

## ENGINEERING BULLETIN #103

### The Advantages of Using 321 SS vs. 304/304L SS

At first glance, it appears that type 304/304L SS is very similar to type 321 SS. When comparing the chemical composition of 321 SS and 304/304L SS, it is clear that the chromium (Cr) and nickel (Ni) ranges of these alloys are very similar. The difference appears when the issue of carbide precipitation in the heat-affected zone (HAZ) is discussed or fatigue strength and temperature are considered.

#### CARBIDE PRECIPITATION

The weld areas with temperatures 930°F – 1470°F are often called the carbide precipitation zone, in which Chromium (Cr) combines with Carbon (C) and precipitates chromium carbides at the grain boundaries. This significantly reduces corrosion resistance of steel in this zone. One of the ways to combat this phenomenon is to lower the carbon content in steel to decrease the carbide precipitation.

304L SS is an example of such steel; the “L” in 304L is for “Lower carbon” (.030% max vs. .080% max for 304 steel). An even more effective way to reduce carbide precipitation is through the addition of Titanium (Ti) to the alloy to stabilize it. The carbon is more attracted to the Titanium (Ti) and therefore it leaves the chromium alone. To be a true “stabilized” grade the 321 steel has to have Titanium (Ti) content at least 5 times than its Carbon (C) content. Reduced risk of corrosion in the HAZ is the main advantage of 321.

#### FATIGUE STRENGTH

In dynamic applications, fatigue strength is also important to consider and in this respect 321 SS has a slight advantage over 304 SS. Fatigue or endurance limits (strength in bending) of austenitic stainless steels in the annealed condition are about one-half the tensile strength. Typical tensile and endurance limits for these alloys (annealed) are presented in the table below.

Alloy	Typical Tensile	Typical Endurance Limit
304L	68 ksi	34 ksi
304	70 ksi	35 ksi
321	76 ksi	38 ksi

## TEMPERATURE FACTORS

Temperature factors could be another factor to consider in some applications. As we can see in the table below the temperature reduction factors are slightly higher for 321 than for 304L at most elevated temperatures.

Temp ° F	304L Factor	321 Factor
70	1.00	1.00
150	0.95	0.97
200	0.91	0.95
250	0.88	0.93
300	0.85	0.91
350	0.81	0.89
400	0.78	0.87
450	0.77	0.85
500	0.77	0.83
600	0.76	0.80
700	0.74	0.76
800	0.73	0.68
900	0.68	0.59
1000	0.63	0.65
1100	0.58	0.59
1200	0.53	0.53

The design guide by “Stainless Steel Producer’s of North America” offers more information on this topic. To learn more, [download the guide](#).

If you have any questions or comments, please [contact us](#).