

# WELDING IN INDUSTRIAL VALVE CONSTRUCTION: CHALLENGES AND SOLUTIONS

BY FELIX DEZEMBER

Welding plays a decisive role in the production of industrial valves for power plants and plant engineering. A major part of welding work involves joining individual components to form a complete valve. A much smaller aspect of welding, yet quite important for the function of

the valves, deals with the protection of surfaces against wear and corrosion by surfacing the protective layers. This is intended to protect the sealing surfaces in the valves from premature wear, thus ensuring permanently tight closure of the valves.

# CHALLENGES

## 1. MATERIAL SELECTION

Valves are made of a wide variety of base materials. Various steels are used in the field of power plant and plant engineering, which, for the most part, are made of materials such as heat-resistant, low-temperature or stainless steels. These steels can withstand the stresses caused by pressurized fluids even at correspondingly high or low temperatures. Furthermore, these materials are also suitable for withstanding impact stress, such as might come from a pressure surge or a steam hammer.

Nickel alloys or other special materials are also used for special stresses. These materials mostly require special welding techniques and specially adjusted welding parameters.

Depending on the properties of the fluids conveyed, the medium-affected surfaces of the valves come into contact with abrasive or corrosive media. This can lead to premature wear and functional failure. Such wear is particularly noticeable on the highly stressed surfaces, such as in the area of the sealing surfaces.

## 2. GEOMETRIC COMPLEXITY

Complex geometric conditions often make the execution of weld seams on valves difficult. This is particularly the case with surfacing claddings or hardfacings, when welding has to be carried out in places that are difficult to access. Small radii and edges often make the work even more difficult and require special equipment and welding techniques.

## 3. QUALITY REQUIREMENTS

Valves are subjected to the highest stresses in power plants and plant engineering. The conveyance of fluid flows in pipelines generally implies high pressure within the pipelines, which the valves must also withstand.

In addition, the materials are exposed to high temperatures, such as those in a water-steam cycle. Only through high quality standards are the valves able to function reliably and achieve a long operating life in the plant. Weld seams must therefore be as free as possible from defects such as cracks, pores or other irregularities to ensure the structural integrity of the valves.



**If we systematically consider the challenges of welding valves, we can see that a number of points have to be taken into account in order to produce high-quality weld seams.**

**A holistic view of the areas of materials science, welding and testing technology is essential.**

**A brief summary of possible solutions is given below.**

# SOLUTIONS

## 1. MATERIAL KNOWLEDGE AND PREPARATION

For a weld to be successful, the base materials to be welded and the stresses during operation must be known as precisely as possible. In particular, the mechanical properties under elevated temperature, such as the hot tensile strength or creep strength, need to be mentioned. Taking this information into account, the appropriate welding consumable can be selected.

Various alloy concepts are used for the surfacing of wear protection layers. Due to the corrosion resistance required, ferrous alloys with a chromium content of around 17% are used at temperatures up to around 500°C in water-steam valves. Nickel and cobalt alloys are also used for highly corrosive media or very high temperatures. Cobalt alloys in particular can show their strengths when subjected to multiple stresses, such as temperature, corrosion and abrasion. In addition to good corrosion properties, they also have a technically usable hardness under elevated temperatures.

The selection of the welding consumable also has a major impact on the selection and manufacture of the weld seam preparation. Careful weld seam preparation and cleaning as well are crucial for the weld seam quality on steels. The point of cleanliness in the welding area is of even greater importance, particularly with nickel and cobalt alloys. The greatest possible cleanliness is an absolute prerequisite for the success of a weld.

## 2. SPECIALIZED WELDING TECHNIQUES

TIG, plasma and laser welding in particular are used for complex geometries and hard-to-reach weld seams. Due to the possible automation of these processes, high-quality weld seams can be produced with repeat accuracy even in areas that cannot be directly viewed by welding personnel.

High-performance processes such as submerged-arc or electroslag welding are used whenever large areas are to be protected against corrosion by means of surfacing. Thanks to the possibility of feeding the welding consumable in the form of strips up to 120 mm wide, even large-area claddings can be produced very economically. A wide variety of possible strip-powder combinations allows metallurgical matching of the anti-corrosion layer to the specific application. Once the required welding parameters have been determined, automation of these processes can be used to produce a uniform layer thickness with consistent metallurgical properties.

## 3. QUALITY CONTROL AND TESTING

The production of high-quality weld seams requires appropriate quality planning. This begins even before the components are manufactured and includes the qualification of the welding processes to be used by means of welding procedure or production control tests.

Despite careful qualification and the use of automated processes, the inspection of weld seams is indispensable in valve construction. The simplest inspection method used is the visual inspection of all of the manufactured weld seams. The surfaces of welded wear or corrosion protection layers can be inspected for cracks by means of dye penetrant testing or magnetic particle testing, depending on the materials to be tested. Ultrasonic testing is the preferred method for detecting possible bonding defects between the surfacing and the base material.

# CONCLUSION

Welding in valve construction is characterized by the very specific challenges that might occur. These challenges can often only be mastered by the right combination of material knowledge, special welding techniques and thorough quality planning that includes quality control. When used correctly, welding can be used to produce valves of high quality and reliability that meet the industry's high demands.

The operational life of valves can be significantly extended by selecting the right wear and corrosion protection. Premature wear is particularly problematic in the area of sealing surfaces, as it results in increased leakage and thus pressure losses in the system. These pressure losses reduce the efficiency of the plant, leading to undesirable results in an era of high energy prices and calls for a greener industry.





## FELIX DEZEMBER

Mechanical engineer with additional qualifications as an international welding engineer.

He has been working at voestalpine Böhler Welding UTP since 2022, focusing on welding consumables for wear and corrosion protection and was previously involved in the welding production of industrial valves.

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