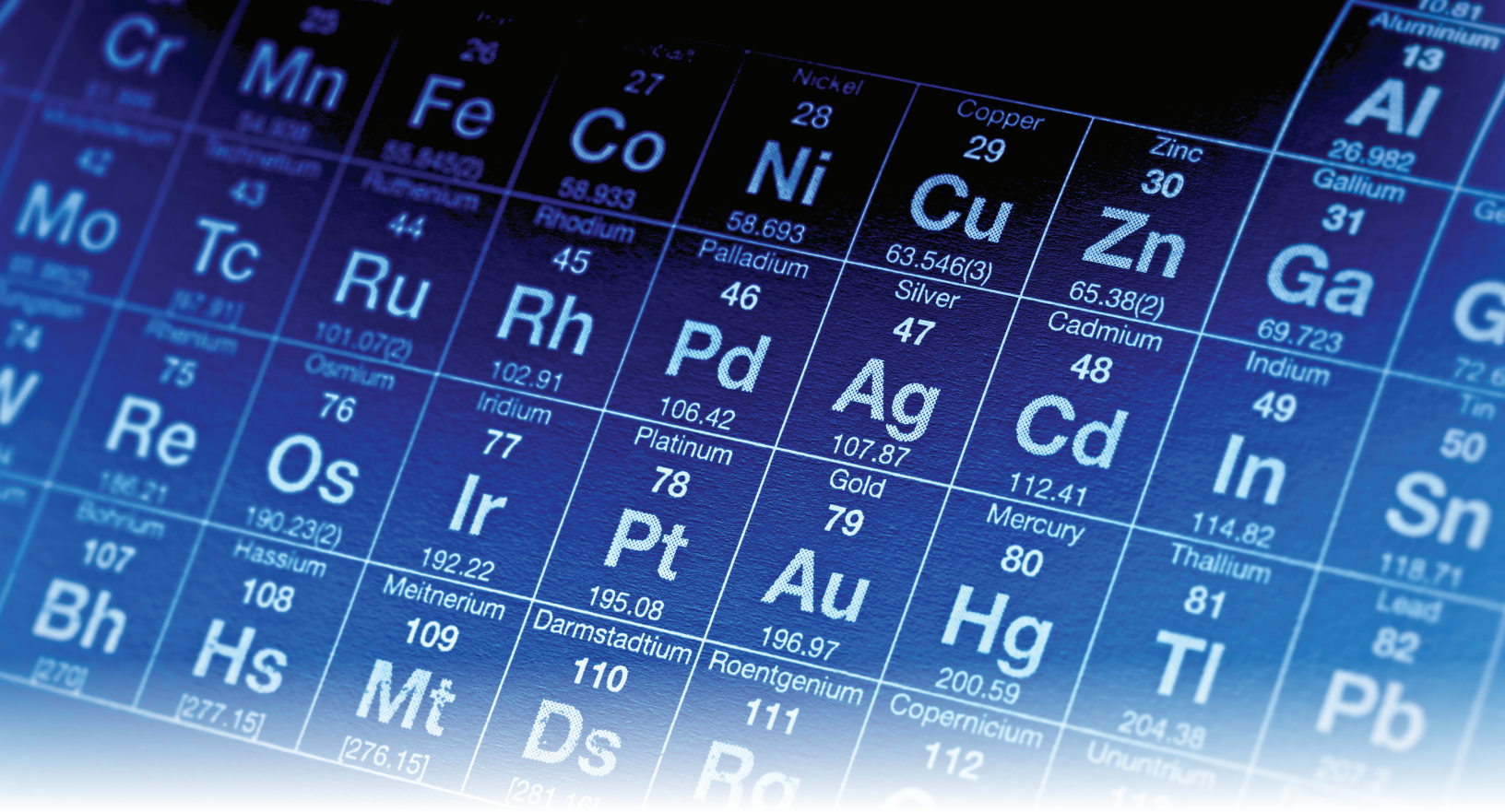
HandyTube
A STEEL PARTNERS COMPANY

APPLICATION NOTE

The Chemistry of Tubing

As one of the world's leading manufacturers of seamless stainless-steel and nickel alloy coil tubing, HandyTube prides itself on producing effective and high-quality products. Our tubes are utilized in a variety of applications, including medical equipment, military vehicles and offshore drilling rigs. Each unique application requires a specific set of tubing properties that will ensure success on the job. These properties are largely determined by the tube's chemical composition, which makes choosing the correct alloy critical. At HandyTube, we recognize the importance of this decision and are more than happy to help our customers select the right alloy for the job.



NICKEL

Nickel is a metal that serves as the backbone of the Incoloy, Inconel and Monel alloy families and is an additive in austenitic stainless steels. Known for its ability to increase the ductility of alloys by creating a Face Centered Cubic (FCC) crystal structure, nickel is a crucial component in metals that are expected to undergo any degree of plastic deformation. Generally, a quantity of roughly 8% nickel by weight ensures austenitic steels will have a FCC crystal structure—guaranteeing impressive ductility. When cold working metal, ductility is paramount. Ductile metals are easily formed and drawn, and they provide ample warning in the form of elongation before fracturing. At HandyTube, we offer several high-nickel alloys, such as N200 and 52Ni, which yield some of the most ductile tubes available.

CHROMIUM

Many of the environments in which HandyTube products are used require some degree of corrosion resistance—a property for which chromium is well known. Chromium forms a thin oxide layer on the surface of steel, which acts as an outer shell that protects the metal inside from corrosion. In austenitic stainless steels, 18% chromium is often more than adequate for ensuring a baseline level of corrosion resistance. Some steels, such as 317, have a higher chromium content to boost corrosion resistance even further. Nickel-based alloys like Inconel usually include about 20% chromium by weight, while Incoloy alloys tend to incorporate about 25% chromium by weight.

Different alloys have varying degrees of resistance to corrosive agents, so be sure to check if the alloy you're considering will be compatible with its environment. For instance, austenitic stainless steels are susceptible to chloride stress corrosion cracking and should not be used in environments with high concentrations of chloride ions, such as ocean water. On the other hand, some alloys should be considered for use in certain situations. Alloy 904, for example, is ideal for environments where sulfuric acid is present due to the metal's high copper content.

MOLYBDENUM

Added in quantities of just a few percent by weight, molybdenum can further improve an alloy's resistance to corrosion, particularly chloride attacks. As a result of this property, it is extremely effective at preventing pitting corrosion—allowing these alloys to be used in marine applications with little risk of pitting corrosion from the salt water. Molybdenum is incorporated in nickel alloys to help raise their strength and creep resistance at elevated temperatures. Stainless steels like 316, 317 and 904L, as well as other alloys like Inconel 825 and 6Mo, are well known for their use of molybdenum to increase corrosion resistance. As a result, they have high pitting resistance equivalent numbers (PREN). Their average PREN numbers are 28, 29.5, 36, 48.5 and 42.3, respectively—demonstrating their superb resistance to pitting corrosion. HandyTube's 316 alloy contains a minimum of 2.5% molybdenum by weight, ensuring a high degree of pitting resistance.

CARBON

Although only used in trace amounts, carbon is an extremely important component in many alloys. When introduced into an alloy, carbon atoms settle into the interstitial sites of crystal lattices and alter the way the crystal structure deforms under stress. Adding carbon to alloys generally makes them stronger but more brittle as well. While austenitic stainless steels generally contain 0.02–0.08% carbon by weight, they can have different sub-grades that vary in terms of carbon content and the effects the carbon has on the alloy's material properties. Steels like 316, 317 and 304 have low-carbon variants that can increase workability and decrease susceptibility to corrosion via sensitization.

Low-carbon alloys are useful in applications where the tubing is expected to operate at elevated temperatures. The lack of carbon in the tube's composition prevents the formation of chromium carbide precipitates, which destroy the steel's corrosion-resistant chromium oxide layer. HandyTube is able to provide low-carbon, dual-certified grades for these austenitic alloys to help our customers make an informed decision about their tube's carbon content.

OTHER TRACE ELEMENTS

Small amounts of sulfur, titanium and niobium are sometimes present in alloys—each having its own unique effect. For instance, when added in trace amounts, sulfur can improve the machinability of metals. While adding titanium or niobium improves mechanical properties like strength, niobium's benefits are geared toward high-temperature applications. Both metals, however, are able to form carbide compounds, reducing the degree to which sensitization occurs in improperly heated alloys. Stainless steels 321 and 316Ti are examples of stainless steels that incorporate titanium.

HandyTube can also manufacture tubes from the hastelloys C-22 and C-276, which incorporate additional refractory elements like tungsten—allowing alloys to function perfectly in high-temperature environments, such as jet engines.

CONCLUSION

The chemistry behind metal alloys is complex and powerful. Even small changes to chemical composition can render an alloy's properties unrecognizable. At HandyTube, we recognize the importance of this decision. While this application note can guide you, always consult a design engineer to help you select the right alloy for the job.