NICKEL ALLOYS STAINLESS STEEL NICKEL STEEL

300 series vs. ferritic stainless steel – Which one should I choose?

JUNE 10 - 2022

Each family of stainless steels has its strengths and weaknesses. Ferritic stainless steels have useful properties – a lower rate of thermal expansion, higher thermal conductivity, strong ferromagnetism and very high resistance to chloride stress corrosion cracking (SCC). When looking at selecting any alloys, it is important to consider all the factors for successful usage.

Ferritic stainless steels have useful properties – a lower rate of thermal expansion, higher thermal conductivity, strong ferromagnetism and very high resistance to chloride stress corrosion cracking (SCC).

Ferritic stainless alloys contain either no nickel or very small amounts, so the cost of the alloying elements used is lower. Despite this advantage, growth of the ferritic family over the last 10 years has been lower than the growth of the 300 series austenitics. Why is that?

Many reasons explain why growth of the ferritic family over the last 10 years has been lower than the growth of the 300 series austenitics

1. Limitations in thicker ferritic material

Firstly, there are limitations in thicker ferritic material, with the maximum thickness dependent on factors including large grain sizes (lower ductility), poor toughness (ductile-to-brittle transition can be as high as 20ºC), quick formation of intermetallic phases in the higher alloyed ferritics, and others.

As a result, thicker sections are not generally available, and even if they were, obtaining suitable properties in welds would be difficult or impossible

2. Limitations at high temperature use

In addition, ferritic stainless steels with a chromium content over 12% are subject to embrittlement at temperatures over about 300ºC, limiting their elevated temperature use. 409, with lower Chromium at 10.5-11.75%, has been successfully used for exhaust systems on vehicles and for exhaust gases from boilers.

Ferritic stainless alloys also lose strength at elevated temperatures compared with austenitic alloys. Toughness is a big issue - ASME Section VIII Division 1 for example, requires all ferritic stainless alloys thicker than 3mm, where the design temperature is lower than -29ºC, to pass Charpy V-notch impact tests. Common 300 series alloys, need this only when the design temperature is below -196ºC.

3. loss of strength and toughness

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4. Formability, ductility and yield strength

Ferritic stainless steels are produced primarily in sheet thicknesses. Their **formability** is generally quite good, a lot like carbon steel, but not as good as the 300 series austenitic alloys. Ferritic alloys can be cold worked only to a moderate level, but are normally used in the fully annealed condition.

Their **yield strength** at 20ºC can be slightly higher than for an annealed 300 series alloy, with their tensile strength slightly lower.

Ductility as measured by the percent elongation is significantly lower.

And what about corrosion resistance and the role of nickel?

After all, the Pitting Resistance Equivalent Number (PREN) doesn't contain a factor for nickel? Some PREN formulas do have a small factor for nickel, but PREN describes resistance to pitting initiation, whereas nickel is important in slowing the propagation of pitting. There are chemical environments, like moderately reducing conditions, where nickel plays an important role. For chloride SCC, while 304 and 316L are highly susceptible, the 6%Mo austenitic alloys are highly resistant, roughly as resistant as the superduplex alloys.

The ferritics are however highly susceptible to hydrogen embrittlement, whereas the nickel-containing 300 series are not.

Each family of stainless steels has its strengths and weaknesses. So whenever looking at a corrosive environment, it is important to find or produce data that directly relates.

might expect. Lower availability of product forms, sizes, surface finishes and other commercial factors has also limited their use. Welded heat exchanger tubes in higher alloyed ferritics are a great success story.

When looking at selecting any alloys, it is important to consider all the factors for successful usage.

The image on the top is a tube bundle in Sea-cure® superferritic stainless steel, used to cool the crude oil coming from storage in salt domes at the U.S. Strategic Petroleum Reserve. Courtesy Plymouth Tube Co.

The Nickel Institute offers a free technical inquiry service to help you when using nickel - **https://inquiries.nickelinstitute.org**

Many publications for users and specifiers are also available free-of-charge on our website.

Of particular relevance is ***The Nickel Advantage***, *Nickel in Stainless Steels*, available in **English**, **French**, **Japanese** and **Chinese**.

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