Caution and creativity:

Designing vessels for the process industries

Hubert Velten

Processing plants, whether petrochemical, chemical, bio-energy or pharmaceutical, are prime users of a great variety of stainless steel grades. Specifying the right grade and double-checking that the grade is up to the task assigned to it are therefore vitally important, requiring both cautious thoroughness and a creative approach. We asked Hubert Velten, Mechanical Engineer at Zeton BV Netherlands, to explain what is involved in overseeing the design of pressurized equipment in a processing plant.

By Hubert Velten, MSc

Introductory

As a Mechanical Engineer, I'm responsible for the design of piping (systems), pressure vessels, pressure design of small-scale pressure-containing systems (reactors, separators, etc.), QA/QC of welding and fabrication, material selection, and all other mechanical-related project and standardization activities.

My job can be described as a cocktail of all kinds of things, and it is this that makes it so pleasant and challenging. My tasks vary from internal and external inspections to engineering on several projects, dealing with customers and their own specifications.

The design of pressure-containing equipment is often complex because it interacts with several fields such as mechanical engineering, application of codes, standards and directives, customer specifications, welding engineering, metallurgy and material selection, and economics. Small-scale pressure systems can be especially challenging: since a design for a selected service at a high temperature or pressure which is not typically covered by standard design codes has to be specified, creativity is important as the requirements of the code or standard often still have to be met.

Stainless requirements

Most of our piping and tubing systems and pressure vessels are made of stainless steels such as AISI 316 or AISI 304. Quite frequently it's economically more feasible to select a standard grade stainless steel compared to carbon steel for instance. The services may demand a certain level of corrosion resistance, while welding of stainless steels may give a clean joint with high tolerances (e.g. in orbital welding), which may be a requirement for biological or pharmaceutical applications. For the more critical applications and services, we frequently switch to exotic (nickel) alloys. Welding of such alloys requires a higher level of workmanship from the welder, and a good welder is not easy to find these days. Typical welding problems may deal with not selecting the right filler material in the engineering phase, or erroneous weld prepping, causing for instance solidification or strain age cracking in nickel alloys. That combined with a tight schedule gives some potential for errors.

Modular pilot plant

This is one of the downsides of working in this industry, but on the other hand it keeps you on your toes.

The dual-certified grades AISI 316 and AISI 304 we use bring "the best of both worlds": the low carbon L-grade makes it less sensitive to sensitization and IC, while the straight grade gives approximately 20% higher stress values compared to the L-grade. These are the grades we habitually use, as they provide a good cost-to-performance ratio. For the more severe services, we've successfully used a lot of different nickel alloys like Alloy 800HT, Alloy 33, Alloy 59, Inconel 600/625, Monel and Hastelloy C-276. These grades may for example handle acids, hydrogen or chlorides at high temperature (e.g. 900 °C at 40 bar for an application with 800HT) and/or pressure (600 °C at 150 bar for an application with Inconel 625). Sometimes it is the customer who selects such materials, based on their lab experiences, but at other times it is we who recommend a material.

Selecting the right grade

Zeton doesn't own the technology that is supplied by our customers; instead we design and provide a "body" in which the technology is contained. Therefore we only get feedback when something goes wrong. Fortunately, that's often not the case. Also, as most plants may only operate for a few cycles or for a relatively short period of time, there's little potential for problems. Although finding the right material of construction isn't the main objective of most of our plants (sometimes the material of construction may even be over-designed), we occasionally designate a (part of a) plant for that function. For example we once used titanium grade 2 for piping and pressure vessels in a plant, where a customer selected this material after lab scale tests. On the other hand, there have also been a few instances where in the design stage a selected alloy wasn't going to meet the design specification. For instance a duplex grade 2205 coil was supposed to be cast in an aluminium block heater, but due to sensitization of the duplex it was believed the base material would become embrittled. Such examples show the key importance of selecting the right grade in the engineering phase.

Overview of the high bay for construction of modular pilot plants.

Buying

We have a few preferred vendors from whom we buy materials. Our past experience has shown not all manufacturers of stainless steel can meet our required level of quality. Although certain markets and regions are growing, quite often accompanied by an increase in their quality level, quality control and assurance is still required. We aim for vendors and mills certified to ISO 9001, with a 3.1 certificate at minimum for each heat we purchase. Unfortunately, the certificate itself doesn't always assure that heat meets the requirements of the specification it was purchased for, but it's a start. When the materials are delivered at the premises where we build our plants, we perform an initial check on all materials and certificates to see if they meet their specifications. Secondly, we do a credit check for each new supplier before adding them to our list.

Sometimes customers require materials that originate only from certain countries, or specific manufacturers have to be used. The latter may be the case with duplex stainless steel and nickel alloys, for example. We often purchase those from the original mills (which in many cases are the trade names), sometimes through a vendor, or we set extra requirements for the (base) material. The applications these alloys are used for frequently demand a high standard of quality, and there's no room for any potential failure.

Looking ahead

Looking to the future, I think the lean duplex grades may turn out to be a good alternative for other stainless grades: lean duplex grades can significantly save on material weight compared to AISI 304 or 316, while its corrosion resistance is often comparable. The market price is very competitive, and the several available grades, like LDX 2101, are still being improved. However, I think the industry still has to prove their competitiveness.

About Hubert Velten, MSc

After finishing his Masters in Mechanical Engineering, Hubert started working as a Mechanical Engineer at Zeton BV Netherlands, his current job. After a short traineeship at Zeton Inc., Canada, he completed a course as International Welding Technician, followed by a course as International Welding Inspector level C. In his free time, he enjoys playing soccer, followed by a good meal in as restaurant.

About Zeton

Zeton BV is part of Zeton International Inc, located in Canada and the Netherlands. Founded in 1986, Zeton offers 25 years of experience in designing plants for the (petro-)chemical, bio-energy and pharmaceutical industries. The Dutch branch (50+ employees) delivers to Europe, the Middle East and Africa, while Canada (125+ employees) provides the rest of the world. Zeton's mission is to provide a complete solution for the design, fabrication and procurement of modular, demonstration, lab scaleand pilot plants.