Durimet 20
CN7M

Bulletin A/1m

Durimet 20

Introduction

Durimet 20 is a high alloy austenitic stainless steel containing nickel, chromium, molybdenum, and copper. The alloy was originally developed by Flowserve (formerly The Duriron Company, Inc.) and carries the cast symbol CN7M. Its composition is balanced to provide increased sulfuric acid resistance over the conventional 18-8 stainless steels while maintaining equal or superior resistance to many other important corrosives. Although Durimet 20 was developed by Flowserve, it is also produced by others under such trade names as Aloyco-20, Esco No. 20, etc. Durimet 20 is available in engineered equipment such as pumps, valves, etc., as manufactured by Flowserve.

Chemical Composition

Table I lists the composition of Durimet 20. The alloy contains sufficient chromium to provide good resistance to oxidizing acids such as nitric and phosphoric. The high nickel content of the alloy stabilizes the austenitic matrix and imparts good resistance to many nonoxidizing (reducing) media as well. The molybdenum content of 2 to 3% builds good pitting resistance and improves the general corrosion resistance to many corrosives such as sulfuric acid and acetic acid.

Durimet 20 also contains 3 to 4% copper to further enhance its resistance to sulfuric acid. The high nickel content, fortified with significant levels of chromium and molybdenum, provides a suitable matrix to place the copper in solid solution, which is fundamentally important in securing excellent resistance to sulfuric acid. Since all of the copper is in solid solution and not present in the alloy as a free element, the possibility of copper contamination of solutions handled by Durimet 20 equipment is practically eliminated.

Table I Chemical Composition

Element	**Percent**
Nickel	27.5-30.5
Chromium	19.0-22.0
Molybdenum	2.0-3.0
Copper	3.0-4.0
Silicon	1.50 max.
Manganese	1.50 max.
Carbon	0.07 max.
Phosphorus	0.04 max.
Sulfur	0.04 max.
Iron	Balance

Mechanical and Physical Properties

Durimet 20, being a wholly austenitic alloy, has mechanical and physical properties similar to the conventional 18-8 stainless steels. Table II lists the minimum tensile properties and nominal hardness and impact strength. Table III lists the nominal physical properties.

Durimet 20 possesses good machinability but does tend to work harden. For best results, slow feeds, deep cuts and powerful, rigid machines are necessary.

Table II Mechanical Properties

Tensile strength, min., psi (MPa)	62,000	(425)
Yield strength, min., psi (MPa)	25,000	(170)
Elongation, min., %	35	
Hardness, Brinell	133	
Impact strength, Charpy Keyhole ft-lbs (Joules)	70	(95)

Table III Physical Properties

Density, lbs/in^3 (g/cc)	0.289	(8.02)
Melting point, approximate, °F (°C)	2650	(1460)
Modulus of Elasticity, psi x 10^6 (MPa x 10^4)	24	(16.5)
Thermal Conductivity, Btu ft/hr/ft^2/°F, at 212°F		12.1
(Watt/m-K, at 100°C)		(20.9)
Coefficient of Thermal Expansion, in/in/°F, 70-212°F, x 10^{-6}		8.6
(m/m/°C, 21-100°C, x 10^{-6})		(15.5)
Specific Electrical Resistance microhms/cm^3, at 21°C		89.6
Specific Heat, Btu/lb/°F, at 70°F		0.11
(J/g/°C, at 21°C)		(0.46)
Magnetic Permeability		1.01-1.10

Heat Treatment

Maximum corrosion resistance is obtained in Durimet 20 by employing a quench anneal heat treatment on all castings. This heat treatment consists of uniformly heating Durimet 20 to 2050°F (1120°C) minimum followed by a rapid quench in water.

Welding

For information on the welding characteristics of Durimet 20, please contact the Flowserve Materials Engineering Department at 2200 East Monument Avenue, Dayton, Ohio 45402, (937) 226-4476.

Specifications

Durimet 20 castings will conform to the latest edition of ASTM A744, Grade CN7M.

Corrosion Resistance

Durimet 20 is used extensively in all industries handling corrosives. It is widely used in the Chemical Process Industries for the manufacture of plastics, pharmaceuticals, explosives, synthetic rubber, caustic and chlorine, fertilizer, soaps and detergents, synthetic fibers, and solvents to name a few. It also finds wide application in the electroplating, metal-refining, and metal-cleaning industries.

Sulfuric Acid

Durimet 20 is best known for its resistance to sulfuric acid. Figure 1 is an iso-corrosion chart for Durimet 20 in pure sulfuric acid. Each line represents a constant corrosion rate expressed in mils per year (MPY). As a general rule, a corrosion rate up to 20 MPY is considered suitable for obtaining an economical service life from most Flowserve equipment made of Durimet 20. However, as with any chart or curve, this illustration is merely intended as a guide. Depending upon specific conditions in any one application, the iso-corrosion lines may be shifted one way or the other.

As indicated in Figure 1, Durimet 20 is suitable for all concentrations of sulfuric acid to 150°F (65°C) and to most concentrations to even higher temperatures. Contaminants in sulfuric acid solutions usually have a pronounced effect on the resistance of Durimet 20. These contaminants may act as inhibitors, accelerators, or may have no effect whatsoever. Inhibitors are generally oxidizing agents such as ferric sulfate, copper sulfate, or nitric acid. The presence of as little as 0.02% (200 ppm) ferric sulfate so effectively inhibits corrosion of Durimet 20 that losses may be reduced as much as 100 times. Other inhibitors show the same effect but not necessarily to the same degree.

Hydrochloric acid and certain chlorides tend to accelerate the corrosion rate of sulfuric acid on Durimet 20. Other strong reducing (nonoxidizing) agents such as hydrogen sulfide, carbon disulfide, or sulfur dioxide also will increase the corrosion rate in sulfuric acid. Deaeration also can result in higher corrosion rates for Durimet 20 in sulfuric acid.

Although the data given in the iso-corrosion chart pertain to laboratory testing under controlled conditions, the trends established have also been verified by plant experience. Commercial castings in Durimet 20 were first produced in 1935 and have been supplied in an ever-increasing volume since that time. During this period, careful records have been maintained on the sulfuric acid serviceability of pumps, valves and wrought products that confirm the laboratory tests.

Sodium Hydroxide

Durimet 20 has found increasing application in the caustic-chlorine industry for handling solutions of sodium hydroxide. Its high nickel content accounts for its excellent resistance to this corrosive as shown in Figure 2. Durimet 20 is an economical alternative to the more expensive nickel or nickel-based alloys. Durimet 20 exhibits good to excellent resistance in all concentrations of sodium hydroxide up to 73% and up to 300°F (149°C). Its superior resistance to caustic combined with good resistance to chloride stress cracking also makes Durimet 20 a good choice for the hot alkaline brine solutions encountered in caustic-chlorine plants.

Nitric Acid

Durimet 20 is particularly suited for nitric acid service. It has corrosion resistance superior to the 18-8 stainless steels at all concentrations. This superiority over the 18-8 alloys includes Type 304L stainless steel which is widely used in nitric acid plants. Figure 3 is an iso-corrosion chart for Durimet 20 in nitric acid.

Other Media

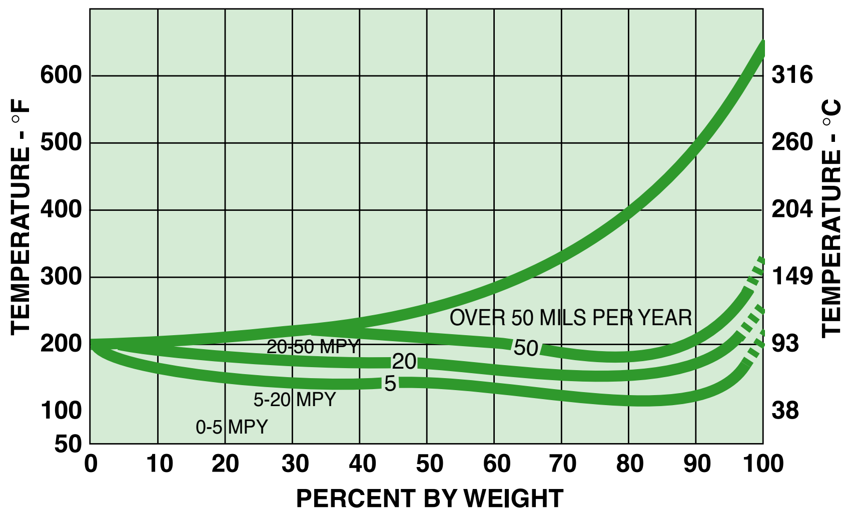
The resistance of Durimet 20 to a large list of common corrosives is indicated in Table IV. The list is intended solely as a guide, and should not be considered as a specific recommendation for any particular operating condition. The descriptions “excellent resistance,” “good resistance” and “poor resistance” have been used. “Excellent resistance” means negligible corrosion. “Good resistance” means that some corrosion is obtained but experience with pumps, valves and similar equipment indicates that an economic service life is obtained. “Poor resistance” indicates that Durimet 20 is not satisfactory for the particular corrosive.

Many factors influence the corrosion resistance of any alloy in service. The factors that must be given consideration are temperature, concentration, aeration, influence of inhibiting or accelerating contaminants, influence of recirculation, solids in suspension, velocity, continuity or frequency of use, and equipment design. The influence of contaminants is probably the most important from a commercial standpoint, for while the majority of contaminants have no influence on corrosion, those that do, generally affect the conditions greatly. Ferric chloride is a good example. Relatively small amounts of ferric chloride can cause destructive crevice corrosion and pitting to take place even though this salt was not added to the solution intentionally. Build-up of the corrosion products in a chloride solution may increase the iron concentration to a sufficient degree to be destructive.

Flowserve Corporation strongly urges the proposed user of Durimet 20 to contact the manufacturer, giving a complete description of the corrosive condition with regard to the factors noted above. In this way our staff of engineers can study your problem and make reliable recommendations based on their many years of experience in the corrosion field.

Sulfuric Acid vs Durimet 20

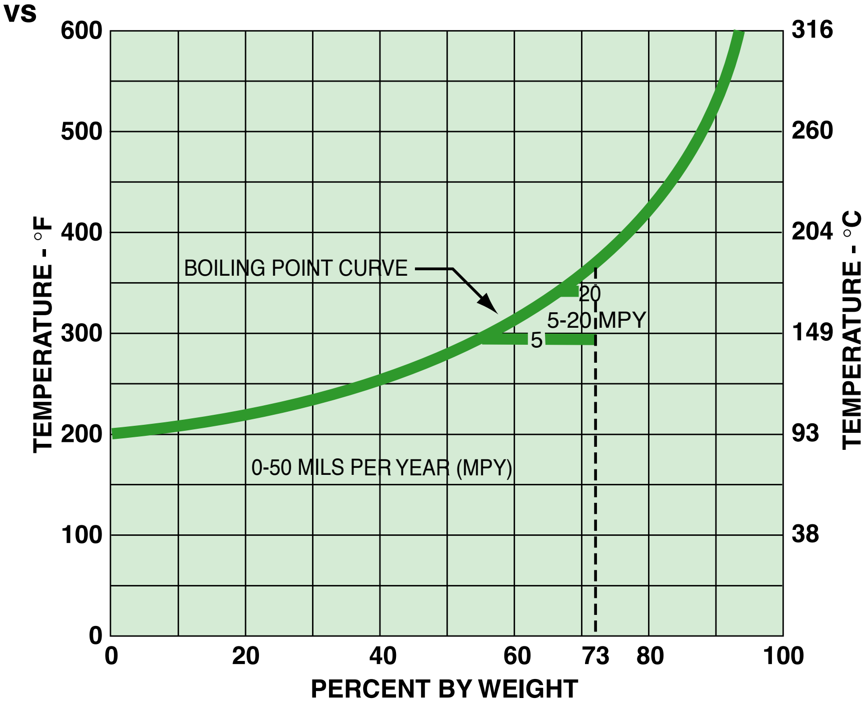
Figure 1



MPY	μ mm/yr
5 =	127
10 =	254
15 =	381
20 =	508
50 =	1270
100 =	2540

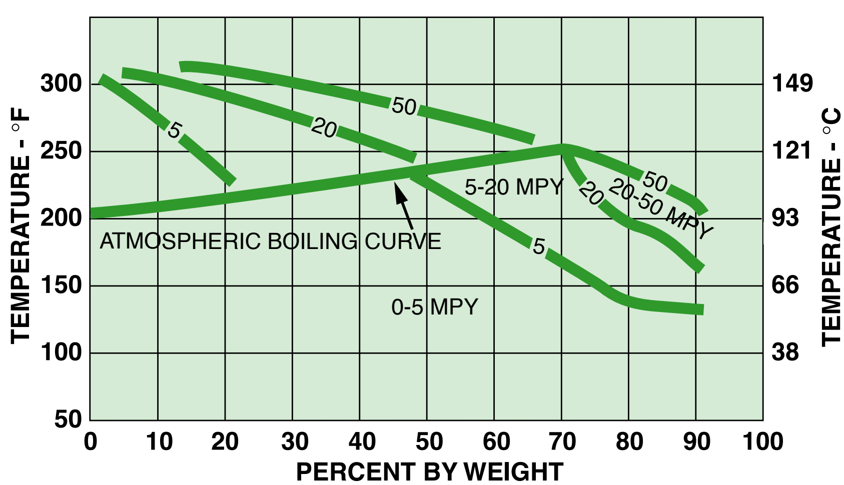
Sodium Hydroxide vs Durimet 20

Figure 2



Nitric Acid vs Durimet 20

Figure 3



Corrosion Chart

Table IV

	Excellent Resistance	Good Resistance	Poor Resistance
Acetic Acid	X		
Acetic Anhydride	X		
Acetone	X		
Alcohol	X		
Alum		X	
Aluminum Chloride			X
Aluminum Sulfate		X	
Amines	X		
Ammonia	X		
Ammonium Chloride		X	
Ammonium Hydroxide	X		
Ammonium Nitrate	X		
Ammonium Phosphate		X	
Ammonium Sulfate		X	
Arsenic Acid		X	
Barium Chloride		X	
Barium Sulfate		X	
Benzene	X		
Benzoic Acid	X		
Boric Acid		X	
Butyric Acid	X		
Cadmium Sulfate	X		
Calcium Bisulfite		X	
Calcium Chlorate		X	
Calcium Chloride	X		
Calcium Hydroxide		X	
Calcium Hypochlorite			X
Carbon Bisulfide		X	
Carbon Tetrachloride	X		
Carbonic Acid	X		
Cellulose Acetate		X	
Chloroacetic Acid			X
Chlorinated Water			X
Chlorine (dry)	X		
Chlorine (wet)			X
Chromic Acid, <30%, 130°F		X	
Chromium Fluoborate		X	
Citric Acid	X		
Copper Chloride			X
Copper Cyanide	X		
Copper Fluoborate		X	
Copper Nitrate	X		
Copper Sulfate	X		
Ethylene Dichloride	X		
Fatty Acids	X		
Ferric Chloride			X
Ferric Nitrate	X		
Ferric Sulfate	X		
Ferrous Sulfate	X		
Formaldehyde	X		
Formic Acid		X	
Gallic Acid	X		
Glycerine (crude)		X	
Hydrocarbons	X		
Hydrochloric Acid			X

	Excellent Resistance	Good Resistance	Poor Resistance
Hydrofluoric Acid, <20%, R.T.		X	
Lactic Acid		X	
Lead Acetate		X	
Lead Fluoborate		X	
Lead Nitrate	X		
Lithopone	X		
Magnesium Chloride		X	
Magnesium Sulfate		X	
Maleic Acid		X	
Mercuric Chloride			X
Mine Water		X	
Nickel Chloride		X	
Nickel Sulfate		X	
Nicotine Sulfate	X		
Nitrobenzene	X		
Oleic Acid	X		
Oleum		X	
Oxalic Acid		X	
Perchloric Acid		X	
Phenol	X		
Phosphoric Acid, <85%	X		
Picric Acid	X		
Potassium Chloride		X	
Potassium Nitrate	X		
Potassium Sulfate	X		
Pyrogallic Acid	X		
Pyroligneous Acid		X	
Salicylic Acid		X	
Sodium Bichromate		X	
Sodium Bisulfate	X		
Sodium Bisulfite	X		
Sodium Carbonate	X		
Sodium Chloride		X	
Sodium Hypochlorite			X
Sodium Nitrate	X		
Sodium Phosphate		X	
Sodium Sulfate	X		
Sodium Sulfide		X	
Sodium Sulfite	X		
Stannic Chloride			X
Stearic Acid	X		
Sulfite Liquor		X	
Sulfur		X	
Sulfur Dioxide	X		
Sulfur Trioxide	X		
Sulfurous Acid	X		
Tannic Acid		X	
Tanning Liquors		X	
Tartaric Acid		X	
Tin Fluoborate		X	
Trichloroethylene	X		
Vinegar	X		
Vinegar Brines		X	
Zinc Fluoborate		X	
Zinc Sulfate	X		

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