



# DMV 4335

## 1. Application

DMV 4335 Nitric Acid Grade is an austenitic stainless steel with extremely low carbon and impurity levels. Principle use is within the Fertilizer industry for nitric acid production, also Water Processing and Nuclear waste reprocessing. Used for Heat Exchanger tubing and process pipe.

Carbon <b>C</b> 0.015% max	Chromium <b>Cr</b> 24-26%	Nickel <b>Ni</b> 20-21%	
Nitrogen <b>N</b> 0.10% max	Molybdenum <b>Mo</b> 0.10% max		
Manganese <b>Mn</b> 1.0% max	Silicon <b>Si</b> 0.15% max	Phosphorus <b>P</b> 0.020% max	Sulfur <b>S</b> 0.005% max

## 2. Main characteristics

- Excellent resistance to corrosion in nitric acid
- Excellent resistance to intergranular corrosion
- Good resistance to pitting
- Good weldability
- Excellent workability

High corrosion resistance in Nitric acid environments is achieved through high Chromium, low Carbon and low impurity levels. Depending on the application (Nuclear/conventional) the inclusion levels are modified by use of special melting procedures from standard EAF-AOD process up to ESR or VAR remelting. The increased level of Nickel improves resistance against stress corrosion cracking.

## 3. Properties

### 3.1 Standards

- UNS: S31002
- EN Number: 1.4335
- W.Nr.: 1.4335

### 3.2 Product Specifications

- ASTM A213 and A312
- EN 10216-5
- SEW 400 (Feb 1991)

NOMINAL DIMENSIONAL RANGE		
<b>Cold Finished</b>		
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
<b>Hot Finished</b>		
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

Specific dimensions by grade available upon request.

### 3.3 Chemical composition

Chemical composition (%).

	%
<b>C</b>	≤0.015
<b>Si</b>	≤0.15
<b>Mn</b>	≤1.0
<b>P</b>	≤0.020
<b>S</b>	≤0.005
<b>Cr</b>	24-26
<b>Ni</b>	20-21
<b>Mo</b>	≤0.10
<b>N</b>	≤0.10

### 3.4 Mechanical Properties at 20°C (68°F) in solution annealed condition.

	MPa	ksi
<b>0.2% Y.S. min.</b>	205	30
<b>1.0% Y.S. min.</b>	210	31
<b>U.T.S. min</b>	500	72
<b>Elongation A% min.</b>	35	

Based on L0 = 5.65/S0, where L0 is the original gauge length and S0 the original cross-section area.

#### Impact resistance

Due to its austenitic microstructure, DMV 4335 has very good impact strength both at room temperature and at cryogenic temperatures.

Tests have demonstrated that the steel fulfils requirements according to the European standards EN 13445-2 and EN 10216-5.

### 3.5 Physical Properties

Density at 20°C (68°F)	
g/cm <sup>3</sup>	lbs/in <sup>3</sup>
7.9	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)	15.5	8.5
200	(392)	16.5	9
300	(572)	17	9.5
400	(752)	17	9.5

Thermal Conductivity			
Temperature		W/(mK)	Btu in/ (ft h °F)
°C	(°F)		
20	(68)	13	7.5
100	(212)	15	8.5
200	(392)	17	10
300	(572)	19	11.5
400	(752)	21	12.5

Modulus of Elasticity			
Temperature		10 <sup>3</sup> MPa	10 <sup>3</sup> ksi
°C	(°F)		
20	(68)	195	28.3
100	(212)	190	27.6
200	(392)	182	26.4
300	(572)	174	25.1
400	(752)	166	23.8

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

### 3.6 Corrosion resistance

With the development of DMV 4335 being focussed on nitric acid service the resultant high Chromium content and low impurity levels ensures improved corrosion resistance compared with conventional austenitic type 304L.

The increased level of Nickel makes DMV 4335 improves resistance to stress corrosion cracking (SCC). DMV 4335 is also highly resistant to intergranular corrosion even after application of long term sensitisation tests such as the Huey test.

Corrosion rate: 0.10 g/m<sup>2</sup>h = 0.12 mm/year = 0.5 mpy in 65% Nitric acid (Huey test) as per EN ISO 3651-1 (5 boiling periods of 48h each).

DMV 4335 also demonstrates significantly increased pitting corrosion resistance compared to type 304L.

### 4 Fabrication

High levels of formability which makes DMV 4335 very suitable for 'U' bent Heat Exchanger tubing where cold working/forming does not impair general corrosion resistance. Annealing is not normally required after bending/ cold working unless being used in environments where Stress Corrosion Cracking (SCC) has increased risk in which case a stress relieving anneal is recommended.

#### 4.1 Heat Treatment

Our tubes are supplied in the solution annealed condition. If subsequent operations take place such as machining or welding and further heat treatment is required then we suggest

Stress relieving: 850-950°C ( 1560-1740°F) for 10-15 minutes then rapid air cool or alternatively 1000-1050°C ( 1830-1920°F) for approx. 1 minute then rapid air cool.

Solution annealing is typically 1000-1100°C (1830-2010°F) for 5-20 minutes then rapid air cool in or water.

#### 4.2 Welding

In common with austenitic stainless grades DMV 4335 has low thermal conductivity and high thermal expansion characteristics which be considered when developing weld procedures to minimise potential joint distortion. The refined, high purity analysis of DMV 4335 will improve susceptibility to weld hot cracking.

Use our online Grade Comparison tool for the full range of DMV grades.

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