CORROSION MATERIALS

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TECHNICAL DATA SHEET

ALLOY 22

UNS N06022 / W.Nr. 2.4602

Description

Alloy 22 is a fully austenitic, nickel-chromium-molybdenum-tungsten alloy with better overall corrosion resistance compared to other nickel-chromium-molybdenum alloys, including alloy C-276, alloy C-4 and alloy 625. The high chromium content provides good resistance to oxidizing media while the molybdenum and tungsten content gives good resistance to reducing media. This combination of corrosion resistance makes alloy 22 particularly useful in applications where mixed acids are present.

Industries and Applications

Alloy 22 is utilized in many aggressive environments across a wide range of industries, including chemical processing, oil and gas, pharmaceutical, food processing, pulp and paper, waste water treatment, pollution control, and nuclear. End use applications for alloy 22 include waste incinerators, equipment for flue-gas desulfurization scrubbers, nuclear fuel reprocessing/spent fuel containers, pickling systems, heat exchanger components, equipment for chemical manufacturing, flow meters and many other highly corrosive applications. The maximum service temperature for alloy 22 is 1250 °F due to the potential formation of detrimental phases.

Resistance to Corrosion

Alloy 22 displays exceptional resistance to a broad range of corrosive environments. This alloy has excellent resistance to oxidizing aqueous media, including wet chlorine and mixtures containing nitric acid or oxidizing acids with chlorine ions. Resistance to reducing acids such as sulfuric and hydrochloric can also be expected. Other corrosive chemicals to which the alloy has resistance include oxidizing acid chlorides, wet chlorine, formic and acetic acids, ferric and cupric chlorides, sea water, brine and many mixed or contaminated chemical solutions, both organic and inorganic. Alloy 22 offers optimum resistance to environments where reducing and oxidizing conditions are encountered in process streams. This is beneficial in multi-purpose plants where “upset” conditions occur frequently.

Fabrication and Heat Treatment

Alloy 22 can be formed by standard processes used for nickel alloys. Although ductile enough to be formed by cold working, intermediate annealing may be necessary due to work hardening. Forging should be between be performed between 1750°F and 2050°F followed by rapid cooling. Annealing can be performed at a temperature range between 2020°F and 2150°F followed by a rapid quench. Cooling at an accelerated rate avoids the formation of detrimental phases which form between 400°F and 1800°F. Welding can be by gas tungsten-arc, gas metal-arc, and shielded metal-arc processes.

Chemical Composition (%)

(Ni) Nickel	Remainder
(Cr) Chromium	20.0 to 22.5
(Mo) Molybdenum	12.5 to 14.5
(W) Tungsten	2.5-3.5
(Co) Cobalt	2.5 max
(Fe) Iron	2.0-6.0
(Mn) Manganese	0.50 max
(V) Vanadium	0.35 max
(Si) Silicon	0.08 max
(P) Phosphorus	0.02 max
(S) Sulfur	0.02 max
(C) Carbon	0.015 max

Mechanical Properties

Product Form	Tensile (min. ksi)	0.2% Yield (min. ksi)	Elong. (min. %)	Hardness* (HRB)
Bar	100	45	45	85-100
Plate & Sheet	100	45	45	85-100
Pipe & Tube	100	45	45	85-100

All properties in this table are for material in the solution annealed condition and are from the governing ASTM specification.

*Hardness is shown for information purpose only.

Physical Properties

Density @ Room Temp.	0.314 lb/in.^{3}
Elastic Modulus @ Room Temp.	29.9 x 10^3 ksi
Melting Range	2475°F to 2550°F
Specific Heat @ Room Temp.	0.091 Btu/lb•°F
Electrical Resistivity @ Room Temp.	44.8 µΩ•in

Cold-Worked Properties

Cold Reduction (%)	Tensile (ksi)	0.2% Yield (ksi)	Elong. (%)
10	130	93	39
20	151	127	23
30	170	151	13
40	192	174	9
50	206	182	10

Alloy 22 cannot be hardened by heat treatment but can be hardened by cold working using various means. The increase in tensile and yield properties is dependent on the percentage of cold reduction induced on the material.

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Aqueous Corrosion Data

Media	Common Name	Temp. °F (°C)	Corrosion Rate (mpy)
99% $C_2H_4O_2$	Acetic Acid	Boiling	Nil
10% $FeCl_3$	Ferric Chloride	Boiling	1
88% CH_2O_2	Formic Acid	Boiling	<1
1% HCl	Hydrochloric Acid	Boiling	3
5% HCl	Hydrochloric Acid	158 (70)	19
10% HCl	Hydrochloric Acid	Boiling	400
5% HCl + 42 g/l $Fe_2(SO_4)_3$	Mixed Acid	150 (66)	2
5% HCl + 2% HF	Mixed Acid	158 (70)	59
5% HF	Hydrofluoric Acid	158 (70)	14
85% H_3PO_4	Phosphoric Acid	Boiling	13
44% P_2O_5	Phosphoric Oxide	240 (116)	21
38% P_2O_5 + 2000ppm Cl	Mixed Acid	185 (85)	1
38% P_2O_5 + 0.5% HF	Mixed Acid	185 (85)	7
10% HNO_3	Nitric Acid	Boiling	<1
65% HNO_3	Nitric Acid	Boiling	134
5% HNO_3 + 6% HF	Mixed Acid	140 (60)	67
5% HNO_3 + 25% H_2SO_4 + 4% NaCl	Mixed Acid	Boiling	12
5% HNO_3 + 1% HCl	Mixed Acid	Boiling	<1
5% HNO_3 + 2.5% HCl	Mixed Acid	Boiling	2
8.8% HNO_3 +15.8% HCl	Mixed Acid	126 (52)	4
2% $H2SO_4$	Sulfuric Acid	Boiling	5
10% $H2SO_4$	Sulfuric Acid	Boiling	12
20% $H2SO_4$	Sulfuric Acid	Boiling	33
50% $H2SO_4$	Sulfuric Acid	174 (79)	16
80% $H2SO_4$	Sulfuric Acid	199 (93)	68
10% $H2SO_4$ + 1% HCl	Mixed Acid	194 (90)	94
25% $H2SO_4$ + 200 ppm Cl-	Mixed Acid	158 (70)	11
50% H_2SO_4 + 42g/l $Fe_2(SO_4)_3$	ASTM G28A	Boiling	40

Coefficient of Thermal Expansion

Temperature (°F)	Coefficient (µin./in.°F)
75 to 200	6.9
75 to 400	6.9
75 to 600	7.0
75 to 800	7.4
75 to 1000	7.7
75 to 1200	8.1

Thermal Conductivity

Temperature (°F)	Conductivity (Btu•in/ft²•h•°F)
100	69
200	76
400	94
600	110
800	125
1000	139

Charpy V-Notch Impact Test[1]

Temp. (°F)	Notched Impact Energy[2] (ft•lb)	(J)
68 (20°C)	88.5	120
-321 (-196°C)	22.9	96

[1]Average of three tests. [2]Results listed are min values.

Applicable Specifications*

Form	ASTM	ASME	VdTÜV
Bar	B574, B564[1]	SB574, SB564[1]	479
Plate & Sheet	B575	SB575	479
Seamless Pipe & Tube	B622	SB622	-
Welded Pipe	B619	SB619	-
Welded Tube	B626	SB626	-

[1]On diameters above 3.5", B564/SB564 is dual certified.
** EN10204-3.1 applies to all product forms.*

Please contact Corrosion Materials for a complete list of items available from our extensive inventory, as well as our value-added processing services.

We supply a complete range of items in many alloys, including C-276, 22, B-2, B-3®, 200/201, 400, 405, K-500, 625, 600, 800H/HT®, 20, F255, 6B, Titanium Gr. 2 and Titanium Gr. 5.

Our machine shop, welding shop and processing departments are equipped with state-of-the-art manufacturing equipment allowing Corrosion Materials the ability to provide the service you desire along with the economic and technical advantages you need and deserve.

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