Edward J. Darby & Son, Inc.: Wire Mesh – Metals & Alloys

The information presented below is provided to give a user of wire mesh and wire cloth a general sense of the various metals and alloys used throughout the industry. As always, for specific information we recommend contacting an expert within your particular field, a metallurgist and/or a qualified engineer to discuss your requirements.

Stainless Steel Alloys

In metallurgy, stainless steel is a generic term used to describe a steel alloy with a chromium content of 10.5% or more. On the whole, stainless steels have a higher resistance to corrosion than plain (or carbon) steel. This resistance to corrosion in stainless steel is largely a result of the unique qualities of chromium.

Chromium combines with oxygen in the atmosphere, naturally forming a thin layer of chromium oxide. This extremely thin and invisible film serves as a protective coating in a wide range of corrosive environments. If the metal is cut or scratched and the film is ruptured, more oxide will quickly "self-repair" itself as to form and recover the exposed surface.

In the wire mesh industry, T-304 stainless steel and T-316 stainless steel are the most commonly used alloys to manufacture wire mesh and wire cloth. Other stainless steel alloys, like , T-310 SS, T-321 SS, T-347 SS, and even T-430 SS, are less popular yet often available through special order or custom manufacturing, depending on quantity required.

T-304 Stainless Steel Wire Mesh: The Standard

T-304 stainless steel is the most widely available of all stainless steels in the wire mesh industry. Aside from the countless combinations of mesh opening sizes and diameter wire available both from stock and through manufacturing, T-304 SS exhibits many benefits and is largely considered the standard of the industry. T-304 SS has excellent corrosion resistance in a wide range of environments and allows itself for usage in a wide range of applications.

Another of the many benefits of T-304 SS is heat resistance. T-304 SS displays good oxidation resistance to a temperature of approximately 1600^{o}F in intermittent service and to a temperature of 1700^{o}F in continuous service. T-304 stainless steel is also excellent for fabrication purposes – it can be formed and cut to size with appropriate tools and machinery. It can also be welded, using most common welding techniques, and it is virtually non-magnetic in the annealed condition. Finally, from a cost standpoint, it is usually the most attractively priced of most readily available stainless steel mesh alloys in the industry, especially when taking into consideration its lifecycle.

T-304 Stainless Steel is available in both woven and welded constructions – both from stock and through custom manufacturing. Please find below the standard chemical composition for T-304 SS commonly used in the wire mesh and wire cloth industry:

T-316 SS Steel Wire Mesh: An Upgrade for Specific Applications

T-316 stainless steel is recognized as the second most widely available of all stainless steels in the wire mesh industry. T-316 stainless steel wire mesh is typically considered as an alternative grade to T-304 stainless steel wire mesh when certain environmental conditions exist. In particular, marine conditions

and applications requiring heavy section welding commonly call for T-316 stainless steel due to its many benefits.

T-316 stainless steel has excellent corrosion resistance, and in particular, performs well in its ability to resist pitting and crevice corrosion in warm chloride environments. The inclusion of molybdenum (Mo) is a major factor to the improved corrosion resistance versus a T-304 SS counterpart.

T-316 stainless steel is heat resistant and has good oxidation resist resistance to a temperature of approximately 1600^{o}F in intermittent service and to a temperature of 1700^{o}F in continuous service. T-316 SS is also excellent for fabrication purposes – it can be formed and cut to size with appropriate tools and machinery. It also has outstanding weld-ability, and it is virtually non-magnetic in the annealed condition.

T-316 stainless steel is available in both woven and welded constructions – both from stock and through custom manufacturing. Please find below the standard chemical composition for T-316 SS commonly used in the wire mesh and wire cloth industry:

Other Stainless Steel Alloys

T-304 L SS – Usually a special order requirement, T-304 L SS woven wire mesh, with its low carbon content, is oftentimes specified in welding applications.

T-316 L SS – Usually a special order requirement, T-316 L SS woven wire mesh, with its low carbon content, is oftentimes specified in welding applications.

T-310 SS – Generally speaking, T-310 SS wire mesh is custom manufactured. It combines excellent high temperature properties with good ductility and weld-ability. It is usually reserved for high temperature service and has excellent toughness.

T-321 SS –T-321 SS wire mesh is usually a custom manufactured item, and as an austenitic 18/8 steel, it is stabilized by titanium and offers similar resistance to general corrosion as T-304 SS. Typical uses may include oil-refinery equipment and welded pressure vessels.

T-347 SS –T-347 SS wire mesh is usually a custom manufactured item, and as an austenitic 18/8 steel, it is stabilized by niobium and tantalum. These elements slightly improve corrosion resistance in certain environments. Typical uses may include high temperature gaskets and chemical product equipment.

T-430 SS –T-430 SS wire mesh usually requires custom manufacturing. It is a basic ferritic non-heat treatable stainless steel and offers good corrosion and oxidation resistance. Typical industrial applications may include plant equipment and oil-refinery equipment.

For additional information on these uncommon stainless steel alloys, please visit Darby's website at: www.darbywiremesh.com/other-wire-mesh-alloys.

On Stainless Steel and Surface Rust*

While stainless steel is corrosion resistant, that does not mean that stainless steel is completely rust proof, nor will it ever rust. It is important to remember that chromium, an important component of any stainless steel, combines with oxygen and forms a thin layer that serves as a protective barrier against a

wide array of corrosive elements. Surface rust can appear when chlorides, like salts, acids and seawater, attack and destroy this chromium-oxide film quicker than it can repair itself.

Additionally, there are a handful of reasons why stainless steel may rust. If a stainless steel comes into contact and rubs against the surface of ordinary carbon steel or iron, surface rust may occur. Also, the welding process may cause rust. External contamination, in the form of harsh chemicals or less-than-ideal fabrication practices, may also cause surface rust.

There are a handful of chemical cleaning agents that will successfully remove free iron and most other contaminants, thereby keeping surface rust to a minimum. It is always important to clean and/or wipe down stainless steel to optimize corrosion resistance. Of course, there are numerous other after-market processes that are often used to protect stainless steel.

Finally, it is critical to highlight the fact that surface rust on stainless steel, albeit unsightly and ugly, should not impact the functionality of stainless steel. Again, the presence of chromium and its ability to form a protective layer, even under a rust spot, will prevent further corrosion. As briefly mentioned above, there are countless options for purchasers of stainless steel to pursue should they want to make sure that no surface rust forms on stainless steel surfaces.

Stainless Steel Alloys - Standard Chemical Composition (in %)

Alloy	Carbon [C]	Manganese [Mn]	Phosphorus [P]	Sulfur [S]	Silicon [Si]	Chromium [Cr]	Nickel [Ni]	Iron [Fe]	Others, if Applicable
T-304	0.08 Max	2.0 Max	0.045 Max	0.03 Max	1.00 Max	18.00 - 20.00	8.00 - 10.50	Balance	N=0.10 Max
T-304 L	0.03 Max	2.00 Max	0.045 Max	0.03 Max	1.00 Max	18.00 - 20.00	8.00 - 12.00	Balance	N=0.10 Max
T-316	0.08 Max	2.00 Max	0.045 Max	0.03 Max	1.00 Max	16.00 - 18.00	10.00 - 14.00	Balance	Mo=2.00-3.00, N=.10 Max
T-316 L	0.03 Max	2.00 Max	0.045 Max	0.03 Max	1.00 Max	16.00 - 18.00	10.00 - 14.00	Balance	Mo=2.00-3.00, N=.10 Max
T-310	0.25 Max	2.00 Max	0.045 Max	0.03 Max	1.50 Max	24.00 - 26.00	19.00 - 22.0	Balance	
T-321	0.08 Max	2.00 Max	0.045 Max	0.03 Max	1.00 Max	17.00 - 19.00	9.00 - 12.00	Balance	Ti= 5 x C (Min)
T-347	0.08 Max	2.00 Max	0.045 Max	0.03 Max	1.00 Max	17.00 - 19.00	9.00 - 13.00	Balance	Nb(Cb)+Ta= 10X C (Min.)
T-430	0.12 Max	1.00 Max	0.04 Max	0.03 Max	1.00 Max	16.00 - 18.00	…	Balance	

Notes: N=Nitrogen
Ti=Titanium
Mo=Molybdenum
Nb(Cb)=Niobium (formerly columbium)
Ta=Tantalum

Plain or Carbon Steel

In the wire mesh industry, plain steel – or carbon steel, as it sometimes referred to—is a very popular metal that is commonly manufactured in both woven and welded wire mesh specifications. It is

comprised primarily of iron (Fe) with a small amount of carbon (C); generally speaking, it is a relatively low cost option that is versatile enough to be used in numerous applications, including window guards, shaker screens and fireplace screens. In some cases, plain steel wire mesh is used in gravel and stone separating in the mining and coal industries.

Plain steel wire mesh, whether it is available from stock or custom manufactured, is strong and magnetic. Oftentimes, it is dark in color, particularly when compared to bright aluminum or stainless steel meshes. And of course, because it is steel, it will not resist corrosion and will rust in most atmospheric conditions. In the certain industries, plain steel wire mesh is disposable item because of its strength and low cost.

Finally, there are times when plain steel is coated, normally an after-market process. Customers who are cost-conscious and still require some level of corrosion protection might opt for Galvanizing, PVC or Powder Coating, or even paint.

Copper

Copper and its alloys have been used for thousands of years, so it is no surprise it is a highly demanded metal option within the wire mesh industry. Copper wire mesh is ductile, malleable and has high thermal and electrical conductivity. As a result, it is often used in RFI shielding, in use in a Faraday Cage or electrical applications.

Copper wire mesh is also durable in many types of applications. Although it is softer than a similar stainless steel wire mesh, it is also resistant to atmospheric corrosion but attacked by oxidizing agents such as nitric acid, ferric chloride, and cyanides, and ammonia acids compounds. Darby's copper wire mesh is 99.9% pure copper.

Copper wire mesh's unique color also makes it an excellent option for use in gutter guards or related residential projects, including fireplace screen, insect screen, and, at times, small critter control. Because of its dark amber-red color, copper wire mesh continues to be a popular option for artists and architects. Further, when copper mesh is exposed to the atmosphere, a patina, or a thin green layer, develops.

Brass

Brass is an alloy that is comprised of copper and zinc, and, like copper, brass is soft and malleable and is attacked by ammonia and related salts. As a wire mesh, the most commonly available brass woven wire mesh is known, in certain circles, as "270 yellow brass", which has a chemical composition of approximately 65% copper, 35% zinc. "260 high brass", which is a 70% copper, 30% zinc is also a popular in the mesh industry, particularly on custom manufactured items.

The presence of zinc in brass woven wire mesh is important as it provides added abrasion resistance and higher tensile strengths; it also hardens the mesh, compared to its softer copper woven wire mesh counterpart. For these reasons, brass wire mesh is commonly used in filtration and separation applications, and it is used to fabricate discs, especially when electrical conductivity is not critical.

In most cases, industrial grade brass woven wire mesh has a golden yellow color to it, and this unique color makes it appealing for use in decorative and even artistic applications.

Bronze

Bronze is an alloy that consists primarily of copper, and thus, it exhibits many of the same characteristics of copper, like malleability, durability and ductility. In the wire mesh industry, commercial bronze wire mesh is the alloy commonly available from stock or through custom manufacturing. Typically, commercial bronze wire mesh has a material chemical composition of: 90% Copper, 10% Zinc.

Bronze woven wire mesh is superior to brass wire mesh in resistance to atmospheric corrosion, which is a reason that bronze wire mesh is commonly used in insect screen. Additionally, when compared to a copper woven wire mesh, bronze wire mesh is harder and less malleable. It is used in industrial applications where separation or filtration is needed or by builders or architects for a unique residential project. Bronze wire mesh has a brownish-red color, and this industrial product is increasingly popular for use in decorative and artistic applications.

Darby specializes in stocking a wide range of popularly requested bronze wire meshes, most notably the standard or market grades. Interestingly, when the mesh count reaches 100 x 100 mesh with a diameter wire of .0045" or finer, phosphorous bronze wire mesh becomes the standard in the industry. The chemical composition of phosphorous bronze wire mesh differs from bronze wire mesh in that a small of amount of phosphorous is included. Phosphorous bronze wire mesh typically has a material chemical composition of: 94% copper, 4.75% tin, and .25% phosphorous. *Phos bronze*, as it is commonly referred to within the industry, exhibits physical and anti-corrosive properties slightly superior to copper and brass.

Aluminum

Aluminum is largely considered the most popular non-ferrous metal in the world, and as such, aluminum alloys are commonly used in the wire mesh industry. Aluminum alloys are composed primarily of aluminum, and also contain other elements like copper, magnesium, manganese, or silicon.

Aluminum woven wire mesh is lightweight; in fact, a good rule of thumb is that, when compared to its stainless steel counterpart, aluminum mesh is approximately 1/3rd the weight of stainless. Aluminum wire mesh is also corrosion resistant in most normal environments but will corrode quickly in the presence of alkaline solutions and hydrochloric and hydrofluoric acids. With an estimated melting point of 1218^{o}F, aluminum has many benefits, including a relatively low cost compared to other meshes. Aluminum woven wire mesh is a popular choice for a wide array of industries including aerospace and automotive, as well as marine and electrical conductivity applications.

As a large supplier of aluminum woven wire mesh, Darby specializes in stocking many of the standard or market grades of aluminum in alloy 5052. As indicated in the chart below, the 5000 series of aluminum contains magnesium which is the main secondary element. This inclusion of magnesium serves as a hardener and offers good corrosion resistance in marine atmospheres.

Alloys 1350, 5056 and 6061 are largely considered special order items in aluminum wire mesh. There are times that these aluminum alloys are on the floor or can be readily manufactured. The chemical composition limits chart for the various alloys of aluminum wire mesh is presented below:

Chemical Composition Limits for Various Aluminum Wire Mesh Alloys (in %)

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ga	V	Other	Aluminum
1350	0.10	0.40	0.05	0.01	…	0.01	…	0.05	…	0.03	…	Trace	99.50
5052	0.25	0.40	0.10	0.10	2.2-2.8	0.15-0.35	…	0.10	…	…	…	…	Remainder
5056	0.3	0.40	0.1	0.05-0.20	4.5-5.6	0.05-0.20	…	0.10	…	…	…	…	Remainder
6061	0.40-0.8	0.70	0.15-0.40	0.15	0.8-1.2	0.04-0.35	…	0.25	0.15	…	…	…	Remainder

Monel 400 (® International Nickel Co.)
Monel 400 is a uniquely strong and durable material composed primarily of Copper and Nickel. As a copper-nickel alloy, Monel 400 exhibits high strength and excellent corrosion resistance in a wide range of media, including sea water, as well as acidic and alkaline environments.

In the wire mesh industry, Monel 400 wire is drawn to specific diameter wire and woven to certain specifications; Monel woven wire mesh is commonly used in marine applications, chemical and hydrocarbon processing equipment, as well as valves, pumps, shafts, fittings and heat exchangers. Darby specializes in stocking the standard or market grade specification of Monel 400 and has since the alloy was made readily available in the early 20th century.

Monel 400 woven wire mesh is generally sold in quantities less than full roll due to the high cost and long life cycle of this alloy.

Typical Chemical Composition of Monel 400 - Commonly used in Woven Wire Mesh (in %)					
Carbon [C](Max)	Manganese [Mn] (Max)	Iron [Fe] (Max)	Copper [Cu]	Nickel [Ni]	S & Si
0.3	2.0	2.5	28.0-34.0	63.0 Min	Traces

Galvanized
Galvanized is not a metal or alloy; it is a process in which a protective zinc coating is applied to steel to prevent rusting. In the wire mesh industry, however, it is often treated as a separate category because of its wide spread use in all types of applications.

Galvanizing can occur either before or after wire mesh is manufactured – both in woven form or welded form. Galvanized before woven wire mesh or galvanized before welded wire mesh indicates the individual wires, themselves, used to manufacture the mesh have been galvanized before the mesh is manufactured. Depending on the mesh/opening size and diameter wire, this is usually the less expensive option, especially if custom manufacturing is required.

Galvanized after woven and galvanized after welded wire mesh is exactly as it sounds. The material is manufactured, normally from in carbon or plain steel, and is often placed in a galvanizing tank, thereby making this a galvanized after woven or welded specification. Generally speaking, this option is more expensive, depending on availability and other variables, but does offer a higher level of corrosion resistance. This added level of corrosion resistance is most noticeable at the joint or intersection of galvanized after welded wire mesh specification.

Due to its attractive price point as well as its corrosion resistance, galvanized wire mesh is very popular among industrial users of wire mesh. Usually galvanized wire mesh is specified in applications where relatively large opening sizes are needed. Keep in mind that galvanizing a relatively fine mesh, after it is woven, is likely to clog the openings rendering it unusable in numerous applications.

Other Alloys
The metal and alloys offered above represent some of the more popular types of wire mesh and wire cloth. Often times, depending on a customer's requirements, other unique and special alloys may be needed. By and large, the alloys listed here are available through special order or custom

manufacturing. These wire mesh alloys include: Titanium, Hastellloy, Nichrome, Inconel, Tungsten, Hoskins 875 and Carpenter 20.

For additional information on these unique alloys, please visit Darby's website at: www.darbywiremesh.com/other-wire-mesh-alloys .

*A majority of the information related to rust and stainless steel was borrowed from Walter J. Sperko, P.E, at Sperko Engineering (www.sperkoengineering.com). We find Mr. Sperko's insight on this subject impressive and as accurate as we have seen. We encourage you to visit the website above for more information.