

# Datasheet

## Introduction

MP35N is a high purity nickel, cobalt, chromium, molybdenum alloy which provides an excellent combination of high strength, ductility, and corrosion resistance. The principal advantage of MP35N is its outstanding corrosion resistance at high strength levels.

The alloy is face centred cubic in the annealed condition and is strengthened by the precipitation of hexagonal phase when the alloy is cold worked. The cold worked structure can be further strengthened by ageing cold worked material to precipitate a cobalt, molybdenum intermetallic compound along the hexagonal planes. Thus strengthening can occur in two steps; transformation strengthening by cold working, then precipitation by ageing the cold worked structure. Since the precipitation occurs along the hexagonal close packed platelets only, precipitation strengthening from the annealed condition cannot be accomplished.

## Advantages

The primary advantage if MP35N are its high strength combined with outstanding corrosion resistance. Most high strength alloys contain carbon and/or um. Intermetallic compounds of these elements precipitate into grain boundaries and decrease their resistance to intergranular attack. Because of the strengthening mechanism of MP35N these interstitial elements are not required for high strength and the vacuum melting practice insures a low impurity level. MP35N is resistant to most mineral acids and sea water. It is also resistant to stress corrosion cracking in boiling 42% magnesium chloride and modified 10% sodium chloride tests. The following tables provide specific corrosion information for MP35N.

## Fabricability

MP35N can be formed in a manner similar to 300 series stainless steel. Tube drawing experience indicates that the work hardening rate is somewhat lower than 304, but a greater force is required to form it.

Welding has been accomplished successfully by TIG and MIG welding techniques. Because of its high purity, no difficulties related to the heat affected zone have been experienced.

The machinability of MP35N compares favourably with that of Waspaloy. Specific machining data can be made available on request.

Annealing can be accomplished by heating to 2000°F and cooling at any convenient rate. Atmospheric control is not critical and hydrogen, oxidising, or neutral atmospheres can be used. After work strengthening, ageing can be performed in a range of 900°F through to 1100°F. A satisfactory compromise between strength and ductility is obtained by cold working 45%, then ageing at 1000°F.

## Production Limits

At present, Superior Tubes have set production limits of 5/8" OD x 0.125" wall maximum in seamless grade, and 5/8" OD x maximum 0.049" wall in WELDRAWN grade. As demand develops, size above 5/8" OD up to 1 1/4" OD (with maximum wall thickness of 0.35") may be considered feasible; discuss your special requirements with the general sales office.

Mechanical Properties			Chemical Composition		Modulus of Elasticity	
Condition	UTS ksi	YS ksi	MP35N is produced by vacuum induction melting followed by vacuum arc remelting and is therefore a very high purity alloy. Nominal composition is as follows		Test Temperature	Elastic Modules PSI x 10 <sup>-6</sup>
Annealed	150/150	60/90	Chromium	20%	70	33.6
Cold Worked	220/250	200/250	Nickel	35%	200	33.0
Cold Worked & Aged	240/300	230/300	Cobalt	35%	400	31.9
	Elong. % in 2"	Rockwell Hardness	Molybdebum	10%	600	30.8
Annealed	50/60	B90/95			800	29.6
Cold Worked	2/5	C 40/50				
Cold Worked & Aged	2/5	~ ~ ~				
Physical Properties			Temperature Range °F		Electrical Resistivity	
Density	~304 lbs./cu.in.		70 to 200	In./in./ °F x 10 <sup>6</sup>	~103 Mi- crohn~cm. (±3%)	
Melting Range	~2400 to 2600°F		70 to 400	7.1	Magnetic Properties	
Coefficient of Thermal Expansion in the work Strengthening and Aged Condition			70 to 600	7.6	~ Non-magnetic	
			70 to 800	8.2		
			70 to 1000	8.3		
				8.7		

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## Tolerances

Round tubing is produced to the following commercial tolerances application to two dimensions only, for average OD/wall relationships. For complete tolerance data send for Data Memorandum #8.

Outside Diameter Range	Nominal Outside Diameter	Nominal Inside Diameter	Nominal wall
Up to, but not including $\frac{3}{32}$ " OD	0.002" - 0.00"	+ .000" - .002"	±10%
$\frac{3}{32}$ " OD to, but not including	+0.003" - 0.000"	+ 0.000" - 0.0003	±10%
$\frac{3}{16}$ " to, but not including $\frac{1}{2}$ " OD	+0.004" - 0.000"	+ 0.000" - 0.004"	±10%
$\frac{1}{2}$ " to, but not including 1- $\frac{1}{2}$ " OD	+0.005" - 0.000	+ 0.000" - 0.005"	±10%

## Accelerated Corrosion Data - Mineral Acid Solutions

	H2 SO4		HCl		HN03	
	10%	78%	10%	37%	10%	65%
MP35 N	0.1	2.2	22.0	17.0	0.1	0.5
Hastelloy B	6.0	~	5.3	~	Not Resistant	
Hastelloy C	0.2	~	1.1	~	0.1	~
Hastelloy F	0.2	~	47.0	~	0.1	~

## Corrosion Rates of Alloys in Simulated Marine Environment at 50°C

Alloy	Condition	10% HCl & FeCl3	10% NaCl & HCl (pH2)	10% FeCl3
MP35N	Surface Crevice	0.0 No Attack	0.0	0.0
Hastelloy C	Surface Crevice	0.7 No Attack	0.1	0.0
Hastelloy F	Surface Crevice	13.0 No Attack	0.1	0.1
Type 316	Surface Crevice	50.0 No Attack	5.0	50.0

## Extended Marine Corrosion Tests

All tests Successive 10 Day Periods, 50°C, Static. Corrosion Rate, Miles per Month

Alloy	10% HCl & FeCl3		10% NaCl & HCl (pH2)		10% FeCl3	
	Open	Crevice	Open	Crevice	Open	Crevice
MP35 N	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
	No visible Effect	Light Crevice Etch	No Visible Effect	0.00	No Visible Effect	0.00
Hastelloy C	0.003	0.003	0.00	0.00	0.00	0.00
	0.003	0.003	0.00	0.00	0.00	0.00
	0.003	0.003	0.00	0.00	0.00	0.00
	0.003	0.003	0.00	0.00	0.00	0.00
	0.003	0.003	0.00	0.00	0.00	0.00
	Light Overall Etch	No Visible Effect		No Visible Effect		

