Low weight high pressure ball valves

Abstract

High reliability, a long service life, application options over a wide range of temperature and pressure, cost-efficient production, as well as economical operation and the lightest and most compact design possible are the main requirements for high pressure sub-sea ball valves. An optimized valve and actuator design, the use of the most well suited materials and innovative, high-precision manufacturing and coating processes are necessary to meet all of these requirements in the best possible way. BHDT GmbH has succeeded in developing solutions for ball valves that meet all of the above-mentioned requirements as well as possible by carrying out complex design studies and conducting intensive manufacturing and coating tests, by using the latest design and simulation software, and performing the most extensive prototype tests.

Current challenges

In the deep sea, valves have to shut off or even regulate the flow of corrosive media while subjected to very high external pressure in salt water. They often remain in the same position for a very long time before they are actuated, which may lead to damage to the ball or seal. Before the valves can be used, they must be transported to their place of use, installed and commissioned at great depths, which is why the aim is to keep their weight as low and the installation space as small as possible. To ensure tightness under high fluid pressures, large contact loads of seals on the ball are necessary, which is why large actuator forces are required to open and close the valve. The greater the coefficient of friction between the ball and the seals is, the greater these forces are. In addition, the valves are exposed to great temperature ranges from -46° C to 135° C and to a fluid pressure of up to 15,000 psi.

State of the art

The materials used in ball valves are mostly quenched and tempered steels for the housing, duplex or nickel-based alloys for the balls, tungsten carbide as a coating for the balls and PEEK or PTFE for seals. These plastic seals in particular limit the application of ball valves to temperature ranges from -29° C to 120° C. The complex structure of ball valves in combination with primarily test-based design evaluations have resulted in very solid and heavy valve designs. Despite the risk of flaking off with large contact pressures and the relatively high coefficient of static friction between the seal and the ball, tungsten carbide is primarily used as the ball coating. Due to the large coefficient of friction and the need for a rotational movement, hydraulic actuators with rack and pinion gears are often used, despite the relatively large design.

BHDT ball valve solutions

Taking the relevant standards and customer requirements into account, and with the help of finite element simulations, the geometry of all of the valve components was optimized in terms of functionality and weight. Here, for example, the seal geometry has been optimized in such a way for tightness to be able to be guaranteed at a wide range of fluid pressure without the risk of having the coating flake. Great efforts were also made in developing a new coating system and implementing it in terms of production technology with the aim of maximizing the adhesion properties and minimizing the coefficient of static friction. A further significant reduction in size and weight can be achieved with the new development of a hydraulic actuator. In addition to the small size, this actuator has the further advantage of converting the hydraulic oil pressure directly into the required rotational movement, which reduces the number of components and the risk of failure.