

VDM® Alloy 25

Conicro 5010 W

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

VDM® Alloy 25 is characterized by:

- Excellent mechanical properties up to 110°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 | | | 14.0 | | |
| Max. | 11.0 | 21.0 | 3.0 | 0.15 | 2.0 | 0.3 | bal. | 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/cm ³ 0.329 lb/in ³ | 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 | 10 ³ 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 $R_{p0.2}$ | | 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

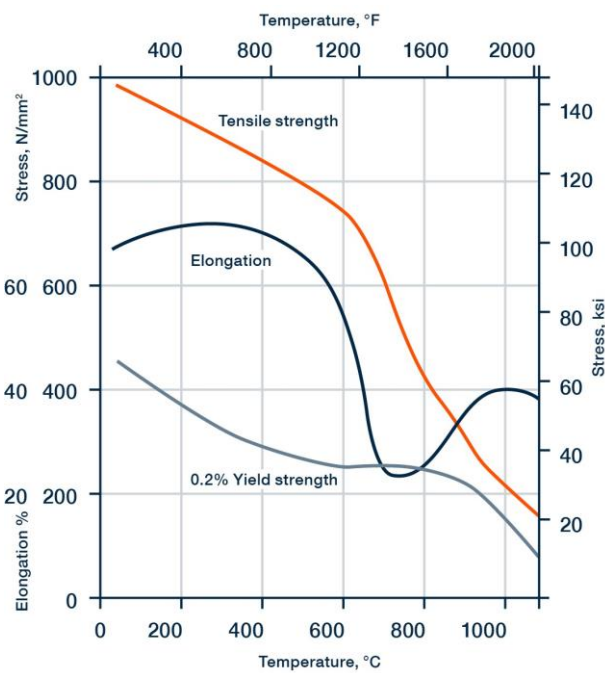


Figure 1 – Typical short-time properties of solution-treated VDM® Alloy 25 sheet at room and elevated temperatures.

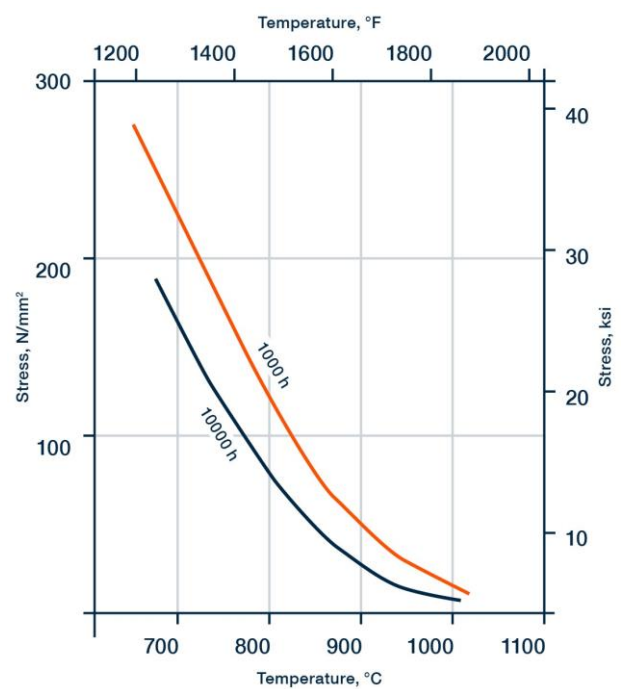


Figure 2 – Typical creep-rupture properties of solution treated VDM® Alloy 25.

Stress-rupture requirements

| Temperature | Stress | Time | Elongation |
|----------------|--------------------------------|---------|------------|
| 815°C (1500°F) | 165 N/mm ² (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 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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