Conicro 5010 W – alloy 25

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Conicro 5010 W is a high-temperature cobalt-base alloy containing chromium, tungsten and nickel additions.

Conicro 5010 W is characterised by:

- excellent mechanical properties 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

Designation and standards

Country	Material designation				Specification				
National standards		Chemical composition	Tube and pipe seamless	Tube and pipe welded	Sheet and plate	Rod and bar	Strip	Wire	Forgings
France									
AFNOR	KC 20 WN				AIR 9162 AIR 9165	AIR 9161 AIR 9165			AIR 3385 AIR 9165
Germany	**W.-Nr. 2.4964** CoCr20W15Ni								
DIN					65021	65038			LN 65035
WL	2.4964				Teil 1 Teil 100	Teil 2 Teil 100		Teil 3 Teil 100	Teil 2 Teil 100
United Kingdom									
BS					HR 240	HR 40			HR 40
USA	UNS R30605								
ASTM									
ASME									
AMS					5537	5759		5796	5759
ISO	TC 17/SC 4 Doc.706 Type C 82								

Chemical composition (%)

	Ni	Cr	Fe	C	Mn	Si*	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

*AMS allows max 1.0

Conicro 5010 W – alloy 25

Physical properties

Typical physical properties at room and elevated temperatures.

Density	9.1 g/cm³	0.329 lb/in³
Melting range	1330–1410 °C	2425–2570 °F
Permeability at 20 °C/68 °F (RT)	< 1.00	
Specific heat	385 J/kg K	0.092 Btu/lb °F

Temperature T		Thermal conductivity		Electrical resistivity		Modulus of elasticity		Coefficient of thermal expansion between room temperature and T	
°C	°F	W/m K	Btu in / ft² h °F	μΩ cm	Ω circ mil / ft	kN/mm²	10³ ksi	10⁻⁶/K	10⁻⁶/°F
0	32								
20	**68**	9.7	67	89	535	226	32.8		
93	**200**		76		553		32.2		6.8
100	212	11.2		93		221		12.3	
200	392	13.0		96		215		12.9	
204	**400**		90		577		31.2		7.2
300	572	14.6		98		208		13.3	
316	**600**		103		587		29.9		7.5
400	752	16.5		99		199		13.8	
427	**800**		118		595		28.6		7.7
500	932	18.4		101		191		14.2	
538	**1000**		132		614		27.3		8.0
600	1112	20.5		104		183		14.6	
649	**1200**		148		638		25.8		8.2
700	1292	22.4		107		175		15.1	
760	**1400**		164		647		24.7		8.6
800	1472	24.4		108		166		15.7	
871	**1600**		180		638		23.2		9.0
900	1652	26.6		103		158		16.4	
982	**1800**		193		572		21.8		9.5
1000	1832	28.9		95		148		17.1	
1093	**2000**		215		608		20.5		9.8
1100	2012	31.0		102		140		17.8	

Conicro 5010 W – alloy 25

Mechanical properties

The following properties are applicable to Conicro 5010 W in the solution-treated condition and indicated size ranges. Specifies properties of material outside these size ranges are subject to special enquiry.

Form	Dimensions		Tensile strength		0.2% Yield strength		1.0% Yield strength		Elongation A_5	Brinell hardness
	mm	inches	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi	%	max HB
Sheet	0.25–3.0	0.01–0.12	900	130	380	55	–	–	transverse 30	282*
Strip	0.25–2.5	0.01–0.10								
Plate	≤ 12.5	≤ 0.5			330	48	–	–	transverse 35	–
Bar ø	≤ 100	≤ 4	860	125						275
Forgings	≤ 75	≤ 3			310	45	–	–	longitudinal 35	248

*AIR 9165

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

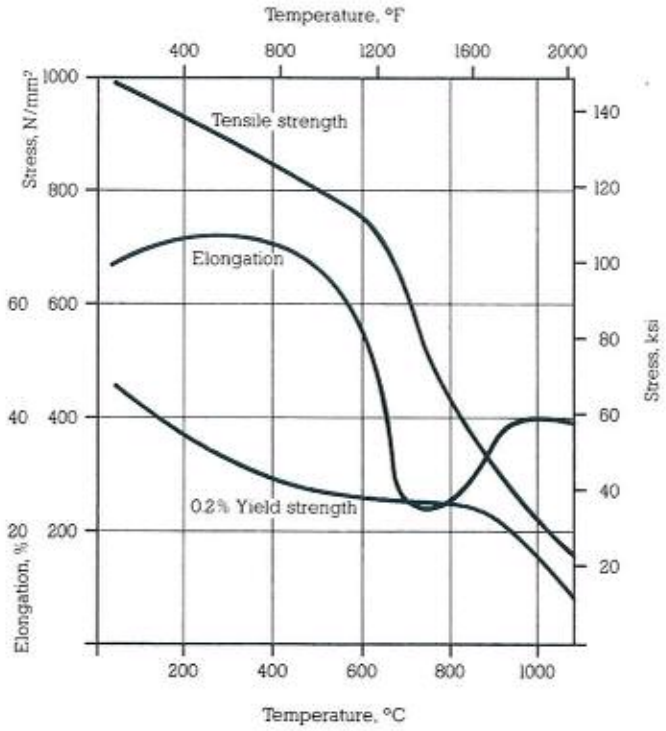

Fig. 1 – Typical short-time properties of solution-treated Conicro 5010 W sheet at room and elevated temperatures.

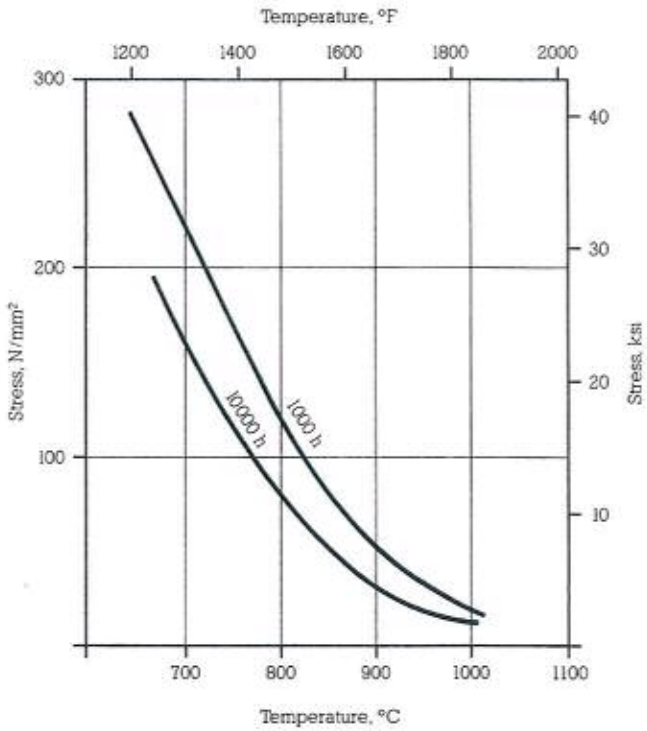

Fig. 2 – Typical creep-rupture properties of solution treated Conicro 5010 W.

Conicro 5010 W – alloy 25

Stress-rupture requirements:

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

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

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

Metallurgical structure

Conicro 5010 W has a face-centred cubic structure.

High-temperature strength is obtained both by solid solution hardening with tungsten and by precipitation of carbides.

Corrosion resistance

Conicro 5010 W exhibits excellent resistance to hot corrosion by sulphidation, and is especially resistant to oxidation under static and cyclic conditions up to 1100 °C (2000 °F), even under high gas velocities. This corrosion resistance, combined with outstanding mechanical properties, make this alloy suitable for many high-temperature applications.

Conicro 5010 W 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

Conicro 5010 W is used for applications requiring high mechanical strength at high temperatures.
Recommended service temperature range is up to 1100 °C (2000 °F).

Typical applications are:

- components for industrial and aircraft gas turbines, including combustion cans, housings, turbine rings, afterburners, 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

Conicro 5010 W is readily fabricated by usual industrial procedures. Hot and cold working, however, require high-power machines, owing to the high strength of the material.

The weldability of Conicro 5010 W is excellent. Joining can be performed by all conventional welding processes.

Heating

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

Conicro 5010 W 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, and town gas 0.25 g/m³ maximum, of sulphur. Fuel oils containing no more than 0.5 % by mass of sulphur are satisfactory.

Electric furnaces are desirable due to their close control of temperature and freedom from contamination. Gas-fired furnaces are acceptable if impurities are at low levels.

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 working

Conicro 5010 W may be hot-worked in the range 1230 to 1000 °C (2250 to 1840 °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 worked within the specified range. If the metal temperature falls below the minimum working temperature, it must be reheated.

Conicro 5010 W – alloy 25

Cold working
Cold working should be carried out on solution-treated material. Conicro 5010 W has a much higher work-hardening rate than austenitic stainless steel and the forming equipment must be adapted accordingly.

When cold working is performed, interstage annealing may become necessary.

Heat treatment
Solution treatment should be carried out in the temperature range 1180 to 1220 °C (2160 to 2230 °F). Water quenching or rapid air cooling is recommended.

During any heating operation, the precautions outlined earlier regarding cleanliness must be observed.

Descaling
Oxides of Conicro 5010 W are more adherent than those of stainless steel. Both mechanical and chemical methods of descaling may be applied. Mechanical methods should be avoided which produce either contamination of the metal, or a highly-deformed surface layer.

Before pickling in a nitric/hydrofluoric acid mixture, oxides must be broken up by grit-blasting or by pretreatment in a fused salt bath.

Machining
Conicro 5010 W should be machined in the solution-treated 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. Heavy feeds are important in getting below the work-hardened 'skin'.

Joining
Conicro 5010 W 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 input is necessary. Interpass temperature should not exceed 120 °C (250 °F).

Neither pre- nor post-weld heat treatment is required.

The following welding products are recommended:

GTAW/GMAW	Conicro S 5010	W.-Nr. 2.4964 CoCr20W15Ni AMS 5796

Availability

Conicro 5010 W is available in all standard mill product forms.

Technical publications

The following publications, amongst others, concerning Conicro 5010 W may be obtained from Krupp VDM GmbH:
„Korrosion von Nickel, Kobalt und Nickel- und Kobalt-Basislegierungen."
U. Brill, Krupp VDM 1992

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