White Paper

Choosing the Proper High-Pressure Water Valve Material

Mickey Heestand, Hunt Valve, Inc.

High-pressure water hydraulics systems have been widely used since they were initially developed in the late 1700s. The first systems were designed as a means of harnessing the power-generating potential of water, an application that is still very much in use today. Water hydraulics systems have evolved over the years into a multitude of uses in the manufacturing, mining and drilling industries. These safe, reliable systems offer consistent efficiency when designed and maintained properly.

Of course, proper design requires a lot of thought, especially when it comes to specifying the components that comprise these types of systems. Valve selection is of critical importance, and a key aspect of that selection process is understanding how the materials used in a valve you're considering will have a long-range impact on valve and overall system performance.

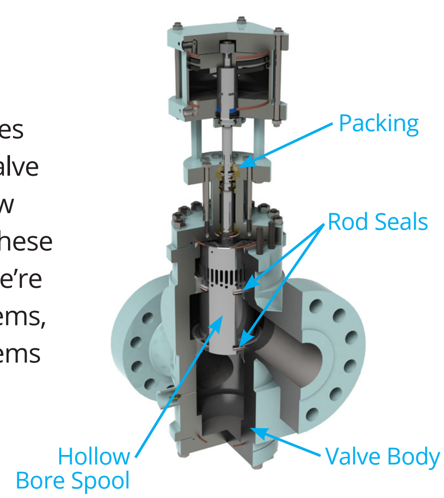
Establishing the Parameters

When an engineer selects valves used in a high-pressure water hydraulic circuit, the required function of those valves is what ultimately guides the engineer's choices. Flow media, pressure, flow velocity and the purpose of a specific valve are the key parameters that will direct the engineer toward a certain type of valve. For instance, if a valve is needed to extend or retract a cylinder in a 750-ton press in a water hydraulics system, then there will be certain group of directional control valves that will fit this application. From there, the engineer can begin the process of deciding on a specific valve based upon cost, ease of maintenance or useful life of a particular valve model.

Beyond these basic operating parameters, the engineer will also turn his or her attention to valve materials. Going back to the example of the valve for the 750-ton press, you'll have to consider whatever additives might be contained in the system media for possible incompatibilities with the valve. For instance, if the flow media contains glycol for fire resistance, then the body, seals and packing components that make up the valve need to be specified with an understanding of the possible effects that glycol may have on those valve components.

Materials Don't Always Play Nice

Understanding these material incompatibilities is crucial, particularly for those parts of the valve that will come into direct contact with the flow media, which are called the "wetted" areas. These will vary for different types of valves. While we're focusing here on water-based hydraulic systems, the approach for specifying materials in systems that use other media would be the same.



Actually, the term “water hydraulics system” is actually a bit of a misnomer, as systems that operate with pure water are very uncommon. The majority of water hydraulics systems are water-based, meaning that they contain a heavy concentration of water mixed with a small percentage of some other additive, typically water soluble oil. The oil is added to improve the lubricity of the water so that it will reduce wear on seals, bushings, valves and pumps, as water by itself is a poor lubricant. Other additives can be added as well, such as glycol to improve fire resistance or biocides to inhibit bacterial growth.

For instance, a water-glycol mix will degrade a polyurethane or polyester seal quite quickly. Similarly, chlorine that is present in some municipal water sources has been known to cause galvanic crevice corrosion in some valve applications. Valve, seal and gasket manufacturers typically publish incompatibility charts that list common substances and how they interact with their materials of construction. This is valuable information for any engineer.

Of course, it’s well-known that water on its own typically leads to corrosion and will affect valve components over time. But it is also imperative that the engineer understand the cleanliness of the flow media. Properly maintained closed-loop systems will not typically experience media cleanliness issues. However, for open-ended systems, such as those used in descaling operations in steel mills, where process water is recycled through the system, particles in the water have a harmful effect on the wetted areas of valves. These particles will impinge upon those surfaces and cause excessive wear. Valve design and selection of materials of construction need to account for these types of media characteristics.

Temperature of the flow media and the operating environment is another factor to be considered. Corrosion will occur at in increased rate at higher temperatures. Additionally, temperature can cause different materials to expand and contract at different rates, which can cause leakage issues, undue binding stress on valve components or seizure.

Common Materials of Construction

Components such as valve spools, valve seats and valve bodies are usually offered in materials that provide a varying range of corrosion resistance, temperature resistance and wear resistance. These are materials that are commonly used in high-pressure water applications:

Ductile Iron: Used for its low cost and availability, ductile iron offers the additional benefit of readily absorbing shock. On the negative side, ductile iron offers poor corrosion resistance.

Brass and Bronze: Brass and bronze valves also offer low cost and are readily available. An added benefit over ductile iron is improved corrosion resistance.

316 Stainless Steel: Known for its excellent corrosion resistance, 316 Stainless Steel valves are more costly than cast iron, brass and bronze valves.

Monel: Monel is a nickel-copper alloy that offers superior corrosion resistance. It is typically used for cladding of valve trim parts.

Inconel: An alloy of nickel, chromium and iron that is used for handling corrosive media at higher temperatures.

Seals, gaskets and packing are typically constructed of the following:

Polyurethane: This durable material is suited for temperatures up to 200°F and pressures up to 6,000 psi and offers excellent abrasion resistance.

Viton: Viton provides excellent chemical resistance and is fares well in high-temperature applications.

PTFE: An extremely low friction material that can function well over a wide range of pressures and temperatures.

Glass-Filled PTFE: PTFE with glass added to improve mechanical properties such as wear resistance and heat transfer.

PEEK: Polyetherketone is well-suited for use with steam applications. It generally offers higher temperature ratings and has good corrosion resistance.

Making a Reasoned Choice That Is Guided By Knowledge

Application parameters and flow media incompatibilities will generally drive valve material decisions, with cost coming in as a concern immediately behind. In most cases, the lowest cost valve that performs the intended function, and is constructed of materials that are compatible with the flow media, should be selected. There are some cases, however, where the service or replacement schedules of certain valve components can be extended by using a more expensive material of construction. That additional cost may be worth it, especially in applications where scheduled downtime must be minimized.

Designing a high-pressure water hydraulics system can be a daunting task for even the most experienced engineer with a wealth of hydraulics experience. There are numerous decisions to be made, and the majority of those decisions have to be made while adhering to a budget. But, if the engineer methodically goes through the process of understanding the operating parameters of the system and the requirements of the various system components, then he will be on his way to designing a safe, reliable and efficient system.

About Hunt Valve

Hunt Valve brings decades of fluid power engineering innovations and solutions to a wide range of industrial and military customers. It specializes in severe-duty valves and complementary engineered components and system solutions for applications that include primary metals (steel, aluminum), energy (nuclear, hydro, downstream oil & gas), process (chemical) and U.S. Navy nuclear-powered vessels, including all submarines and carriers in operation as well as the Virginia Class, Ford Class and soon-to-be-in-production Ohio Replacement. To learn more about the Experts in Extreme Engineering, visit www.huntvalve.com.

About the Author

Mickey Heestand, Vice President and Senior Mechanical Engineer

Heestand's leadership role at Hunt Valve includes oversight of the company's welding and nondestructive test procedures, Welder Workmanship Training and Examination and contract engineering reports. He is also responsible for a portion of NDT Level II inspector training and testing. On June 23, 1998, Heestand was granted a U.S. inventor patent (US 5769123 A) for developing the cylinder actuated descale valve. This patent is owned by Hunt Valve. Prior to joining the company in 1986, Heestand worked at GM as a welder maintenance repair supervisor, gaining experience in hydraulics and control. He is an ASNT NDT Level III who is certified in several NDT methods (VT, PT and MT). He is also tested to meet HVC-specific requirements and certified by Hunt Valve as a NAVSEA Examiner. Heestand has a bachelor's degree in mechanical engineering from Youngstown State University.