

## 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:

- (Petro-) Chemical industries:
  - esp. in the production, concentration and use of phosphoric acid or sulphuric acid
  - in general applications, meeting very aggressive conditions, like acetic acid, vinyl chloride, etc.
- Oil & Gas production and processing:
  - in OCTG (Oil Country Tubular Goods), as tubing and casing for deep sour oil and gas wells
  - for subsea, process and utility services, e.g. for offshore platform equipment
- Maritime applications:
  - e.g. in desalination plants; sea-water systems, heat exchangers using sea water as coolant

## 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 Specifications

- UNS N08028 acc. to ASTM B 668 and ASME SB 668
- 1.4563 acc. to EN 10216-5 and EN 10297-2
- 1.4563 acc. to SEW 400 and VdTÜV Datasheet 483

### 3.2 Chemical Composition

DMV 928 typical values:

	Weight %
<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>	27.00
<b>Ni</b>	32.00
<b>Mo</b>	3.50
<b>Cu</b>	1.00
<b>Fe</b>	Balance

$PRE_N \geq 38$

$(PRE_N = \%Cr + 3.3 \times \%Mo + 16 \times \%N)$

### 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)
<b>1.0% Y.S. min.</b>	245	(36)
<b>U.T.S. min</b>	500	(73)
<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:

Temp. °C (°F)	0.2% Y.S. min. MPa (ksi)	1.0% Y.S. min. MPa (ksi)
<b>100 (212)</b>	190 (27.5)	220 (31.9)
<b>200 (392)</b>	160 (23.2)	190 (27.5)
<b>300 (572)</b>	150 (21.7)	180 (26.1)
<b>350 (662)</b>	145 (21.0)	175 (25.4)
<b>400 (752)</b>	135 (19.6)	165 (23.9)
<b>450 (842)</b>	125 (18.1)	155 (22.5)
<b>500 (932)</b>	120 (17.4)	150 (21.7)
<b>550 (1022)</b>	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 Datasheet, 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 °C (°F)	10 <sup>-6</sup> / K	10 <sup>-6</sup> / °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 °C (°F)	W / (m K)	Btu in / (ft h °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 °C (°F)	10 <sup>3</sup> MPa	10 <sup>3</sup> ksi
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

( ) = calculated values

## 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. YS = 760 MPa (110 ksi) 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)
- Yield: 100% of elastic limit
- Duration: 500 h

## 4 – Supply

### 4.1 Dimensional Range

Outside diameter:

6 mm – 219.1 mm (0.24" – 8.6")

Wall thickness:

1 mm – 30 mm (0.04" – 1.18")

### 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 world-wide customers in the chemical, petrochemical industries and oil and gas production and processing.

For any specific queries, please contact our sales offices.

QUALITY IN ROUND TERMS.

## Contact

### Headquarters

#### Salzgitter Mannesmann Stainless Tubes GmbH

Wiesenstraße 36  
45473 Mülheim an der Ruhr  
Germany

Tel.: +49 208 458 01  
Fax: +49 208 458 2640  
[www.smst-tubes.com](http://www.smst-tubes.com)

### Sales Contacts

#### Salzgitter Mannesmann Stainless Tubes

##### Italia S.r.l.

Via Piò 30  
24062 Costa Volpino (BG)  
Italy

Tel.: +39 035 975 744  
Fax: +39 035 975 803  
Email: [salesitaly@smst-tubes.com](mailto:salesitaly@smst-tubes.com)

#### Salzgitter Mannesmann Stainless Tubes

##### Deutschland GmbH

Wiesenstraße 36  
45473 Mülheim an der Ruhr  
Germany

Tel.: +49 208 458 2611  
Fax: +49 208 458 2641  
Email: [salesgermany@smst-tubes.com](mailto:salesgermany@smst-tubes.com)

#### Salzgitter Mannesmann Stainless Tubes

##### France SAS

Route de Semur  
21500 Montbard  
France

Tel.: +33 3 80 89 52 00  
Fax: +33 3 80 89 52 26  
Email: [salesfrance@smst-tubes.com](mailto:salesfrance@smst-tubes.com)

#### Salzgitter Mannesmann Stainless Tubes

##### USA, Inc.

12050 West Little York  
Houston Texas 77041  
USA

Tel.: +1 713 466 7278  
Fax: +1 713 466 3769  
Email: [salesusa@smst-tubes.com](mailto:salesusa@smst-tubes.com)

Whilst every care has been taken in compiling the technical information in this brochure, due to the continuing development and complex nature of the various factors used, it is given for information only. Our company cannot be held responsible for the information contained herein and our customers should carefully check for themselves where necessary in order to make the appropriate selection, bearing in mind the conditions governing the fabrication of our alloys as well as the conditions in service. Information held in this datasheet can be changed without notice.