VDM Metals

VDM® Alloy 75
Nicrofer 7520

Material Data Sheet No. 4035
June 1994 Edition

Nicrofer® 7520 – alloy 75

The high-temperature alloy Nicrofer 7520 is a creep-resistant nickel-chromium-iron alloy with controlled carbon content and a small addition of titanium.

Nicrofer 7520 is characterized by:

- excellent resistance to oxidizing atmospheres at temperatures up to 1100 °C (2000 °F)
- high scaling resistance up to 1000 °C (1830 °F)
- good mechanical properties at temperatures up to 1000 °C (1830 °F)
- good metallurgical stability

Designations and standards

Country National standards	Material designation	Specification							
		Chemical composition	Tube and pipe		Sheet and plate	Rod and bar	Strip	Wire	Forgings
			seamless	welded					
D DIN VdTÜV	**W.-Nr. 2.4951** NiCr20Ti	**17742**	**17751**	**17751**	**17750**	**17752**	**17750**		**17754**
F AFNOR	NC 20 T								
UK BS			HR 403		HR 203	HR 5 2 HR 504	HR 203	2 HR 504	HR 5
USA ASTM ASME AMS	UNS N06075								
ISO	NiCr20Ti	9722	6207		6208	9723	6208	9724	9725

Table 1 – Designations and standards.

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	Cu	Al	Ti
min.	bal.	19.0		0.08		0.3			0.2
max.		21.0	5.0	0.13	1.0	0.7	0.5	0.3	0.6

Table 2 – Chemical composition (wt.-%).

Physical properties

Density Melting range	8.4 g/cm³ 1340 – 1380°C	0.303 lb/in.³ 2440 – 2520 °F
Permeability at 20 °C / 68 °F (RT)	≤ 1.001	

Temperature (T)		Specific heat		Thermal conductivity		Electrical resistivity		Modulus of elasticity		Coefficient of thermal expansion between room temperature and T	
°C	°F	J / kg K	Btu / lb °F	W / m K	Btu in. / ft² h °F	µ Ω cm	Ω circ mil / ft	kN / mm²	10³ ksi	10⁻⁶ / K	10⁻⁶ / °F
0	32										
20	**68**	445	0.106	12.1	84	109	655	221	32.0		
93	**200**		0.110		94		665		31.5		6.4
100	212	465		13.7		110		217		11.7	
200	392	490		15.6		112		211		12.6	
204	**400**		0.117		108		674		30.5		7.0
300	572	515		17.1		115		204		13.2	
316	**600**		0.124		120		695		29.4		7.4
400	752	540		18.8		117		197		13.8	
427	**800**		0.131		134		705		28.3		7.7
500	932	570		20.5		117		190		14.3	
538	**1000**		0.138		147		700		27.1		8.1
600	1112	600		22.6		115		182		14.8	
649	**1200**		0.146		164		692		25.8		8.4
700	1292	620		24.5		115		174		15.4	
760	**1400**		0.152		178		692		24.4		8.7
800	1472	650		26.4		115		165		16.0	
871	**1600**		0.160		192		692		22.8		9.1
900	1652	675		28.1		115		154		16.6	
982	**1800**		0.166		205		696		20.7		9.6
1000	1832	700		29.9		116		140		17.5	

Table 3 – Typical physical properties at room and elevated temperatures.

Nicrofer® 7520 – alloy 75

Mechanical properties

The following properties are applicable to Nicrofer 7520 in the solution-treated condition and indicated size ranges. Specified 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/mm^2	ksi	N/mm^2	ksi	N/mm^2	ksi	%	HB
Plate	≤ 20	≤ 0.8	650	94.3	240	34.8	270	39.2	25	≤ 230
Sheet, strip	≤ 2.5	≤ 0.1								
Tube	wall ≤ 5	≤ 0.2								
Rod, bar	≤ 100	≤ 4								
Forgings (cross section)	≤ 8000 mm^2	≤ 124 $in.^2$					–	–		

Table 4 – Minimum mechanical properties at room temperature according to DIN 17750/51/52/54.

Temperature (T)		Plate, sheet, strip					Rod, bar, forgings				
		Tensile strength		0.2 % Yield strength		Elong. A_5	Tensile strength		0.2 % Yield strength		Elong. A_5
°C	°F	N/mm^2	ksi	N/mm^2	ksi	%	N/mm^2	ksi	N/mm^2	ksi	%
93	**200**		116		65	30		102		38	40
100	212	800		450		30	700		260		40
200	392	790		445		30	680		230		40
204	**400**		115		64	30		99		33	40
300	572	780		435		30	680		225		41
316	**600**		112		62	30		99		32	41
400	752	750		425		30	675		220		42
427	**800**		107		62	30		97		32	41
500	932	680		400		30	660		220		40
538	**1000**		94		56	30		92		32	40
600	1112	580		350		30	600		220		40
649	**1200**		73		44	35		79		31	43
700	1292	400		250		40	470		200		53

This table is continued on the next page.

Temperature (T)		Plate, sheet, strip					Rod, bar, forgings				
		Tensile strength		0.2 % Yield strength		Elong. A_5	Tensile strength		0.2 % Yield strength		Elong. A_5
°C	°F	N/mm²	ksi	N/mm²	ksi	%	N/mm²	ksi	N/mm²	ksi	%
760	**1400**		38		25	60		49		24	65
800	1472	200		130		85	270		130		70
871	**1600**		18		12	85		25		12	65
900	1652	110		70		85	140		70		61
982	**1800**		10		6	77		13		6	57
1000	1832	60		30		75	80		30		55

Table 5 – Typical short-time mechanical properties of Nicrofer 7520 at elevated temperatures and in the solution-treated condition.

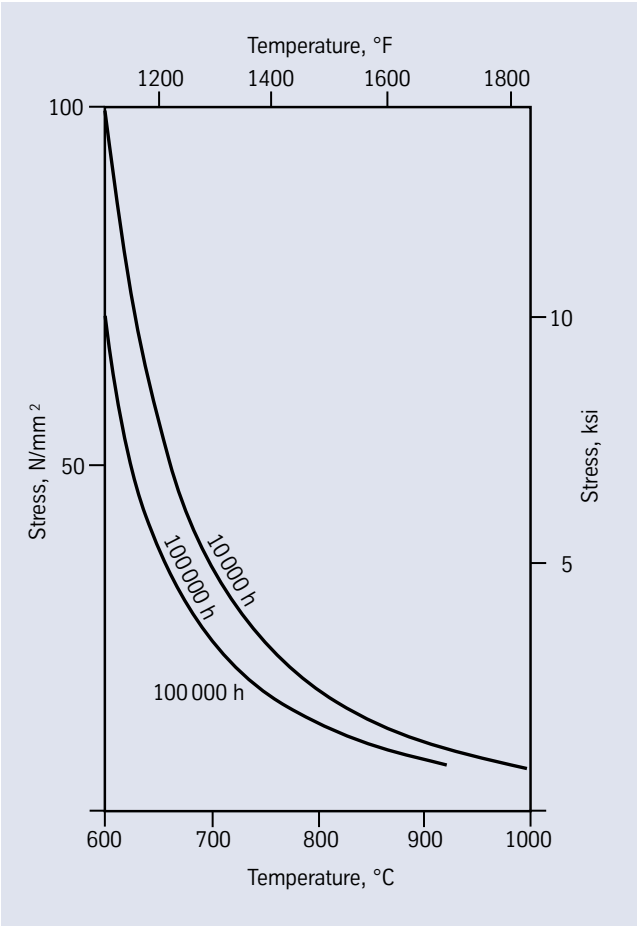

Fig. 1 – Typical creep-rupture properties of Nicrofer 7520, solution treated.

Metallurgical structure
Nicrofer 7520 has a face-centered cubic structure. Chromium carbides, nitrides and carbonitrides can occur in the matrix.

Corrosion resistance
Nicrofer 7520 shows excellent oxidation and scaling resistance up to 1100 °C (2000 °F). It forms an adherent oxide layer which protects the surface against progressive attack.

Applications
The high scaling resistance and good creep properties of Nicrofer 7520 give it wide application in high temperature service up to 1100 °C (2000 °F).

Typical applications are:
- components for industrial and aircraft gas turbines (casings, combustion chambers, ducting)
- industrial furnace components
- high temperature fasteners, springs, dies and cores
- thermocouple sheathing

Fabrication and heat treatment
Nicrofer 7520 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 Nicrofer 7520 is good. Joining can be performed by all conventional welding processes.

Nicrofer® 7520 – alloy 75

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

Nicrofer 7520 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 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 oxidizing and must not fluctuate between oxidizing and reducing. Flame impingement on the metal must be avoided.

In all heating operations the material may be charged into the furnace at temperature.

Hot working
Nicrofer 7520 may be hot-worked in the range 1220 to 900 °C (2230 to 1650 °F). Cooling should be by water quenching or as fast as possible.

Heat treatment is required after hot working to ensure maximum creep resistance and optimum properties.

The material may be charged into the furnace at maximum working temperature. 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.

Cold working
Cold working should be carried out on heat-treated material. Nicrofer 7520 has a higher work-hardening rate than austenitic stainless steel, and the forming equipment must be designed accordingly.

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

Heat treatment
Heat treatment should be carried out in the temperature range 1000 to 1050 °C (1830 to 1920 °F). Water quenching is desirable for maximum creep resistance.

Interstage annealing may be performed at temperatures up to 1050 °C (1920 °F).

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

Descaling
Oxides of Nicrofer 7520 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/hydroflouric acid mixture, oxides must be broken up by grit-blasting or by pretreatment in a fused salt bath.

Machining
Nicrofer 7520 should be machined in the heat-treated condition. The alloy´s high work-hardening rate shoud 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
Nicrofer 7520 can be welded by all conventional processes, including gas tungsten-arc (GTAW/TIG), gas metal-arc (GMAW/MIG) and shielded metal-arc welding (SMAW/MMA). Pulsed arc welding is the preferred technique.

Prior to welding, material should be in the heat-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 Nicrofer S 7020	W.-Nr. 2.4806 SG-NiCr20Nb AWS A 5.14 ERNiCr-3
SMAW	W.-Nr. 2.4648 EL-NiCr19Nb AWS A 5.11 ENiCrFe-3

Availability
Nicrofer 7520 is available in all standard mill product forms.

Imprint

Date of publication
June 1994

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