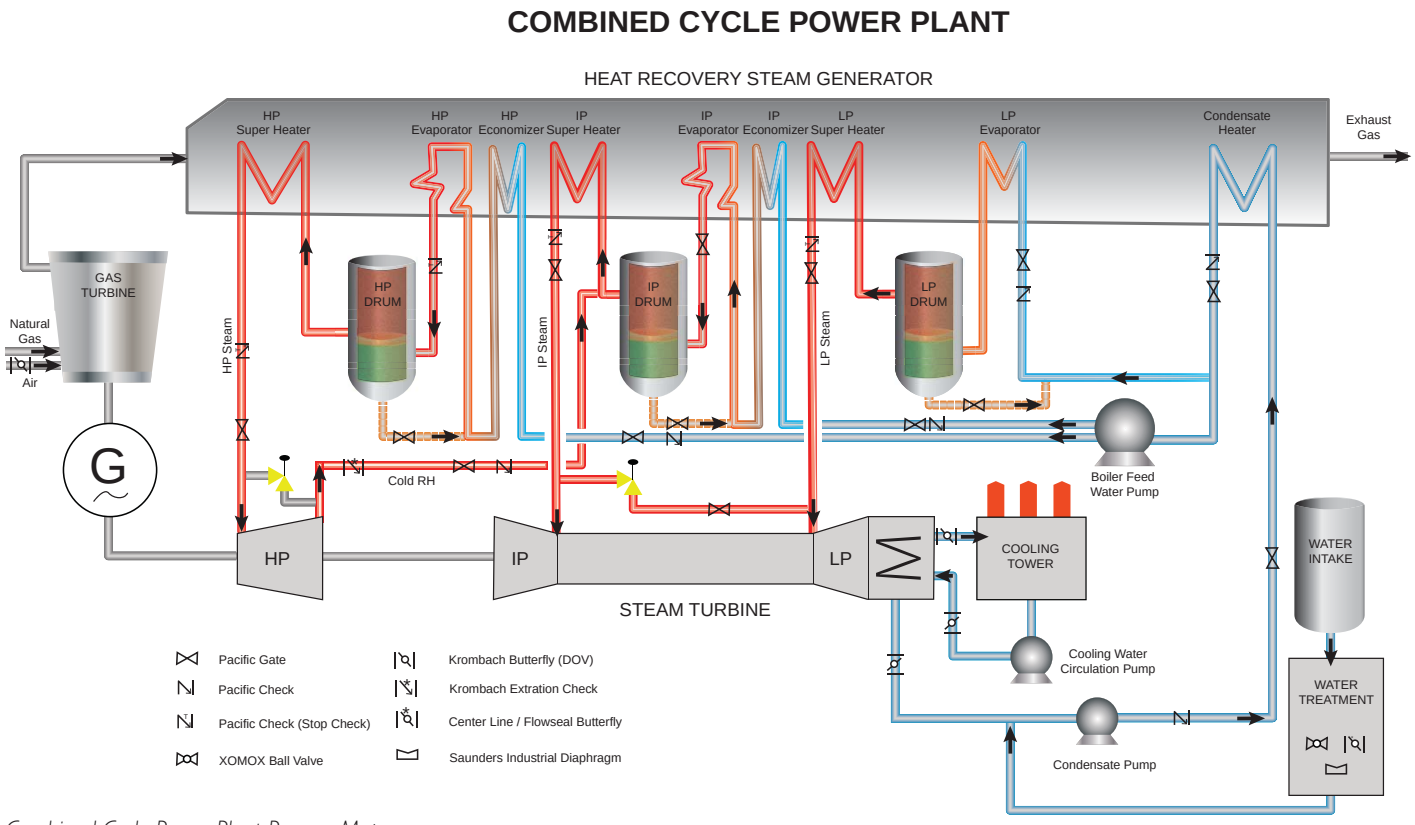


Combined Cycle Power Plant Process Map.

Power industry applications: A valve selection overview

Increasingly volatile cyclic conditions in modern power plants are quickly intensifying both the demands and the stress being placed upon process equipment, especially when it comes to valves. Continuously striving to increase efficiencies and maximize operational performance, power producers worldwide rely on process equipment to deliver unparalleled performance. In combined-cycle power plants, gas turbine starts, thermal transients and gas turbine acceleration have become increasingly severe, forcing process equipment to accommodate higher flows at increased temperatures.

By Rich Ford, Crane ChemPharma & Energy

Similarly challenged are coal-fired power plants, where efficiency is the direct result of steam temperature and pressure. With more and more research dedicated to methods of generating more power from the same inputs, operating pressures and temperatures continue to increase with the demand for stronger, more suitable high-temperature materials.

Due to the vast range of applications within power generation plants, myriad valve types are utilized to accommodate the specific operating conditions of each. From special applications to isolation to flow reversal protection, valves used in power generation have a variety of characteristics to consider when selecting the most appropriate design for a given application.

Metal-seated Ball Valves

The high temperature demands and volatile environment of power plants make metal-seated ball valves a preferred alternative to soft-seated valves in severe service conditions. Designed to withstand temperatures in excess of 1,000°F, metal-seated ball valves provide uninterrupted service in challenging applications and are less susceptible to the degradation common with soft-seated ball valves in similar applications.

Metal seated ball valve.

A variety of coatings can be chosen for the ball and seat rings, whose metal-to-metal contact provides tight shutoff and a longer service life when compared to alternative valves types.
Some advantages of metal-seated ball valves include low repair cost, bi-directional sealing, fire safe and anti-static (API and BS) features, a long life span and lower total cost of ownership. They likewise deliver optimal torque transmission and are able to withstand temperatures up to 1500°F or 800°C.

Resilient-seated Concentric Butterfly Valves

Generally rated for temperatures up to 450°F and with the lowest pressure rating, resilient-seated concentric butterfly valves are intended for general use and are common in less-severe power applications including cooling water circulation, feed water distribution and condensate pumps, among others. Compared to other valve types, butterfly valves feature an inherently simple, economic design that is cost-efficient to purchase, install and maintain.
In resilient-seated butterfly valves, shutoff is achieved through the interference fit of the disc edge and the seat, which can be created from a variety of polymers or elastomers.
Some advantages of resilient-seated concentric butterfly valves include their utilization in both gaseous and liquid service. Due to their simple design with fewer parts than alternative valve types, resilient-seated butterfly valves offer ease of installation, maintenance and automation while being lightweight & cost-effective.

Resilient-seated concentric butterfly valve.

High-performance Butterfly Valves

Like other butterfly valve designs, the wafer shaped body and lightweight design of high-performance butterfly valves (HPBV) can offer significant cost savings in equipment, installation, repair and piping support. With similarly limited temperature and pressure ratings in soft-seated designs, these valves are most often utilized in water intake systems, cooling water systems, filtering systems and industrial waste water applications in the power industry and others.
Designed with two offsets rather than the single offset characteristic of concentric butterfly valves, HPBV have an increased sealing ability and create less friction to deliver a longer service life. While the most common seat material is PTFE, metal seats are also available, enabling HPBVs to be utilized in higher pressures and temperatures up to 1000°F with fire safe capabilities.
High-performance butterfly valves offer many advantages with both soft-seated designs that provide bubble tight shut-off and metal-seated designs that can deliver ASME Class IV leakage protection. With a variety of body styles available, they can be produced in fire safe designs and offer the best performance of any butterfly valve in vacuum-to-low pressure applications.

High performance butterfly valve.

Triple Offset Butterfly Valves

As the name conveys, triple-offset butterfly valves have a third offset in the form of a conical-shaped seat that eliminates friction during valve opening and closing. The most effective butterfly valves in high-pressure and high-temperature applications, triple-offset butterfly valves deliver bubble-tight sealing and a much longer service life in power applications than alternative butterfly valve designs.
Triple-offset butterfly valves offer the best sealing and longest life of all butterfly valve designs while delivering bi-directional gas tightness. With innovative self-centering, flexible disc sealing and optimal torque transmission, these valves offer fire safe designs and the flexibility to create customized solutions.

Triple offset butterfly valve.

Isolation Valves

One of the most critical pieces of fluid handling equipment in any severe service application is an isolation valve. Designed to stop the flow of media during maintenance or emergency situations, these valves are indispensable in maintaining the safety and functionality of power generation facilities. Also utilized to determine flow path and connect external process equipment, isolation valves serve a unique purpose within industrial systems. Two common types of isolation valves are gate and globe valves, which come in both bolted bonnet and pressure-seal designs.

Bolted Bonnet and Pressure Seal Gate Valves

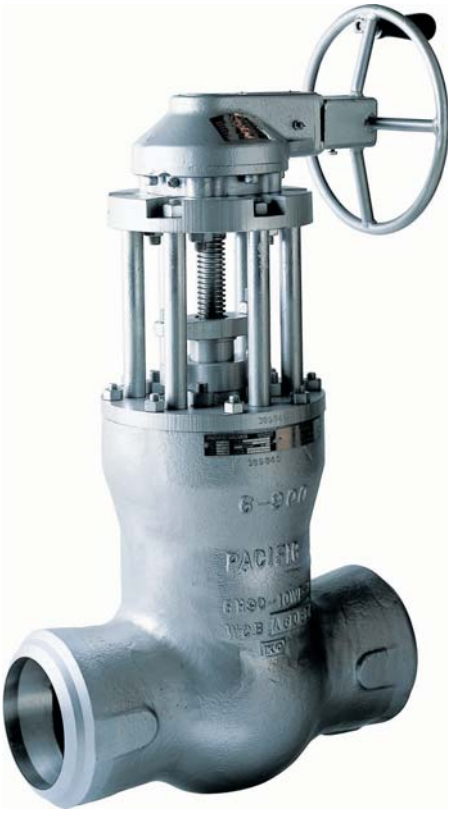
Operated by introducing or removing a gate or wedge into the flow path, gate valves are often employed as isolation devices in applications that require minimum restriction to the flow of a fluid. Unlike globe valves, gate valves are not recommended for throttling and should be utilized to either fully permit or fully prevent the passage of a medium through a fluid handling system.

Among the various designs of gate valves, parallel disc & flexible wedge are desirable in power applications, as the flexibility of the parallel disc requires little torque as it is position seated and uses system pressure for tight seal. Wedge type is fully guided and resists sticking or binding due to thermal expansion. Likewise, the straight-through design of the valve body and wedge maximize flow while minimizing turbulence, pressure drop and the erosion of moving parts.

In deciding between a bolted bonnet (not recommended above ANSI Class 600) and pressure seal design in gate valve selection, the same criteria apply as outlined in the globe valve section. Pressure Seal valves are used where high pressure/temperature conditions can force the bolted bonnet gasket seal apart, causing external leakage

The perfect solution for high-pressure applications is a design where the gasket seal becomes tighter as the internal pressure increases. Pressure seal bonnet design valves use the system pressure to press the bonnet into the gasket and sealing ring; the higher the pressure, the tighter the seal. As described, both bolted bonnet and pressure seal designs can withstand extreme pressures; however, the constancy of extreme pressure should likewise be evaluated in selecting the appropriate bonnet design.

The advantages of gate valves include superior shutoff service for high-pressure and temperature applications and designs that offer fully-guided carrier assembly that is position seated rather than torque seated. Gate valves eliminate excessive leakage, thermal binding and maintenance and offer easy in-line repair and fitting. Self-cleaning designs are available, and lower torque requirements allow smaller actuation packages while wedge guiding reduces seat rubbing and extends the valve's life cycle.



Pressure seal gate valve.

Bolted bonnet gate valve.

Bolted Bonnet and Pressure Seal Globe Valves

For applications that require fine throttling control, globe valves are especially suitable. However, even in the fully-open position, the baffle is restrictive, making globe valves a less desirable solution in applications that require a high flow rate. Therefore, when choosing a globe valve, it is especially important to consider the medium, the level of flow necessary, and the degree of control required from the valve.

Both the seat and plug size determine the degree of flow control, as well as the number of turns it requires to open the valve the desired distance, so all will need to be accounted for during the valve selection process.

In high-pressure and high-temperature power applications, bolted bonnets ensure the leak-proof closure of the valve body and contain the packing that protects the valve during cycling. Joined by metal studs and nuts and sealed with a gasket between the flange faces, bolted bonnet designs are able to withstand the extreme cycling pressures and temperatures in power applications. Despite their sealing capabilities, however, bolted bonnets can become susceptible to leaks as pressure increases.

Developed in response to the possibility of bolt relaxation in bolted bonnet globe

Pressure seal T-globe valve.

Pressure seal Y-globe valve.

valve designs and the associated potential for leaks, pressure-seal gaskets create a seal that tightens as the internal pressure of a valve increases. While this design delivers distinct advantages in severe service power applications, it is best suited in situations with a consistent pressure in excess of 500 psi.

Globe valves are advantageous in power generation due to their effectiveness in both on/off and control applications. Containing few parts, globe valves' simplicity of design facilitates maintenance in place while delivering superior sealing capabilities. Low friction between seals increases valve life and eliminates the potential for CCOP, pressure locking or thermal binding.

Flow Reversal Protection Valves

To further ensure the overall safety of a power plant and protect mechanical equipment from the damage caused by flow reversal, it is essential to integrate check valves throughout the fluid handling system.

The demands placed on check valves and their constant exposure to fluid can make them highly susceptible to wear and other operational challenges like sticking, jamming and wedging. The daily forces that act upon check valves in severe service applications are particularly harsh, and over time, the heavy slamming caused by turbulence can compromise their performance. Given the abrasive conditions and challenges in check valve sizing and selection, choosing the right equipment for an application is critical to achieving maximum valve performance.

Nozzle Check Valves

These highly-engineered check valves have been specifically designed for fast-reversing systems where backflow is a constant concern. The unique design of nozzle-style valves can minimize the damaging effects of water hammer, eliminate chatter, protect rotating equipment, reduce pressure loss in piping systems and provide a quick dynamic response for immediate shutoff.

Unlike alternative check valve designs, nozzle check valves consider the design velocity required to stabilize the disc open against its stop even with moderate flow oscillation. When a noticeable reduction in flow occurs, the disc reacts immediately to limit backflow and slamming.

Highly engineered nozzle-check valve.

Nozzle style check valves offer a variety of benefits, as their internal geometry can be modified to suit the application and they can be engineered and sized for the application, not the line size.

One piece body castings are available, ensuring minimum wear and extended valve life. Delivering quick dynamic response and tight shutoff, nozzle check valves are suitable for reciprocating compressor service and are capable of fully-open position with a maintenance-free design.

Dual-plate Check Valves

Dual-plated Check Valve.

Another highly-engineered check valve type, dual-plate check valves are generally stronger, lighter, smaller and more efficient than conventional swing check valves. To best protect the costly equipment within power generation applications and deliver the lowest total cost of ownership, dual-plate valves rely on springs to increase the valve reaction and response time. As a result, the valve's dynamic response time is greatly improved while the chance of water hammer is likewise reduced.

Lightweight & compact compared to traditional swing check valves, dual-plate check valves offer independent spring design for rapid response to changes in flow conditions and reduce the risk of water hammer in non-slam applications. Firesafe options and retainerless designs are available to eliminate fugitive emissions and a variety of spring torques can be designed to suit critical velocity systems and improve response time.

Bolted Bonnet Swing Check or Pressure Seal Tilt Disc Check Valves

Check valves are used to allow flow to travel in one direction. They protect systems from reverse flow. The tilting disc check valve is designed for high velocities, turbulence, and water hammering due to its design. The shape of the disc is designed for maximum lift, with minimum pressure drop. This is also called a "non-slam" design. The disc swings at a 45 degree angle (limited travel), which

Pressure seal tilting disc check valve.

eliminates "flutter" of the disc. Our swing check valves are designed with low pressure drop and are best suited for moderate velocity applications. In any application, the correct sizing of check valves are important, as miscalculations in flow velocity, media and operating conditions can impact the performance capabilities of the valve and jeopardize the safety of downstream process equipment. Check valves are an essential component of nearly every application in combined-cycle and coal-fired power plants alike. Depending on the severity of the application and potential for flow reversal, proper selection is critical to ensuring maximum protection.

Bolted bonnet and pressure seal check valves are advantageous in that they are more cost-effective than nozzle and dual-plate check valves and deliver tight shutoff even in vertical installations. Available in a variety of configurations, they deliver a relatively higher Cv than alternative piston-type check valves and offer simple operation and relative ease of maintenance. Finally, an internal disc hanger provides adjustable alignment, better sealing, and eliminates potential leakage, a combination of features delivered by no other valve type.

Conclusion

As the power industry faces increasing energy challenges and the need for ever-enhanced efficiency fuels the next generation of power production, valves and other process equipment must be designed to address the specific conditions of the changing environment. While temperature and pressure burdens placed upon equipment become more demanding based on continuous cycling, valve users require solutions that are safe, reliable and specially engineered to meet the energy needs of an increasingly-demanding nation. In valve selection, it is important to consider the benefits of each, and work directly with a proven manufacturer to ensure that your valve equipment is equipped to address the needs of next-generation power production.

About the author

Rich Ford, of Crane Chem-Pharma & Energy, is a veteran sales engineer who has worked with Crane Pacific for the past 15 years to evaluate customer process data and functional requirements and specify valve solutions that will exceed the needs of industry users.