



# DMV 928

## 1. Applications

DMV 928 is used in a wide variety of applications where general corrosion resistance and resistance to chloride-ion acid are necessary, such as:

### ■ Petrochemical industries

- in the production, concentration and use of phosphoric acid or sulphuric acid
- in general applications with very aggressive conditions, like acetic acid, vinyl chloride, etc.

### ■ Maritime applications

- in desalination plants; sea-water systems, heat exchangers using sea water as coolant

### ■ Downhole O&G applications in Cold Hardened condition

- See separate Data Sheet for OCTG.

Carbon <b>C</b> < 0.02	Chromium <b>Cr</b> 27	Nickel <b>Ni</b> 32	
Molybdenum <b>Mo</b> 3.5	Copper <b>Cu</b> 1.0		
Manganese <b>Mn</b> 2.0	Silicon <b>Si</b> <0.07	Phosphorus <b>P</b> <0.03	Sulfur <b>S</b> S <0.01

Chemical composition nominal %

## 2. Main Features

DMV 928 is an austenitic low carbon iron-nickel-chromium-molybdenum alloy with addition of approximately 1 wt% copper.

## 3. Description

### 3.1 Reference Standards

- UNS N08028 acc. to ASTM B 668 and ASME SB 668
- 1.4563 acc. to EN 10216-5 and EN 10297-2

### 3.2 Chemical composition

DMV 928 contains:

	Weight%min
<b>C</b>	< 0.02
<b>Si</b>	< 0.07
<b>Mn</b>	< 2.00
<b>P</b>	< 0.03
<b>S</b>	< 0.01
<b>Cr</b>	27
<b>Ni</b>	32
<b>Mo</b>	3.5
<b>Cu</b>	1.0
<b>Fe</b>	Balance

PREN ≥ 38  
(PREN = %Cr + 3.3 x %Mo + 16 x %N)

## 3.3 Mechanical Properties

Following values are guaranteed in the solution annealed condition:

### 3.3.1 Tensile Properties at 20°C (68°F)

UNS N08028 acc. to ASTM B 668:

	MPa	ksi
<b>0.2% Y.S. min.</b>	214	31
<b>U.T.S. min.</b>	500	73
<b>A% min.</b>	40	

1 MPa=1 N/mm<sup>2</sup>; 1 ksi=6.9 MPa

Grade 1.4563 acc. to EN 10216-5 and EN 10297-2:

	MPa	ksi
<b>0.2% Y.S. min.</b>	215	(31.2)
<b>1.0% Y.S. min.</b>	245	(36.8)
<b>U.T.S. min</b>	500	(72.5)
<b>A% min.</b>	35	

1 MPa=1 N/mm<sup>2</sup>; 1 ksi=6.9 MPa ( ) = calculated values

### 3.3.2 Tensile Properties at Elevated Temperature

Grade 1.4563 acc. to EN 10216-5 and EN 10297-2:

Temperature °C	(°F)	0.2 Y.S. min MPa (ksi)	1.0 Y.S. min MPa (ksi)
100	(212)	190 (27.5)	220 (31.9)
200	(392)	160 (23.2)	190 (27.5)
300	(572)	150 (21.7)	180 (26.1)
400	(752)	135 (19.6)	165 (23.9)
450	(842)	125 (18.1)	155 (22.5)
500	(932)	120 (17.4)	150 (21.7)
550	(1022)	115 (16.7)	146 (21.1)

1 MPa=1 N/mm<sup>2</sup>; 1 ksi=6.9 MPa  
( ) = calculated values

For UNS N08028 "maximum allowable stress values" according to ASME Sec. II Part D:

Temperature (°C)	°F	Stress value (MPa)	ksi
(38)	100	(126)	18.2
(93)	200	(126)	18.2
(149)	300	(121)	17.5
(204)	400	(113)	16.4
(260)	500	(106)	15.4
(316)	600	(99)	14.3
(371)	700	(93)	13.5
(426)	800	(88)	12.8

1 MPa=1 N/mm<sup>2</sup>; 1 ksi=6.9 MPa  
( ) = calculated values

### 3.3.3 Impact Resistance

According to VdTÜV data sheet, the notch impact resistance at 20°C (68°F) in longitudinal direction must be min. 100 J/cm<sup>2</sup> (average value of three samples, with min. 70 J/cm<sup>2</sup> individual value).



### 3.4 Physical Properties

Density at 20°C (68°F)	
g/cm <sup>3</sup>	lbs/in <sup>3</sup>
8	0.29

Coefficient of Thermal Expansion between 20°C (68°F) and...			
Temperature		10 <sup>-6</sup> /K	10 <sup>-6</sup> /°F
°C	(°F)		
100	(212)	15.0	(8.3)
200	(392)	15.4	(8.5)
300	(572)	15.8	(8.7)
400	(752)	16.2	(9.0)
500	(932)	16.5	(9.4)

() = calculated values

Thermal Conductivity			
Temperature		W/(mK)	Btu in/(ft h °F)
°C	(°F)		
20	(68)	10.8	(6.24)
100	(212)	12.0	(6.94)
200	(392)	13.8	(7.98)
300	(572)	15.8	(9.13)
400	(752)	17.9	(10.3)
500	(932)	20.0	(11.6)

() = calculated values

Modulus of Elasticity			
Temperature		10 <sup>3</sup> MPa	10 <sup>3</sup> ksi
°C	(°F)		
20	(68)	195	(28.3)
100	(212)	190	(27.4)
200	(392)	185	(26.8)
300	(572)	177	(25.7)
400	(752)	170	(24.6)
500	(932)	162	(23.5)

1 MPa=1 N/mm<sup>2</sup> ; 1 ksi=6.9 MPa

### 3.5 Corrosion Properties

DMV 928 has high resistance to crevice and pitting corrosion. In reference to the pitting resistance index (PRE<sub>N</sub>) of about 38, this alloy is one of the most resistant compared to the common high-nickel grades and type 300 stainless steels. This property makes them particularly suitable for chloride and sea water heat exchangers at temperatures up to 60°C (140°F) provided that the following conditions are met:

- Periodic cleaning of tube inside surface
- Fresh water rinsing during shut down
- Continuous flow inside the tube

DMV 928 is also resistant in sulphuric, phosphoric, hydrochloric, hydrofluoric and polythionic acids.

Due to the high chromium content and low carbon level, DMV 928 pipe and tube have an excellent resistance to intergranular corrosion.

In particular, they meet the standard copper – copper sulphate – sulphuric acid test (ASTM A 262 Practice E) in the sensitized condition.

In the Huey test per ASTM A 262 Practice C, the corrosion rate on sensitized material is less than 0.2 mm/y (0.0079 in/y).

In particular, laboratory test on C-rings or U-bent specimens taken from annealed or even cold worked, min Yield Strength 125ksi (862MPa), materials have shown not to be susceptible to rupture under following test conditions:

- CO<sub>2</sub>: 50 bar
- H<sub>2</sub>S: 3 bar
- NaCl: 100 g/l
- Temp.: up to 230°C (447°F)
- Duration: 500 h

### 4 Supply forms

#### 4.1 Dimensional Range

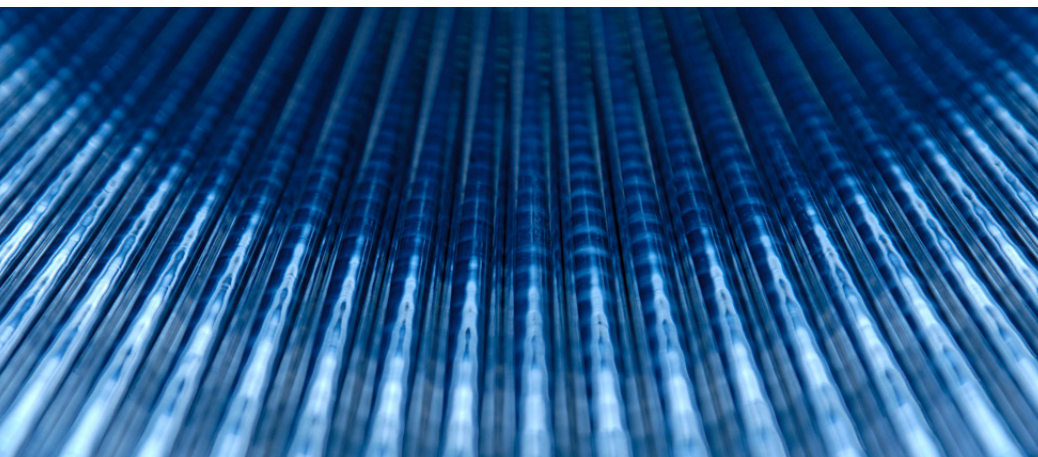
NOMINAL DIMENSIONAL RANGE		
Cold Finished		
Outside Diameter	mm	inch
min	1.6	0.063
max	244.5	9.626
Wall thickness	mm	inch
min	0.1	0.004
max	40	1.575
Hot Finished		
Outside Diameter	mm	inch
min	32	1.260
max	280	11.024
Wall thickness	mm	inch
min	2.8	0.110
max	60	2.362

#### 4.2 Delivery Condition

Pipe and tube are delivered in cold or hot finished condition depending on size and specification. Normally they will be supplied in annealed condition.

#### 4.3 U-bent

Pipe and tube in DMV 928 are also available in U-bent version in lengths of up to 30 m (straight); the high deformability of the material allows cold bending down to a very small bending radius.



## 5. Fabrication

### 5.1 Heat Treatment

Pipe and tube in DMV 928 are solution annealed in the temperature range of 1080°C to 1140°C (1976°F – 2084°F) and then rapidly cooled in air or water. If any additional cold or hot working operations will be done, holding at temperatures in the range of 500°C – 900°C (930°F – 1650°F) is favorable for the mechanical and corrosion properties. As for other stainless steels, cleanliness requirements

(especially contamination from greases) must be strictly observed. The furnace atmosphere must have very low sulphur content.

When subsequently used in moist environment, oxidation must be avoided by

- use of highly reducing atmosphere (cracked ammonia, hydrogen...) or
- removal by pickling after heat treatment.

DMV 928 cannot be hardened by heat treatment.

### 5.2 Bending

DMV 928 is generally suitable for further cold or hot forming.

- For hot bending, the proposed temperature is 1000°C – 1150°C (1832°F – 2102°F) followed by rapid cooling.
- Cold bending of pipe and tube must respect an elevated work-hardening rate compared to the common type 300 stainless steels. This should be taken in account when selecting forming equipment.

Therefore cold formed pipe and tube have to be solution annealed again if the forming degree is > 20% or the R/D ratio is < or equal 2.5. For corrosion reasons, sometimes it is recommended to perform a new solution annealing even following smaller forming degrees.

### 5.3 Welding

DMV 928 has a good weldability. Preheating and heat treatment after welding is normally not necessary. To avoid hot cracks in the weld metal, processes recommended by the filler producers have to be observed. Only approved filler materials should be considered, that have been tested for the

expected application temperature. The calculation values for the filler materials should be respected.

In all cases, the usual cleanliness precautions for welding nickel-based alloys and stainless steels should be taken into account.

Where the subsequent application might be in moist environment, all oxidation must be avoided or eliminated.

## 6. Standards and References

DMV 928 may be delivered in accordance with the commonly used European, American and other international standards.

Our specialists are at your service for any guidance on drawing up your specifications.

Salzgitter Mannesmann Stainless Tubes has delivered DMV 928 pipe and tube to a wide range of worldwide customers in the chemical, petrochemical industries and oil and gas production and processing.

For any specific queries, please contact our sales offices.

While our Company has compiled and organized this data to the best of its knowledge, the data is provided on an "as is" basis only. To the fullest extent permissible by applicable law, we neither make any representation nor give any warranty -neither express, implied or statutory- regarding this data, including, but not limited to, with respect to completeness, accuracy, reliability, security, timeliness, fitness or suitability for any particular purpose, merchantability or any decisions you may make based on it. To the same extent, our company does not assume any other liability regarding this data for any direct, indirect or consequential or any other losses or damages of whatsoever kind (whether based on contract, tort, delict, warranty or any other legal theory) resulting from its use. The use of this data is at your own risk, unless otherwise agreed in writing. Our company reserves the right to modify its content at its own discretion at any time and without prior notice.