Withstanding the challenges of saltwater: Choosing the compatible steel

The choice of the material of parts and components is almost always a compromise between performance and cost. This article outlines some considerations when choosing a suitable pressure transmitter for applications with seawater, e.g. in ballast water management systems or desalination units.

The best solution for any application with corrosive media is – from a performance perspective – the use of Titanium as it offers excellent corrosion resistance. The big disadvantage of titanium is the very high cost of both the material itself and high machining cost. Therefore, engineers look for more cost-effective solutions which still fulfill the requirements of the application.

In many cases, 1.4404 (AISI316L) is used as it offers a reasonable corrosion resistance at a quite low price, just slightly above basic stainless steel such as 1.4305. But experience in the field shows that pressure transmitters with this quite common material can fail before time due to corrosion. Typically, the higher the temperature and / or the higher the salt or corrosive content, the faster it fails.

A Trafag customer using pressure transmitters for desalination units specified 1.4404 (AISI316L), and it worked fine for most cases. But in units which were used in tropic areas, some of the transmitters became corroded after a relatively short time. The customer was looking for a better alternative to AISI316L, and for cost reasons, Titanium was not an option. Trafag offers for such applications pressure transmitter with ceramic sensors and 1.4462 duplex steel process connection and housing. This has been the perfect solution for all critical installations of this customer for several years now, and installations equipped with duplex steel pressure transmitters are working fine now even under elevated temperatures or with high salt content.

Trafag ECTN 8477 is available in different steels depending on the suitable application. Samples after being exposed to salt mist test IEC 60068-2-52, severity level 1; 1.4305 standard steel, 1.4404 (AISI 316L), 1.4462 duplex steel (from left to right).

A pressure transmitter made of duplex steel 1.4462 could be a perfect solution for all cases, but unfortunately the cost of duplex steel is slightly higher, and the machining of duplex steel is very expensive. Due to its mechanical properties, it causes excessive wear on tools and slowing down machining speed, thus making the parts quite expensive, cost-wise roughly in the middle between AISI316L and titanium. So, also in this case, engineers need to carefully assess the risks of the application and balance between more cost and improved performance, i.e. corrosion resistance in this case.

However, for higher temperatures, high salt concentration or other corrosive contents of the liquid, there is still only one safe choice: Titanium.

Reverse osmosis system for a drinking water facility.

How to assess the corrosion resistance

There are two major criteria to assess the corrosion resistance against salt water of a stainless steel based on material specifications: PREN Pitting Resistance Equivalent Number and CPT Critical Pitting Temperature, both depending on the contents of the material. For practical tests, a good and reliable indication is the salt mist test according IEC 60068-2-52:1996.

Exact testing procedures to measure the PREN corrosion resistance of various types of stainless steel are specified in the ASTM G48 standard. Generally, the higher the PREN-value, the more corrosion resistant the steel is, and steels with PREN-values above 32 are considered seawater (corrosion) resistant. The PREN of 1.4404 (AISI316L) is 23…28.5 whereas the 1.4462 duplex steel is at 31…38, depending on the exact composition of contents.

There are different methods to assess the CPT which is defined as the "lowest temperature on the surface of the specimen at which stable propagating pitting occurs under specified test conditions" (ISO 17864:2005), some basic empiric rules of thumb based simply on the Molybdenum content. The CPT of 1.4404 (AISI316L) is between 24 and 27.5°C compared to 27.5…34.5°C of the 1.4462 duplex steel. Therefore, particularly for higher temperatures e.g. in tropical seawater, 1.4462 is the safer choice, with much better corrosion resistance than AISI316L and yet at lower cost than titanium. However, for even higher temperatures, high salt concentration or other corrosive contents of the liquid, there is still only one safe choice: Titanium.

Salt spray test chamber: Practical assessment of corrosion resistance is typically performed with a salt mist test according IEC 60068-2-52:1996 which is also part of GL test specification. The samples are exposed during 2h to salt mist and then stored during 7days in warm humid environment. This procedure is repeated 4 times.

Trafag's solutions for marine applications

Marine Pressure Transmitter ECTN 8477

Certified for marine applications by DNV-GL with EU RO Mutual Recognition Type Approval

Available in 1.4404 (AISI316L), 1.4462 duplex steel and titanium

Optionally with frontal membrane for clogging media or liquids containing particles

Data sheet: www.trafag.com/H72322

Submersible pressure transmitter ECL 8439

Certified for marine applications by DNV-GL with EU RO Mutual Recognition Type Approval

Available in 1.4404 (AISI316L), 1.4462 Duplex Steel

Measuring range adjustment with Android app and interface box to adapt to tank level and specific mass of the liquid

Data sheet: www.trafag.com/H72336

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