Metallic Materials Quick Reference Guide

Swagelok®

Carbon Steel

Carbon steels are the simplest form of steels, comprised of iron and carbon with a small amount of manganese. Some grades add phosphorus, sulfur, and sometimes lead to improve machinability. Often used for equipment and transport lines for oil, air and gas applications. Carbon steels are often coated or plated for enhanced corrosion resistance.

Alloy 400

Monel® 400 is a nickel-copper alloy widely used in marine environments. It offers exceptional resistance to hydrofluoric acid, and is resistant to stress corrosion cracking and pitting in most fresh and industrial waters. Stagnant seawater has been shown to induce crevice and pitting corrosion in this alloy.

Source–Special Metals Corp. product literature

Alloy 600

Inconel® 600 is a nickel-chromium-iron alloy which is highly resistant to chloride-ion induced stress corrosion cracking. It also has reasonable resistance to many organic and inorganic compounds. Its high strength and resistance to oxidation at elevated temperatures also make it a good choice for these types of service conditions.

Source–Special Metals Corp. product literature

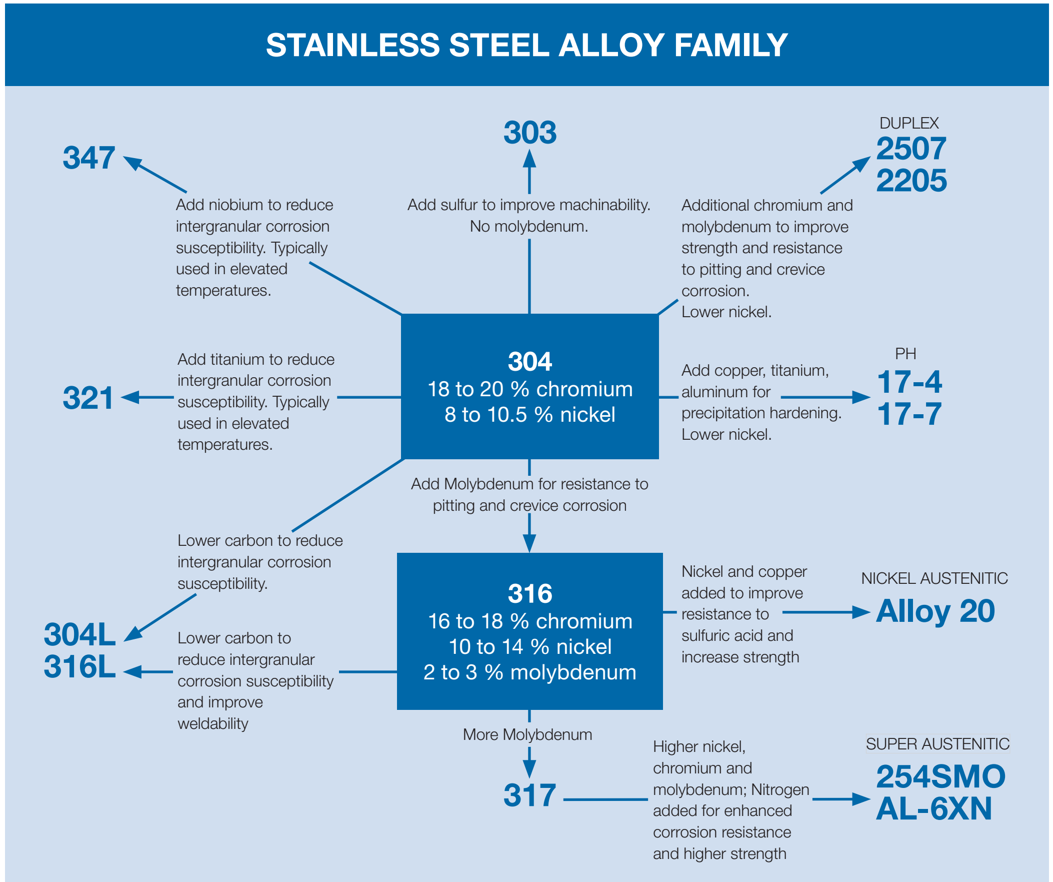
Alloy 625

Inconel® 625 is a nickel-chromium-molybdenum alloy with a small quantity of niobium. The alloy combination of this material provides very good resistance in a wide variety of severely corrosive environments, including hydrochloric and nitric acids. It is used for its outstanding resistance to aggressive attack, specifically; crevice corrosion, pitting, and chloride-ion stress corrosion cracking as well as high-temperature oxidation. It is also known for its high strength in both ambient and elevated temperatures. Resistance to sour gas makes this alloy a popular choice for critical components in such environments.

Source–Special Metals Corp. product literature, Haynes International product literature

Tantalum

This metal is almost immune to chemical attacks below 150°C (302°F). However, it can be attacked by hydrofluoric acid. Its high melting point (>3000°C (5432°F)) often makes it a choice for furnace components.



Alloy 825

Incoloy® 825 is a nickel-iron-chromium-molybdenum alloy designed for a high level of resistance to general corrosion, pitting and crevice corrosion, as well as stress corrosion cracking in a wide range of media. Some environments in which Incoloy 825 is particularly useful are sulfuric acid, phosphoric acid, sulfur-containing flue gases, sour gas, oil wells and seawater.

Source–Special Metals Corp. product literature

Alloy B-2

Hastelloy® B-2 is known for its excellent resistance to hydrochloric acid in all concentrations and temperatures. The nickel and elevated molybdenum content in this alloy offers it excellent resistance to stress corrosion cracking as well as pitting and crevice corrosion.

Source–Haynes International product literature

Alloy C-276

Hastelloy® C-276 contains nickel, molybdenum and chromium as the main elements. It is among the most corrosion resistant alloys currently available, making it the most widely selected material for the most severe environments encountered in chemical and petrochemical processing, flue gas desulfurization, pulp and paper industries, sour gas, etc. The high level of molybdenum in this alloy makes it exceptionally resistant to pitting and crevice corrosion. It is also one of the few materials that withstands the corrosive effects of wet chlorine gas, hypochlorite, and chlorine dioxide. This alloy is not a recommended choice for strong oxidizing environments, such as, hot and concentrated nitric acid.

Source–Haynes International product literature, –Allegheny Ludlum product literature

Brass

Brass is a common name for many copper-zinc alloys. Lead is added to certain grades for enhanced machinability. Brass is generally corrosion resistant to natural (non-industrial) environments and water. Exposure to ammonia and mercury are known to cause stress corrosion cracking in most brass alloys.

Aluminum Alloys

Most alloys in this group are selected because of their light weight, lower cost and satisfactory resistance to natural (non-industrial) environment conditions. Anodized or coated aluminum alloys are also designated for seawater applications.

Titanium

Titanium alloys have excellent resistance to corrosion in a wide variety of environments including seawater, salt brines, inorganic salts, bleaches, wet chlorine, alkaline solutions, oxidizing acids and organic acids. These alloys have excellent resistance to crevice corrosion in salt solutions and generally outperform stainless steels. Unalloyed titanium (Grades 1, 2, 3 & 4) typically do not suffer crevice corrosion at temperatures below 80°C (175°F). Titanium is incompatible with fluorides, strong reducing acids, very strong caustic solutions, and anhydrous chlorine. Due to its combustibility, titanium is not suitable for oxygen service.

Source–Allegheny Ludlum product literature

Zirconium

The main use of zirconium is for nuclear power generation applications. Reactor-grade zirconium is essentially free of hafnium and has a low thermal neutron absorption cross-section. Zirconium is exceptionally resistant to corrosion by many common acids, alkalis, and sea water, and is therefore used extensively by the chemical industry where corrosive agents are employed. Zircaloy alloys such as Zircaloy-2 and Zircaloy-4, were developed specifically for nuclear applications. They combine the excellent corrosion resistance of zirconium with alloying elements to improve the material's mechanical strength.

Source–Online sources: http://periodic.lanl.gov/elements/40.html, http://www.wahchang.com

Plastic and Elastomer Materials Quick Reference Guide

PEEK

Polyetheretherketone is a semi-crystalline, high-performance thermoplastic material that is insoluble in all common solvents and has excellent resistance to a very wide range of organic and inorganic liquids. Mechanical properties are almost constant up to 300°F (149°C). PEEK can withstand short-term exposure to approximately 572 °F (300°C).

PFA

Perfluoroalkoxy copolymers are melt processable, semi-crystalline materials that have outstanding chemical resistance and can withstand a wide temperature range from -328 to 482°F (-200 to 250°C). PFA is slightly less chemical resistant than PTFE, but has considerably higher resistance to deformation under load than PTFE.

PTFE

Polytetrafluoroethylene is a semi-crystalline thermoplastic material that has a melt viscosity that is significantly higher than most other polymers. As a result, it can not be melt processed. PTFE can withstand continuous service temperature of 500°F (260°C) and is known to be chemical resistant to almost all substances. The material's main weakness is its poor resistance to deformation under load.

PCTFE

Polychlorotrifluoroethylene is a semi-crystalline polymer whose type and degree of crystallinity depend strongly on its molecular weight and thermal history. PCTFE exceeds both PTFE and PFA in resistance to deformation under load but is susceptible to chemical attack by many organic materials.
It can withstand continuous exposure to 302°F (150°C).

PPS

Polyphenylene sulfide is a semi-crystalline thermoplastic commonly known as Ryton®. PPS can withstand long-term exposure to 392°F (200°C) and short-term exposure to 500°F (260°C). PPS can be molded to tight tolerances and will maintain dimensional integrity even at elevated temperatures. PPS can be severely attacked by oxidizing chemicals.

Elastomers

Buna-N

(Nitrile Rubber) Recommended for general purpose sealing of water, petroleum oils, solvents and some alkalis. It is superior to most other elastomers with regard to compression set, abrasion and tear resistance. Typical upper use temperature is approximately 250°F (121°C).

EPR

(Ethylene-Propylene Rubber) Offers excellent resistance to atmospheric ageing and ozone, phosphate ester hydraulic fluids, brake fluids, weak acids and bases. Has good wear resistance. Attacked by oils and petroleum lubricants. Typical upper use temperature is approximately 250°F (121°C).

TFE/P

Aflas® offers excellent chemical resistance to automotive lubricants, battery acids, jet fuels and oil field applications. The most common use in plastic valves is in ozone water treatment systems, where it is excellent. Typical upper use temperature is approximately 400°F (204°C).

Fluorocarbon (VDF/HFP)

Provides chemical resistance to a wide range of chemicals including mineral acids, salt solutions, chlorinated hydrocarbons and petroleum oils. Not recommended for use with steam or ammonia. Typical upper use temperature is approximately 400°F (204°C). DuPont's Viton® is one of many brands of fluorocarbon elastomer.

Polychloroprene

Was first introduced by DuPont as Neoprene. It resists degradation from sun, ozone and weather and performs well in contact with hydrocarbon oils and many chemicals. It has excellent physical toughness. Typical upper use temperature is approximately 250°F (121°C).

Butyl

Offers very low permeability and chemical resistance to hot water and steam up to 250°F, brake fluids, some acids, alcohols, and many other chemicals. It is not compatible with mineral oil, fuels, or chlorinated hydrocarbons. Typical upper use temperature is approximately 250°F

Perfluoroelastomer

Offers chemical resistance that is far superior to most other elastomers. It can have limited low temperature use and high compression set. The maximum service temperature varies from 428°F (220°C) to 600°F (316°C) depending on the compound used.

Fluorosilicone Rubber

This elastomer is noted for its retention of flexibility, resilience and tensile strength over a wide temperature range. It is not, however, noted for its chemical resistance. Typically limited to static applications. Typical upper use temperature is approximately 350°F (177°C).

Silicone

Offers good resistance to extreme high and low temperatures.
It has excellent resistance to oxygen, ozone, UV and many chemicals. Low tensile strength, poor wear resistance and tear strength. Typically limited to static applications. Typical upper use temperature is approximately 400°F (204°C).

PES

Polyethersulfone, commonly known as Radel® A, is an amorphous thermoplastic with exceptional high temperature properties. PES remains in satisfactory condition in long-term continuous use without causing any dimensional change or physical deterioration at temperatures as high as 399°F (204°C). PES has poor weathering resistance and is attacked by some alcohols and ketones.

POM

Polyoxymethylenes are semi- crystalline acetal homopolymers (Delrin®) or copolymers that offer high fatigue strength, good creep resistance, toughness and impact resistance. POM can withstand temperatures in excess of 200°F (94°C). POM is sensitive to acid hydrolysis and oxidation. Low levels of chlorine in potable water (1-3 ppm) can cause stress corrosion cracking.

PI

Known commonly as Vespel®, polyimide is an amorphous material with good thermal stability, chemical resistance and excellent mechanical properties. PI exhibits very low creep and high tensile strength. These properties are maintained during continuous use to temperatures of 450°F (232°C) and for short excursions, as high as 900°F (482°C). Typically not effected by many solvents, oils and weak acids. PI is not recommended for use in alkalis or inorganic acids.

PEI

Polyetherimide (PEI), commonly known as Ultem®, is an amorphous, amber-to-transparent thermoplastic with characteristics similar to PEEK. Relative to PEEK, PEI is less expensive, but less temperature-resistant and lower in impact strength. It offers good heat resistance, solvent resistance, flame resistance, high dielectric strength, natural flame resistance, and exhibits extremely low smoke generation. PEI has excellent mechanical properties and performs in continuous use to 340°F (170°C).

PAI

Commonly known as Torlon®, polyamide-imide is an amorphous thermoplastic that has the highest strength and stiffness of any thermoplastic up to 525°F (275°C).
It has outstanding resistance to wear and creep.
PAI is virtually unaffected by aliphatic and aromatic hydrocarbons, chlorinated and fluorinated hydrocarbons, and most acids at moderate temperatures. The polymer, however, may be attacked by saturated steam, strong bases, and some high-temperature acid systems. Proper post-cure of PAI is necessary to achieve optimal chemical resistance. PAI can absorb a significant amount of water when exposed to high humidity for extended time periods.

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