The end result is a usable, marketable by-product (such as gypsum used in the manufacture of wallboard).

The process requires very large dampers and fans to move the gas as well as many automated valves and gates, which control the flow of the slurry throughout the process. Many different types of actuators are used, and it is very important to make the right choice of actuator for each specific requirement. In fact, many FGD facilities utilize a variety of pneumatic, hydraulic, and electric actuators in the same plant. However, a good design will consolidate actuators with similar power requirements as much as possible to achieve overall operating and maintenance efficiencies.

MAJOR PROBLEMS ASSOCIATED WITH ACTUATORS IN POWER PLANTS

Power plants have demanding environments that require a high level of expertise related to actuator selection, performance, and maintenance.

The following are a few examples of problems that need to be addressed in order to make sure that the actuators selected are appropriate for the application.

Rotork IQ electric actuators can take a lot of punishment. Here, networked IQs operate in a power plant's rugged FGD environment.

HIGH TEMPERATURES

There are areas in the plant where temperature is a major concern. Some of the areas are straight forward, while others require some technical explanation to understand the consequences.

The ambient temperature in some areas of the plant will depend on typical weather variants. In colder areas of the world, plants are built inside buildings in order to protect against inclement weather. During the summer months ambient temperatures can easily reach 120 degrees F.

In warmer climates, plants are not enclosed, but still see high ambient temperatures due to direct sunlight and hot summer weather. Again, 120 degrees F is not uncommon.

The transfer of heat from pipes with steam at 1000 degrees F can radiate to nearby equipment to have temperatures higher than ambient. When one adds the heat which is conducted through a valve or damper stem inside an electric actuator, the temperatures can exceed the 160 degree F limit of the electronic actuator.

The exact temperatures in these different applications are difficult to ascertain. Suffice it to say, many designers specify actuator trims to meet these high temperature conditions.

Areas of concern include suitable lubricants, soft rubber seals, and electric wire insulations. O-rings and oil seals are usually specified to be manufactured with Viton® and wire insulation with Teflon® materials. Suitable trim materials are required for high temperature areas. Rotork has done extensive testing to insure that the non-electronic actuators designed for high temperature applications can withstand temperatures up to 300 degrees F.

A more difficult problem comes with the stem expansion of gate and globe valves in high temperature service. The effects of operating the valve with high temperature service conditions for a typical gate or globe valve are as follows.

With the valve in the fully opened position, a portion of the length of the valve stem is outside the valve bonnet and is relatively cool. When the valve is seated by a motor in a relatively quick amount of time (that is, before the stem heats up and expands), the stem is then heated by the hot service fluid trapped in the body of the valve and exerts additional thrust pushing the valve further into the seat. That thrust is then absorbed by the valve seats, the actuator thrust bearing, and drive nut.

After the valve has been closed, the valve cools and the seats contract. That leads to difficulty in unseating the valve when it needs to be reopened. Also, the valve can unseat itself causing it to leak by driving the disc/shaft up.

The solution to this problem is to use a temperature compensator. It can be achieved by either springs or beveled washers in the drive bushing area, or at the thrust base to allow for some stem movement.

This is a commercial manufacturing issue that adds cost to the initial purchase price of the equipment, but it is a situation that needs to be addressed by designers to insure proper operation of any valve and actuator that will be exposed to high-temperature conditions.

HIGH SPEED

Wherever self-locking gearing is required, attention should be paid to how high-speed electric actuators are configured.

Self-locking actuator and stem combinations can be accomplished either by the actuator gear ratio or valve stem threading. It is an important item to look at in certain applications. Basically, if the stem is self-locking, the actuator does not need to be. The opposite is also true.

However, back driving a valve is such a bad situation that it must be double-checked.

Most designers feel if the gear ratio is a minimum of 60:1, then the actuator is self-locking. There are also common charts to determine whether the stem with its particular characteristics is self-locking.

When the electric actuator is driving a secondary gearbox, there are times that the actuator can be operating at quite a high output speed. These situations are rare, but need to be considered in the combination of the actuator and gearbox so that damage to the operating mechanism or gearbox will not occur.

This issue is especially important to look at in applications where the actuator is holding a piece of equipment in place against flow or gravity, such as with a guillotine damper.

ACTUATOR SIZING, MODULATING SERVICE, VOLTAGE DROPS

Sizing of actuators is an integral part of the process and can have an enormous effect on the installed cost of the automated valve.

There are some specific issues related to sizing actuators in power plants that should be addressed.

A basic concern of sizing any actuator for a valve is to insure that there is enough force to move the valve.

In the case of a threaded stem, a few important facts need to be considered.

The first calculation is made to determine the thrust that is required. (In this booklet, we measure thrust in pounds.)

In a simple equation, the raw thrust required for a particular valve is a function of the bore area relative to the differential pressure across the valve.

A valve factor, which is dependant on the type of valve, is also included. This equates to a raw thrust which is the major component of the thrust requirement.

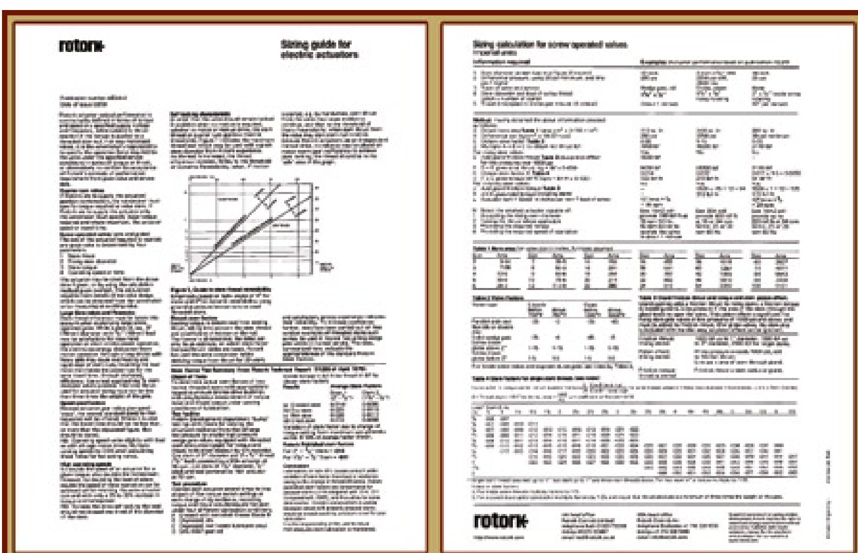
In most cases, the stem piston thrust is added, which is dependant on stem size. The actual force to turn a valve stem is measured in foot pounds of torque. This is determined by multiplying the required thrust by a stem factor, which comes from the stem data of the valve.

It is best to run the raw numbers and then add a suitable safety factor.

In certain industries, the same valves can be sized quite differently. In areas where similar valves are used at lower temperatures, full differential pressure might be used to insure there is a sizing safety factor. Of course, this is not sensible when the valve classification is chosen due to temperature considerations.

On very high thrust applications, the stem factors need to be looked at quite carefully, and the thrust calculations can be affected by the stem data itself. This is an area where close coordination between valve and actuator suppliers is required.

Most motor operated valve applications are sized under guidelines that assume operating times of about 12 inches per minute. Based on this assumption, the typical operating times for a MOV will be three minutes or less.


rotork

Sizing guide for electric actuators

Rotork can provide you with a sizing guide. Ask for publication number AE2/0.2; or, download it at Rotork's Web site: www.rotork.com.

When this is the case, the rated torque of the machine is considered to be acceptable for the entire stroke. Some manufacturers tend to de-rate the actuator in cases where the operating time starts to increase to limit temperature rise in the motor. This type of extended service needs to be considered in very large valves or applications such as guillotine dampers.

Another common area where an electric actuator will be de-rated is in modulating service. Manufacturers have different opinions about this, but most have some way of calculating the de-rating of the actuator if it is to run in a continuous mode. This is strictly a consideration of torque over time.

The discussion of what constitutes a modulating actuator must also take into consideration other items within the actuator. These include, but are not limited to, motor starters, motor insulation, drive sleeve materials, and even drive sleeve configurations.

There are certain drive designs that specialize in continuous modulation, and the sizing is inherently in the published figures. The more specialized controls required for this service should not be considered add-ons or options, but as standard equipment. An example of this type of drive is one that operates a fan damper. The gearing for a fan damper drive is oversized in order to withstand the heavy-duty cycle encountered.

Actuator manufacturers rate their electric motor operators for 1200 or more operational starts per hour as high-modulating rates. Many consider that rate to be synonymous with "continuously" modulating. However, in reality, "continuous duty" means the drive could be required to move in either direction constantly for some considerable amount of time, until it finds its equilibrium point.

Any drive that never finds its set point will have a very short life expectancy. So, while it is rare that a valve would be constantly modulating, it is reasonable that it might have to operate continuously for days during start up modes and during times of ramping the units up and down.

Therefore, it makes much more sense to discuss the specific application rather than rely on rated starts and stops. This is especially true because different actuator manufacturers have different opinions regarding duty cycles and life expectancies of their equipment.

Another type of sizing consideration which often occurs in power plants is sizing for reduced voltages. It probably seems strange for a power-producing facility not to have sufficient voltage for the equipment. There are many reasons for this, and it is a problem that happens frequently.

Sizing on a reduced voltage of just 20% can reduce the output power of the machine by about one third. It is not something that should be done lightly, as it means a larger actuator, larger valve stem, and more robust valve bonnet assembly.

SUMMARY

The information in this booklet is a brief, general overview about the roles valve and damper actuators play in a typical coal-fired power plant.

However, every plant and every application is different and has its own special requirements.

Rotork has had more than 50 years experience in providing high-quality, reliable solutions for the power industry and can help you determine the best actuator for your exact needs.

We can provide information about electric, pneumatic, hydraulic, and electro-hydraulic actuators. So, please feel free to contact us if you have questions or need information.

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Rotork Controls, Inc., Rotork Fluid System, and Jordan Controls are Rotork Group companies.

Family of Rotork Actuators

Rotork IQ Pro multi-turn electric actuator and setting tool. The IQ Pro includes on-board data logging for valve monitoring and predictive maintenance. It is easily integratable into most facilities' control systems.

Rotork Skilmatic SI electro-hydraulic, quarter-turn, and linear actuators. Available for modulating or two-positon fail-safe applications.

Rotork Fluid System offers a full-range of pneumatic actuators. Available in spring-return or double-acting configurations.

Jordan Controls provides modulating actuators ideal for many power plant applications.

Rotork produces IEEE-382 nuclear qualified actuators and high-temperature A-range motor operators.

There are many dozens of different valve and damper actuators specifically suited for Power Industry applications available from the companies in the Rotork Group (including Rotork Controls, Inc., Jordan Controls, and Rotork Fluid System).

The actuators at the left are only a small example of the many products Rotork offers to the Power Industry.

In fact, we have a wealth of engineering knowledge and extensive experience serving the Power Industry, dating back more than 50 years.

A professional sales and service force is available to help you solve all of your valve and damper actuator requirements.

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