VDM Metals

A company of ACERINOX

VDM® Alloy 25

Conicro 5010 W

Material Data Sheet No. 6002 **Revision 02**

April 2024

VDM® Alloy 25
Conicro 5010 W

VDM® Alloy 25 is a high-temperature cobalt-base alloy containing chromium, tungsten and nickel additions.

VDM® Alloy 25 is characterized by:

- Excellent high temperature strength up to 1100°C (2000°F)
- Excellent resistance in sulphidising gas atmospheres
- Good resistance to scaling and oxidation up to 1100°C (2000°F)
- Very good resistance to hydrochloric, nitric, phosphoric and sulphuric acids, as well as to salt spray at elevated temperatures
- Good formability and weldability

Designations and standards

Standard	Material designation
DIN EN	2.4964 – CoCr20W15Ni
UNS	R30605

Product form	DIN EN	AMS	AFNOR
Sheet, plate	65021	5537	AIR 9162 AIR 9165
Rod, bar	65038	5759	AIR 9162 AIR 9165
Wire		5796	

Table 1 – Designations and standards

Chemical composition

	Ni	Cr	Fe	C	Mn	Si[1)]	Co	W	P	S
Min.	9.0	19.0		0.05	1.0		bal.	14.0		
Max.	11.0	21.0	3.0	0.15	2.0	0.3		16.0	0.015	0.015

1) AMS allows max. 1.0

Table 2 – Chemical composition (%)

Physical properties

Density	Melting range	Relative magnetic permeability at 20 °C (68 °F)	Specific heat
9.1 g/cm³ 0.329 lb/in³	1,330 – 1,410 °C 2,425 – 2,570 °F	< 1.00	385 J/kgK 0.092 Btu/lb°F

Temperature		Thermal conductivity		Electrical resistivity	Modulus of elasticity		Coefficient of thermal expansion	
°C	°F	W / m · K	Btu · in / sq. ft · h · °F	µΩ · cm	GPa	10³ ksi	10^{-6} / K	10^{-6} / °F
0	32							
20	68	9.7	67	89	226	32.8		
93	200		76			32.2		6.8
100	212	11.2		93	221		12.3	
200	392	13.0		96	215		12.9	
204	400		90			31.2		7.2
300	572	14.6		98	208		13.3	
316	600		103			29.9		7.5
400	752	16.5		99	199		13.8	
427	800		118			28.6		7.7
500	932	18.4		101	191		14.2	
538	1,000		132			27.3		8.0
600	1,112	20.5		104	183		14.6	
649	1,200		148			25.8		8.2
700	1,292	22.4		107	175		15.1	
760	1,400		164			24.7		8.6
800	1,472	24.4		108	166		15.7	
871	1,600		180			23.2		9.0
900	1,652	26.6		103	158		16.4	
982	1,800		193			21.8		9.5
1,000	1,832	28.9		95	148		17.1	
1,093	2,000		215			20.5		9.8
1,100	2,012	31.0		102	140		17.8	

Table 3 – Typical physical properties

Microstructural properties

VDM® Alloy 25 has a face-centered cubic structure. High-temperature strength is obtained both by solid solution hardening with tungsten and by precipitation of carbides.

Mechanical properties

The following mechanical properties apply to VDM® Alloy 25 in the solution-treated condition and indicated size ranges. Specifies properties of material outside these size ranges are subject to special enquiry.

Product Form	Dimensions		Yield strength $R_{p\ 0.2}$		Tensile strength R_m		Elongation A	Hardness Brinell
	mm	in	MPa	ksi	MPa	ksi	%	Max HB
Sheet	0.25-3.0	0.01-0.12						
Strip	0.25-2.5	0.01-0.10	380	55	900	130	Transverse 30	282[1)]
Plate	≤ 12.5	≤ 0.5	330	48			Transverse 35	
Bar Ø	≤ 100	≤ 4			860	125		275
Forgings	≤ 75	≤ 3	310	45			Longitudinal 35	248

[1)] AIR 9165

Table 4 – Minimum mechanical properties at room temperature according to AMS

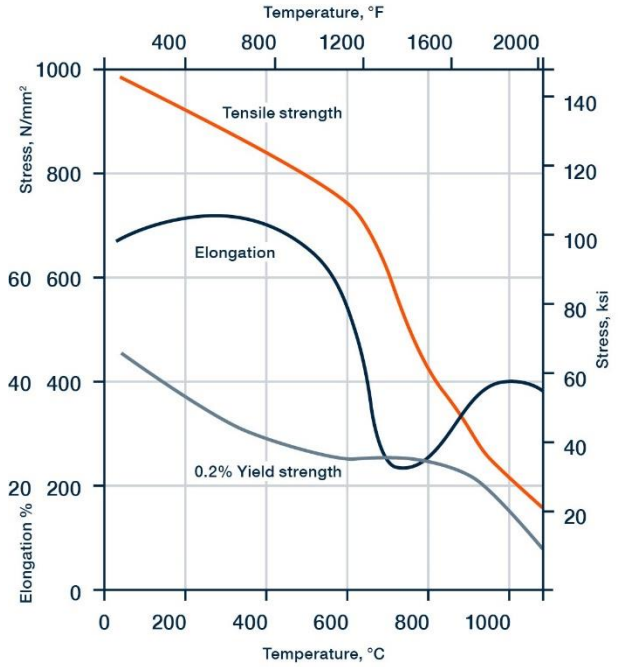

Figure 1 – Typical short-time properties of solution-treated VDM® Alloy 25 sheet at room and elevated temperatures.

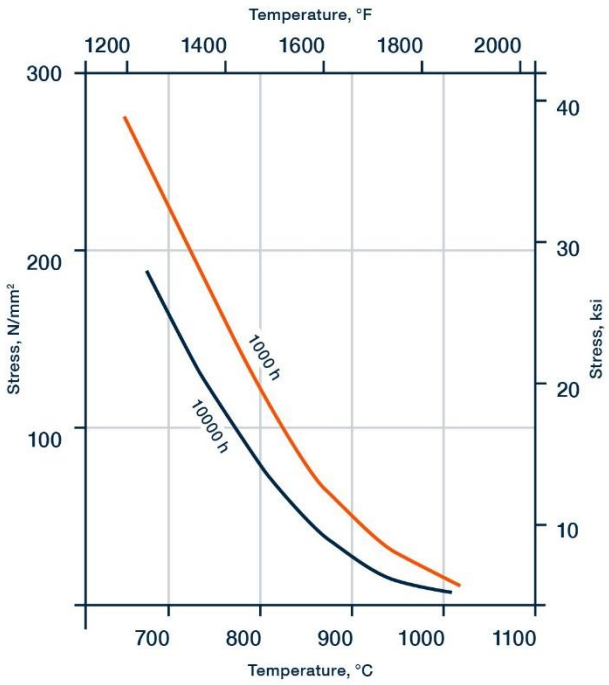

Figure 2 – Typical creep-rupture properties of solution treated VDM® Alloy 25.

Stress-rupture requirements

Temperature	Stress	Time	Elongation
815°C (1500°F)	165 N/mm² (24 ksi)	min 24h	min 10%

Bending test for sheet in the solution-treated condition without cracking (mandrel diameter)

Up to 1.27 mm (0.05 in)	> 1.27 to 4.76 mm (> 0.05 to 0.187 in)
180° 1.5 x thickness	120° 2 x thickness

Corrosion resistance

VDM® Alloy 25 exhibits excellent resistance to hot corrosion by sulphidation, and is especially resistant to oxidation under static and cyclic conditions up to 1,100 °C (2,000 °F), even under high gas velocities. This corrosion resistance, combined with outstanding mechanical properties, make this alloy suitable for many high-temperature applications. VDM® Alloy 25 also displays unusually good resistance to chemicals such as hydrochloric, phosphoric, sulphuric and nitric acids at certain temperatures and concentrations, as well as to salt sprays.

Applications

VDM® Alloy 25 is used for applications requiring high mechanical strength at high temperatures. Recommended service temperature range is up to 1,100 °C (2,000 °F).

Typical fields of application for VDM® Alloy 25 are:

- Components for industrial and aircraft gas turbines, including combustion cans, housings, turbine rings, after-burners, casings and ducts
- Air heaters
- Furnace muffles, rolls and radiant tubes
- High-temperature heat exchangers, valves and springs
- Equipment for chemical processes at high temperatures

Fabrication and heat treatment

VDM® Alloy 25 is readily fabricated by usual industrial procedures. Hot and cold working, however, require high-power machines, owing to the high strength of the material.

Heating
It is important that the workpieces are clean and free of any contaminants before and during heat treatment. Sulfur, phosphorus, lead and other low-melting-point metals can result in damage during the heat treatment of the material. This type of contamination is also contained in marking and temperature-indicating paints or pens as well as in lubricating grease, oils, fuels and similar materials. The sulfur content of fuels must be as low as possible. Natural gas should contain less than 0.1% by weight of sulfur. Heating oil with a maximum sulfur content of 0.5% by weight is also suitable. Electric furnaces are to be preferred due to precise temperature control and lack of contaminants due to fuel. Gas-fired furnaces are acceptable if impurities are at low levels. The furnace temperature should be set between neutral and slightly oxidizing and should not change between oxidizing and reducing. The workpieces must not come in direct contact with flames.

Hot forming
VDM® Alloy 25 may be hot-worked in a temperature range of 1,230 to 1,000 °C (2,250 to 1,840 °F). Cooling should be by water quenching or as fast as possible.

Solution treatment is recommended after hot working to ensure maximum creep resistance.
When the furnace has reached temperature, the material should be soaked for 60 minutes per 100 mm (4 in) of thickness. After soaking for the required time the metal should be withdrawn immediately and works within the specified range. If the metal temperature falls below the minimum working temperature, it must be reheated.

Cold forming
Cold working should be carried out on solution-treated material. VDM® Alloy 25 has a significantly higher work hardening rate than other widely used austenitic stainless steels and the forming equipment must be adapted accordingly.
When cold working is performed, interstage annealing may become necessary.

Heat treatment
Solution annealing should take place at temperatures between 1,180 and 1,220 °C (2,160 and 2,230 °F). Water quenching or rapid air cooling is recommended. During any heating operation, the precautions outlined earlier regarding cleanliness must be observed.

Descaling and pickling
Oxides of VDM® Alloy 25 and discoloration adjacent to welds are more adherent than on stainless steels. Grinding using extremely fine abrasive belts or grinding discs is recommended. It is imperative that grinding burns be avoided. Before pickling in nitric-hydrofluoric acid mixtures, the oxide layers should be destroyed by abrasive blasting or fine grinding, or pre-treated in in a fused salt bath. The pickling baths used should be carefully monitored with regard to concentration and temperature.

Machining
VDM® Alloy 25 should be machined in the heat-treated condition. Because of the considerably elevated tendency toward work hardening in comparison with low-alloy austenitic stainless steels, a low cutting speed and a feed level that is not too high should be selected and the cutting tool should be engaged at all times. An adequate depth of cut is important in order to cut below the previously formed strain-hardened zone. Optimum heat dissipation through the use of large quantities of suitable, preferably aqueous, lubricants has considerable influence on a stable machining process.

Welding information

VDM® Alloy 25 can be welded by gas tungsten-arc (GTAW/TIG), and plasma welding. Pulsed arc welding is the preferred technique. Prior to welding, material should be in the solution-treated condition, clean and free from scale, grease, marking paints etc. A zone approximately 25 mm (1 in) wide on each side of the joint should be ground to bright metal. Low heat inputs is necessary. Interpass temperature should not exceed 120 °C (250 °F). Neither pre- nor post-weld heat treatment is required.

Availability

VDM® Alloy 25 is available in all 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 weights 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

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Disclaimer
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