

FA 05 Cast without flaws

High-quality materials are becoming increasingly important for making valves. Costs and application determine the way they are made – cast or forged.

Valves make no noise whilst performing their tasks of reliably controlling or shutting off the flow of different media, or protecting the environment during exploration and production. Until valves can fulfil their duties, they need to be made in several production steps. These range from development to choosing the right material, casting, assembly, welding and installation.

During the development phase it is essential to choose the proper material. The material determines whether a valve can withstand operating conditions with problematic media and in hazardous environments. What is imperative when designing a valve?

GSR Ventiltechnik explains that the choice of materials used for a valve and its individual components – such as body, gasket or magnets – have to be carefully selected to match various applications. „Knowledge of the concentration, temperature and contamination level of the fluid is decisive for selecting the right material“, says the company Buschjost. Additional criteria are operating pressure and the maximal volume flow. Next to the temperature level, high pressure levels and flow velocities also have to be considered when choosing a material. In chemical applications and process technology, corrosion resistance is a further factor that has to be considered.

Materials depending on application

Valve makers can choose from a vast amount of diverse materials. A short overview: aluminium comes into question as a

metallic material for bodies and components, especially if the valve is going to be used with neutral media. Grey iron, spheroidal graphite iron and cast steel are also suited for such media. Cast steel is used in applications with higher temperature levels. Red bronze is used in applications with slightly aggressive water or steam and seawater. Certain stainless steel types withstand aggressive media very well. Duplex and titanium materials are high resistant, yet also more expensive.

Materials are chosen depending on sector and application emphasises Klaus Union, too. Mike Blasberg, division manager international valves, gives examples. „In the power plant sector, materials especially suited for high pressure and temperature levels are used. Austenitic materials are used for chemical and petrochemical applications, as well as grey iron/ spheroidal graphite iron with an electrostatic powder coating.“

Metallic materials

The nuclear sector focuses on high levels quality. „In water-steam cycles mainly ferritic qualities are used, whereas austenitic 18/8 steels are used in the primary circuit“, explains Jürgen Pick, sales manager Sempell and director product management nuclear valves Tyco Global Power. The maximal temperatures in nuclear power plants go up to 350 °C. „In modern coal-burning power plants however we see temperatures of up to 620 °C, which require martensitic materials, for instance F91 or F92.“ Steam temperatures of up to 720 °C however require nickel-based materials. Alloy 617 is currently being used as a material in test facilities. „Corrosion resistant alloys are also used for the food industry.“ Pick's assessments refer to load-bearing parts such as body, bonnet, and flange.

High-quality materials seem to be becoming more and more important. „As the power plants of the future will work with increasingly higher temperature and pressure levels, the requirements for temperature resistance will increase“, foresees Christoph Pauly, a press officer at KSB. Expectations are not only rising in this regard. Pipeline construction and stations along the route will face rising pressure levels, which are needed to increase capacity. Components for offshore applications will also have to withstand the environment in the ever-growing depths of gas and oil production.

Growing demand for stainless steel

A+R Armaturen has already adapted. Its high performance metal-seated ball valves with nominal diametres ranging from 2“ to 12“, ANSI 600 made from duplex materials were ordered for a Chinese coal chemical plant.

Metso is also focussing on stainless steel. The new range of stainless steel safety valves is being developed and produced in the company's Valve Technology Centre based in Helsinki, which opened last year. „Our interest in stainless steel components grew due to fast growing demand in the oil and gas sector, where stainless steel products are the de facto standard“, says Sami Nousianen, manager of Metso's product centres, intelligent products and actuators. The valves are to be used in demanding offshore applications. For this purpose, the Finnish company is building a positioner with an explosion proof stainless steel design for corrosive environments.

Klaus Union also offers a successful combination of valves and stainless steel. Rustproof stainless steel is convincing due to its resistance to high and low temperature levels, whilst its smooth and tough surface gives bacteria and fungi no hold, even after

decades of use. On top of it all, stainless steel is easy to clean.

Plastics and ceramic

For Klaus Union, stainless steel is therefore highly important. „It's the material we use the most“, explains Mike Blasberg, division manager valves international. Next to its durability, it is also „readily available.“ And the success story still has to come to an end. „There is still upward potential in the range of applications“, adds Blasberg.

For parts such as the body, metallic materials could face competition from various plastics or ceramic. These withstand dilutions of acids, alkaline solutions and salts, or aggressive media. „Plastics find recognition everywhere, where temperatures are below 80 °C“, explains Jürgen Pick, sales manager Sempell and director product management nuclear valves Tyco Global Power. This is the case in wastewater technology, as well as in industrial applications.

One can only guess what the future has in store. „The share of stainless steel could dwindle, should alternative materials be further developed. In addition, coating processes could increasingly become alternative solutions to stainless steels“, surmises Dr. Thomas Herbers, Klaus Union's technical director. Ceramics, however, are „still in the early stages“, says Jürgen Pick, Sempell. „There definitely are ceramics on the market with a high level of temperature resistance, in combination with excellent impact strength.“

To cast or to forge?

Once a material has been selected, it has to be brought into form. It is common practice to either cast or forge valves and their components. Castings, regardless of type, „are cheaper to make than if they were forged“, underlines Pick. Castings require models, which are identical to the final form as far as possible. „Model costs hardly have an impact when the order volume is large; mechanical processing is minimised and is only done for the screw connections, seats and pipe connections.“ Parts are forged either by open die or closed die forging. Pick: „Forming makes the first similar to cast models. Most of the time, closed die parts are not hollow, but solid, due to the difficult forging processes.“

Pick adds that finishing or repair welding is commonplace for castings, especially for bodies. „This creates unforeseen costs during the manufacturing process, which are nearly always avoided when forging.“ The choice of material is however also determined by quality demands. „Forged steel bodies are required for a lot of critical components in nuclear energy.“

Cast iron valves cheaper

All in all, cast iron valves have a cost advantage on their side, „however also a higher production risk, caused by finishing weldings“, states Pick.

KSB AG also makes use of both methods. „Bodies for valves and pumps are forged, as well as shafts and spindles“, press officer Christoph Pauly reports. „Or put simply, the amount of forgings in our products rises significantly from PN100 up.“

The size of forged parts has grown quite a lot in past years. „Parts which laboriously used to be made as castings today are forged, due to safety reasons“, adds Pauly. Even though machining requires considerably more time and effort.

On deciding the pros and cons of casting, valve makers have to consider the advantages and disadvantages. Companies owning a foundry are more flexible and can experiment. The valve maker does not have to depend on the fixed plan of a foundry with diverse customers. Or, in other terms: a more important order can simply be preponed.

Pro and contra an own foundry

KSB uses its own foundries, all around the world. The KSB group operates foundries in the USA, Mexico, Germany, Brazil, Indonesia, Pakistan, India and China. „They process more than 40 different casting materials, from grey iron to high-alloyed cast steel or chilled cast iron“, explains the company. Production output is accordingly high. KSB's foundries ship over 10.000 tons of castings annually, as components for different valves and pumps and related products of non-group customers.

Sempell buys all semi-finished or finished parts, such as seals and actuators, from specialised makers. „These manufacturers have specialised in their core products and always are good partners who can advise valve makers when facing particular challenges“, emphasises Jürgen Pick, Sempell. Metallurgy is a specialised field, „so that processors such as Sempell better ask a specialist when faced with questions of detail. Destructive testing of materials is also always procured.“

Optimising self-sufficiency

From Pick's point of view it makes sense to operate a foundry or forge of one's own. „Tyco, which owns Sempell, has decided to buy a foundry in order to supply all subsidiaries within the corporation with cast parts.“ Apart from optimising self-sufficiency, the measure also „naturally has cost advantages.“

Several valve makers do without foundries of their own, on basis of understandable reasons. If the plant isn't running at full capacity one will occur losses, should one be unsuccessful in offering casting services to other makers. The decision is also dependent from the size of a company. „Production just doesn't pay itself out for us“, declares engineer (dipl.-ingenieur) Christian Beer of MIT. No problem for the supplier of system solutions, assembly groups and special valves for process technology: „We closely cooperate with various suppliers to nonetheless meet the demands of our customers.“ Which has so far proven itself. Collaborating with suppliers has not shown itself as a disadvantage.

Production process in flux

The production process in general is in flux – a look ahead. „The problem still exists that a specific production plant has to be constructed and set up with enormous effort, until it meets optimal requirements“, laments Dr. Peter Post, head of Festo's corporate research and programme strategy department. „If the product faces changes, it becomes necessary to reconceptualise parts of the plant and rebuild it.“

Post believes it would be an optimisation, if plant components were able to communicate with each other in the future. „Components are integrated into manufacturing plants, which

network between themselves in an intelligent manner, configure themselves with minimal effort and meet the demands of a production order in a self-controlled fashion. This would give us maximal flexibility.“

According to Post, new developments should promise „that tasks performed today by a master computer will in future be performed by components.“ Valve makers will also profit from such change.

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