VDM Metals

A company of ACERINOX

VDM® Alloy 20
Nicrofer 3620 Nb

Material Data Sheet No. 4117 **Revision 01**
April 2021

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Nicrofer 3620 Nb

VDM® Alloy 20 is a low carbon, niobium stabilised austentic nickel-iron-chromium alloy with alloying additions of copper and molybdenum.

VDM® Alloy 20 is characterized by:

- excellent resistance to sulphuric and phosphoric acids
- good resistance to intergranular corrosion
- very good resistance to chloride-ion induced stress-corrosion cracking
- good resistance to pitting and crevice corrosion
- good mechanical properties at both ambient and elevated temperatures, up to approximately 500 °C (930 °F).

Designations and standards

Standard	Material designation
DIN EN	2.4660 - NiCr20CuMo
UNS	N08020
ISO	FeNi35Cr20Cu4Mo2

Product form	DIN EN	ASTM	ASME
Plate, sheet	17750	B 463	SB 463
Strip	17750	B 463	SB 463
Rod, bar	17752	B 472 B 473	SB 473
Wire	17753	B 473 B 475	

Table 1 – Designations and standards

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	Cu	Mo	Co	Nb+Ta	P	S
Min.	32.0	19.0	Bal.				3.0	2.0		8 x C		
Max.	38.0	21.0		0.07	2.0	1.0	4.0	3.0	1.5	1.0	0.025	0.015

The chemical composition in other specifications may differ slightly in some elements.

Table 2 – Chemical composition (%) acc. to DIN 17744

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)
8.1 g/cm³	1,380 – 1,420 °C	max. 1.002
0.29 lb/in³	2,520 – 2,600 °F	

Temperature		Specific heat		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	J / kg · K	Btu / lb · °F	W / m · K	Btu · in / sq. ft · h · °F	µΩ · cm	GPa	10³ ksi	10^{-6} / K	10^{-6} / °F
20	68	456	0.109	11.5	80	107	202	29.3		
93	200		0.111		89			28.7		8.3
100	212	466		13.0		110	198		15.0	
200	392	476		14.8		113	192		15.6	
204	400		0.114		103			27.8		8.8
300	572	485		16.5		116	185		16.0	
316	600		0.116		117			26.7		8.9
400	752	492		18.2		119	179		16.4	
427	800		0.118		130			25.7		9.2
500	932	500		19.8		121	172		16.7	
538	1,000		0.120		142			24.5		9.4
600	1,112	508		21.5		123	164		17.1	
649	1,200		0.122		154			23.2		9.6
700	1,292	(515)		(23.0)		(125)	(157)		(17.4)	

Table 3 – Typical physical properties at room temperature and increased temperatures

Microstructural properties

VDM® Alloy 20 has a face-centred cubic structure. The balanced chemical composition and optimum annealing temperature promote the formation of niobium carbides and ensure that the corrosion resistance is not impaired by sensitisation.

Mechanical properties

The following mechanical properties are applicable to VDM® Alloy 20 in the stabilized-annealed condition.

Temperature		Yield strength $R_{p\,0.2}$		Yield strength $R_{p\,1.0}$		Tensile strength R_m		Elongation A
°C	°F	MPa	ksi	MPa	ksi	MPa	ksi	%
20	68	240	35	280	40.6	550	80	30
93	200		30.5		35.8		75.8	
100	212	210		250		520		
149	300		28.3		34.1		73.2	
150	302	195		235		505		
200	392	180		220		495		
204	400		26.1		31.9		71.5	
250	482	170		210		480		
260	500		24.2		29.9		69.2	
300	572	160		200		470		
316	600		22.5		28.3		66.7	

Table 4 – Minimum mechanical properties of VDM® Alloy 20 (plate thickness up to 25 mm [1 in.]).

Corrosion resistance

VDM® Alloy 20 has excellent corrosion resistance to sulphuric, phosphoric and organic acids and to aqueous salt solutions. The resistance to nitric acid is also good.

Due to the controlled chemical composition, the alloy also has excellent resistance to such forms of corrosion as intergranular corrosion. The molybdenum content ensures good resistance to pitting and crevice corrosion.

Optimum corrosion resistance can only be achieved if the material is used in a clean, metallically bright state.

Applications

VDM® Alloy 20 is used in a wide variety of applications up to temperatures of approximately 500 °C (930 °F).

Typical applications are:

- equipment for the manufacture of sulphuric acid and for processes based on sulphuric acid
- extraction columns in the production of amino acid and the processing of pharmaceuticals
- production of synthetic polymers
- equipment for food processing to protect against contamination

Fabrication and heat treatment

VDM® Alloy 20 is readily hot and cold formable, machinable and weldable.

Heating
It is very important that the workpiece be clean and free from any contaminant before and during heating.

The material may become embrittled if heated in the presence of contaminants such as sulphur, phosphorus, lead and other low-melting-point metals. Sources of contamination include marking and temperature-indicating paints and crayons, lubricating grease and fluids, and fuels.

Fuels must be low in sulphur; e.g. natural and liquefied petroleum gases should contain less than 0.1 % by mass of sulphur. Fuel oils containing no more than 0.5 % by mass of sulphur are also suitable.

The furnace atmosphere should be neutral to slightly oxidising and must not fluctuate between oxidising and reducing. Flame impingement on the metal must be avoided.

Hot forming
VDM® Alloy 20 can be hot formed in the temperature range between 1,150 and 900 °C (2,100 to 1,650 °F) with subsequent rapid cooling in water or air. Heat treatment after hot forming is recommended to achieve optimum corrosion properties and fine grain structure. For heating, the workpieces should be placed in the furnace which has already been heated to the setpoint. Holding time approx. 60 minutes per 100 mm thickness.

Cold forming
VDM® Alloy 20 exhibits higher work hardening rates than austenitic stainless steels. This must be taken into account when selecting the forming equipment, and the workpiece should be in the annealed condition. Intermediate annealing is necessary for high levels of cold working. In the case of cold forming above 15 %, a new stabilizing annealing must be carried out.

Heat treatment
Soft or stabilising annealing should be carried out in the temperature range 920 to 960 °C (1,690 to 1,760 °F), preferably at about 950 °C (1,740 °F). Rapid cooling in water is required to achieve optimum corrosion properties. For thicknesses below approx. 3 mm, rapid air cooling may also be used. Stress-relieving annealing is carried out at approx. 540 °C (1,000 °F). The above-mentioned cleanliness requirements must be observed for each heat treatment.

Descaling and pickling
Oxides of VDM® Alloy 20 and discoloration adjacent to welds are more adherent than on stainless steels. Grinding with very fine abrasive belts or discs is recommended. Before pickling in a nitric/hydroflouric acid mixture, oxides must be broken up by grit-blasting, fine grinding or by pretreatment in a fused salt bath.

Machining
VDM® Alloy 20 should be machined in annealed condition. The alloy's high work-hardening rate should be considered, i.e. only low surface cutting speeds are possible compared with low-alloy standard austenitic stainless steel. Tools should be engaged at all times. Sufficient chipping depth is important to undercut the previously created work-hardened zone.

Welding information

The weldability of VDM® Alloy 20 is excellent. Joining can be performed by all the conventional welding processes.

Joining
VDM® Alloy 20 can be welded by all the conventional methods. Proven welding processes are: GTAW (TIG), GMAW (MIG), Plasma, PHW, SMAW. Pulsed arc welding is the preferred technique. Prior to welding, material should be in annealed condition, clean and free from scale, grease and marking paints. A zone approximately 25 mm (1 in.) wide on each side of the joint should be ground to bright metal. Sometimes tarnishing can be removed by brushing the joint in the warm condition.

Care must be taken to ensure low heat input and rapid heat dissipation. The interpass temperature should not exceed 120 °C (250 °F). Neither pre- nor post-weld heat treatment is required.

Welding filler
The use of the following fillers is recommended for gas-shielded welding methods:

GTAW/GMAW:

VDM® FM 625 (W.-Nr. 2.4831)
DIN EN ISO 18274: S Ni 6602 (SG-NiCr 21 Mo 9 Nb)
UNS N06625
AWS A 5.14: ERNiCrMo-3

or

VDM® WS 59 (W.-Nr. 2.4607)
DIN EN ISO 18274: Ni 6059 (SG-NiCr23Mo16)
AWS A 5.14: ERNiCrMo-13

Electrodes (SMAW):

W.-Nr. 2.4621
EL-NiCr20Mo9Nb
AWS A5.11 ENiCrMo -3

or

W.-Nr. 2.4609
EL-NiCr22Mo16
AWS A5.11 ENiCrMo-13

When selecting coated electrodes, those with a low Si content should be used. To achieve optimum properties, the GTAW or GMAW process is preferred.

Availability

VDM® Alloy 20 is available in all the standard mill product forms.

Plate, sheet

Delivery condition: Hot or cold rolled, annealed, de-scaled resp. pickled

Condition	Thickness mm (in)	Width mm (in)	Length mm (in)	Piece weight kg
Cold rolled	1 – 7 (0.04 – 0.28)	1,000 – 2,500 (39.4 – 98.43)	≤ 12,500 (492.13)	
Hot rolled	3 – 100 (0.12 – 3.94)[1)]	1,000 – 2,500 (39.4 – 98.43)	≤ 12,500 (492.13)	≤ 2,700 (106.3)[2)]

[1)] 2 mm thickness on request
[2)] Piece wights up to 4,500 kg on request

Strip

Delivery condition: Cold-rolled, heat-treated, pickled or bright annealed

Thickness mm (in)	Width mm (in)	Coil - inside diameter mm			
0.02 – 0.15 (0.0008 – 0.006)	4 – 230 (0.16 – 9.06)	300	400	500	–
0.15 – 0.25 (0.006 – 0.01)	4 – 720 (0.16 – 28.34)	300	400	500	–
0.25 – 0.6 (0.01 – 0.024)	6 – 750 (0.24 – 29.5)	–	400	500	600
0.6 – 1 (0.024 – 0.04)	8 – 750 (0.32 – 29.5)	–	400	500	600
1 – 2 (0.04 – 0.08)	15 – 750 (0.6 – 29.5)	–	400	500	600
2 – 3 (0.08 – 0.12)	25 – 750 (0.98 – 29.5)	–	400	500	600

Rolled sheet – separated from the coil – are available in lengths from 250 to 4,000 mm (9.84 to 157.48 in).

Rod

Delivery condition: Forged, rolled, drawn, heat-treated, oxidized, de-scaled or pickled, machined, peeled, ground or polished

Condition	Outside diameter mm (in)	Length mm (in)
Rolled, drawn	6 – 125 (0.24 – 31.5)	≤ 12,000 (472.44)
Forged	125 – 600 (0.47 – 23.62)	≤ 7,500 (295.28)

Wire

Delivery condition: bright drawn, ¼ hard to hard, bright annealed in rings, containers, on spools and headstocks

Drawn mm (in)	Hot rolled mm (in)
0.16 – 10 (0.006 – 0.4)	5.5 – 19 (0.22 – 0.75)

Legal notice

30.04.2021

Publisher
VDM Metals International GmbH
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