K-TUBE ALLOYS

ALLOY	COMMENTS/DESCRIPTION
302/304	302/304 are 18-8 austenitic Cr-Ni stainless steel alloys selected for their excellent strength, high ductility, excellent drawing, forming, and coiling properties. This alloy is also one of the least expensive medical materials. Essentially non-magnetic, 302/304 become slightly magnetic when cold-worked. This means that medical devices that have been manufactured with large amounts of cold work need to be tested before being used in the MR environment. 302 alloy is the same as 304 alloy except 302 has a 0.12% carbon maximum. In 304, the maximum carbon is 0.08%. Low carbon content means less carbide precipitation in the heat-affected zone during welding and a lower susceptibility to intergranular corrosion. Technically, 304 alloy meets the requirements of 302, except that 302 is harder than 304 with the same amount of cold work. Both hardness and tensile strength are increased when cold worked. Additionally, 304 has better corrosion resistance than 302. Applications for 302/304: Stylets, catheters, wire guides, springs and needles
304L	304L is the same as 304, but with slightly higher nickel content (8-12%) and lower carbon content. The lower carbon level increases weldability and lessens inclusions. The chemistry of 304L makes it less susceptible to sensitization (ie, the reduction in a material's corrosion resistance due to exposure to elevated temperatures.) 304L is slightly weaker than 304. Applications for 304L: Catheters, wire guides, small parts made from straightened and cut wire, and orthodontic uses
316	316 is an 18-8 Cr-Ni stainless steel modified by the addition of molybdenum. The 2-4% molybdenum content increases resistance to marine environments. It is non-magnetic in the annealed condition and not hardenable by heat treatment. This alloy has good ductility in the cold-worked condition. It has high creep strength at elevated temperatures and good heat resistance. The alloy is biocompatible and possesses good corrosion resistance. Fabrication characteristics are similar to 302 and 304. Applications for 316: Suture wire, orthopedic cables, skin closure staples, catheters, stylets, bone pins, and many small machined parts
316L	316L has the superior corrosion resistance of 316, but also has superior resistance to intergranular corrosion following welding or stress relieving. It has good corrosion resistance to most chemicals, salts, and acids. The low carbon content of 316L reduces the possibility of in vivo corrosion. 316L has high creep strength at elevated temperatures, and its fabrication characteristics similar to 302 and 304. Applications for 316L: Suture wire, orthopedic cables, skin closure staples, catheters, stylets, and bone pins
321	321 is similar to 304 except Ti content helps prevent chromium carbide precipitation resulting from welding or elevated temperatures. It resists scaling and vibration fatigue. 321 has fabrication characteristics similar to 302/304 and 316/316L. Applications for 321: Aircraft exhaust stacks and manifolds, chemical processing equipment, weld equipment, and jet engine parts

430	430 is one of the most widely used types of stainless steels. Since it does not contain nickel, the alloy is in the ferritic condition. Therefore 430 does not respond to cold-working as the austenitic grades of stainless steel do. The steel has good corrosion resistance in mildly corrosive environments and good resistance to oxidation at elevated temperatures. It is magnetic in all conditions. In the annealed condition the steel is ductile, does not harden excessively during cold work, and can be formed using a large variety of roll-forming or mild stretch-bending operations, as well as the more common drawing and bending processes. Being a ferritic material, 430 is prone to brittle fracture at sub-zero temperatures, thus it cannot be used in cryogenic applications. As the steel does not contain nickel or molybdenum, it is cheaper than any of the 300 series steels. Applications for 430: Automotive trim, interior architectural uses, nitric acid plant equipment, oil refinery equipment
434	434 is similar in chemistry and performance to 430 stainless steel. 434 has the addition of molybdenum to increase its resistance to corrosion. The alloy combines a ferritic structure with good fabricability and strength characteristics. Applications for 434: Automotive trim, interior architectural uses, nitric acid plant equipment, oil refinery equipment
17-7PH	17-7 PH is a Cr-Ni stainless steel. It has the same, easy-to-work characteristics of the 300 series alloys, yet it is capable of being hardened by a simple heat treatment. It is suitable for use in fresh water, industrial and marine atmospheres, and mild chemical and oxidizing environments. 17-7 PH should not be used in salt water or reducing environments. It has higher tensile compared to 300 series when cold-worked, and is more expensive than 300 series alloy. Applications for 17-7 PH: Very detailed, intricate parts due to its low distortion in heat treatment. Very stable
Inconel 625	Inconel is a nickel-chromium-molybdenum alloy with the addition of niobium. The niobium acts with the molybdenum to stiffen the alloy's matrix—providing high strength without a strengthening heat treatment. This alloy is an excellent general purpose material for elevated temperatures. The alloy resists a wide range of severely corrosive environments and is especially resistant to pitting and crevice corrosion. Applications for I-625: Chemical processing, aerospace and marine engineering, pollution-control equipment, and nuclear reactors
Hastelloy C-276	A versatile, corrosion-resistant alloy, Hastelloy does not usually need to be solution heat-treated after welding. Also, Hastelloy has vastly improved fabricability and excellent resistance to localized corrosion from both oxidizing and reducing media. It resists formation of grain-boundary precipitates and is therefore suitable for chemical-process applications in the as-welded condition. C-276 has excellent resistance to strong oxidizers like ferric and cupric chlorides, hot contaminated media (organic and inorganic), chlorine, formic and acetic acids, acetic anhydride, seawater, brine solutions, sulfur compounds, wet chlorine gas, and hypochlorite and chlorine dioxide. Applications for Hastelloy C-276: Chemical process equipment and desulfurization of flue gas equipment
Invar 36	Invar 36 alloy is a 36% nickel-iron alloy possessing a rate of thermal expansion approximately 1/10th that of carbon steel up to 200°C. This alloy has been used for applications where dimensional changes due to temperature variation must be minimized, such as in radio and electronic devices, aircraft controls, optical and laser systems, etc. Applications for Invar 36: Bimetallic thermostats and in rod and tube assemblies for temperature regulators