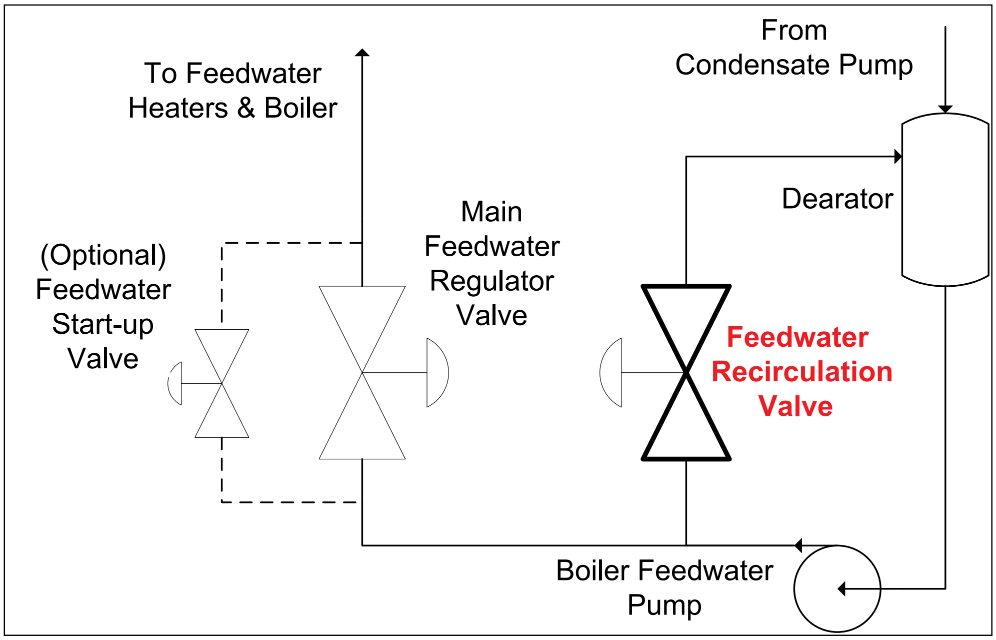
POWER PLANT APPLICATIONS

Feedwater System Series —

Boiler Feedwater Recirculation Valve

System Overview

In drum style boilers, the feedwater system is integral to boiler efficiency and to overall plant performance. The feedwater system spans from the deaerator through to the boiler and is used to provide feedwater to the boiler to match the steam flow demand. The major control components involved with the feedwater system include the boiler feed pump, boiler feedwater regulator(s), and the boiler feedwater recirculation valve. (Figure 1).



Boiler Feedwater Recirculation Application

The boiler feedpump is used to supply the required feedwater from the deaerator to the steam drum to match the steam demand requirements of the plant. Specific to the design and piping layout of every plant is a Net Positive Suction Head (NPSH) available. This defines the inlet pressure at the suction side of the pump, due to the effects of gravity and system design. If the pump draw were to exceed the NPSH, the inlet line pressure would drop below the vapor pressure resulting in flashing and cavitation. Not only would the cavitating feedwater physically damage the pump, the reduced flow rate would allow it to overheat.

To prevent this, a minimum available flow must be maintained to circulate through the pump, regardless of downstream boiler load requirements. Boiler feedpumps are expensive investments for plants, typically ranging from $150,000-$250,000 or more, so it is imperative to protect them.

To protect the boiler feedpump from damaging conditions, plants have a recirculation line that bypasses the boiler and recirculates feedwater directly back to the deaerator or condenser. This recirculation line is designed to make certain that the boiler feedpump has the required flow available to protect the pump at all boiler load conditions. Older plants may still employ the use of an on/off valve or even a continuous line here, but the majority of plants utilize a severe service control valve so they can maximize boiler efficiency.

Boiler Feedwater Recirculation Valve

The purpose of the boiler feedwater recirculation valve is to protect the plant's investment in the boiler feedpump while still allowing the feedpump to deliver the required flow to the boiler.

Because of the nature of this application, the boiler feedwater recirculation valve is typically the most severe service application in any power plant. Depending upon plant type and design, the feedwater recirculation valve will see upstream pressure in the 2500-4500PSI range, and is responsible for taking almost a full pressure drop across the valve. Since this valve is usually closed during normal operation of the plant, the valve is typically designed for Class V shutoff, and needs to fail open on loss of power.

The Problem

Because of the severe service that this valve sees it is generally maintenance intensive. Tight shut-off is critical to protect the valve trim. Because of the high upstream pressure, a small amount of seat leakage will ultimately result in the destruction of the trim and lead to a more substantial leak path. It is common for this valve to have trim rebuilds and or retrofits frequently.

Operationally, there are gains to be made by improving controllability with this valve and by ensuring that the valve has tight shut-off. Due to current industry trends and external drivers, many power plants are operated under conditions that differ from what they were originally designed for or how they have operated in the past.

Many plants are now required to operate at lower load conditions more frequently than before. When plants are operating at low load, accurate recirculation is required to protect the pump and provide operational efficiency. The feedwater pump provides flow to both the feedwater control valve and to the recirculation line, while the recirculation valve maintains enough flow through the pump to keep it from cavitating. However providing too much flow through the feedwater recirculation valve is lost energy for the plant.

A larger problem for plants is lost efficiency due to leakage of the feedwater recirculation valve. As discussed earlier, when the valve seat is degraded due to poor shut-off, the leakage is compounded quickly due to high pressure "wire-draw" of the seats causing the leak path to get substantial quickly. As the leak path becomes greater, the pump will have to work harder to get the flow to the boiler, as a larger and larger portion of the flow is being unnecessarily recirculated through the leaking recirculation valve to the deaerator. As the boiler load requirement increases, the boiler may be unable to receive full rated flow of the pump due to a leaking feedwater recirculation valve, and will be required to operate below full load capability.

It is important for plants to select a control valve that has the right inherent characteristics for their feedwater recirculation application. Rangeability and cavitation control are a must in this application and are inherent to the valve trim design. Beyond the physical attributes of the valve, it is also important to have an actuator that is responsive, repeatable and rigid in performance. If the actuator is not all of these things, the valve trim will need to be continually replaced.

Most plants are still utilizing pneumatic spring and diaphragm actuators to actuate their feedwater recirculation valves. These types of actuators are sufficient for many, less critical, plant applications, which do not provide recognized payback for tighter control. The use of pneumatic actuators inherently results in hysteresis due to “stiction”, which is caused by the need to overcome frictional forces created between the valve packing and valve stem. The main limitation with these actuators is due to the compressibility of air as a control medium. Recent years have seen an improvement in pneumatic control due to the advent of “smart” positioners. These positioners reduce the effect of “stiction” in pneumatic actuators by introducing advanced control algorithms in the positioner. The downside to “smart” positioners is an additional increase in dead time, to help correct for “stiction”, particularly in valves with larger actuators, and when the control signal step change is small (2% or less).

Another downside to pneumatic actuators is their lack of rigidity. Because air is the operating medium, and is compressible, they can often be “moved” by the process. Pneumatic actuators do not have the stiffness that is inherent to a hydraulic actuator and therefore do not have the ability to control as accurately when small steps are required. The rigidness of a hydraulic actuator is well suited for an application requiring fine control and tight shut-off such as boiler feedwater recirculation.

The REXA Solution

REXA Electraulic™ actuation offers a rugged, responsive and repeatable solution for feedwater recirculation applications. The **REXA** Xpac actuator is 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 valve control performance and allows for tight shut-off.

REXA L-Series linear actuators can be used to improve the controllability and shut-off of any manufacturer’s control valve.

A typical **REXA** actuator for this application would be an L4000 or L10000 series with anywhere from a 2 to 4 inch stroke (dependent upon valve type), and a B or C power module for the correct speed of response. The actuator could be designed for fail open service or fail in place service dependent upon the strategy of the plant, and would come standard with an elastic coupling to provide consistent seat force and visual indication of seat contact.

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Boiler Feedwater Recirculation Valve

The Value for the Plant

Upgrading from pneumatic actuators to **REXA Electraulic** actuators on boiler feedwater recirculation valves can provide immediate benefits for any power plant. Maintenance savings will be immediately realized through tighter shut-off, improving trim life of the control valve, and reducing labor and material costs.

An upgrade to **REXA Electraulic** actuators from pneumatic actuators will yield the following operational improvements:

- – Increased Boiler efficiency
- – Increased Ramp rate
- – Increased Unit Availability (Improved ability to survive process upsets)
- – Improvement in Unit Turn-down (Minimum Load operation)

In most plants the ROI for upgrading to a REXA hydraulic actuator on the boiler feedwater recirculation valve can be counted in a matter of weeks. ■

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