Nicrofer® 5923 hMo - alloy 59

Material Data Sheet No. 4030
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Corrosion-resistant alloy

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Nicrofer® 5923 hMo – alloy 59

Nicrofer 5923 hMo is a nickel-chromium-molybdenum alloy with an extra-low carbon and silicon content. The alloy was developed by ThyssenKrupp VDM and has excellent corrosion resistance and high mechanical strength.

Nicrofer 5923 hMo
is characterized by:

- outstanding resistance to a wide range of corrosive media under oxidising and reducing conditions
- excellent resistance to pitting and crevice corrosion and freedom from chloride-induced stress-corrosion cracking
- excellent resistance to mineral acids, such as nitric, phosphoric, sulphuric and hydrochloric acids and in particular to sulphuric and hydrochloric acid mixtures
- excellent resistance to contaminated mineral acids
- good corrosion resistance to hydrochloric acid over the whole concentration range up to 40 °C (104 °F).
- good workability and weldability without susceptibility to post-weld cracking
- approval for pressure-vessel use with wall temperatures of – 196 to 450 °C (– 320 to 840 °F)
- approved in NACE Standard MR0175, to the highest Level VII for sour gas service

Designation and standards

Country National standards	Material designation	Specification							
		Chemical composition	Tube and pipe seamless	Tube and pipe welded	Sheet and plate	Rod and bar	Strip	Wire	Forgings
D **VdTÜV**	**W.-Nr. 2.4605** NiCr23Mo16Al	505			505	505			505
F AFNOR									
UK BS									
USA ASTM ASME	UNS N06059		B 622 SB 622	B 619/626 SB 619/626	B 575 SB 575	B 574 SB 574	B 575 SB 575		B 564 SB 564
ISO									

Table 1 – Designation and standards.

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	Mo	Co	Al	P	S
min.	bal.	22.0					15.0		0.1		
max.		24.0	1.5	0.010	0.5	0.10	16.5	0.3	0.4	0.015	0.005

Table 2 – Chemical composition (wt.-%) according to ASTM.
Note: Some compositional limits of other specifications may vary slightly.

Physical properties

Density	8.6 g/cm³	0.311 lb/in.³
Melting range	1310 – 1360 °C	2390 – 2480 °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	$\frac{J}{kg\ K}$	$\frac{Btu}{lb\ °F}$	$\frac{W}{m\ K}$	$\frac{Btu\ in.}{ft^2\ h\ °F}$	µ Ω cm	$\frac{Ω\ circ\ mil}{ft}$	$\frac{kN}{mm^2}$	10^3 ksi	$\frac{10^{-6}}{K}$	$\frac{10^{-6}}{°F}$
20	68	414	0.099	10.4	72	126	758	210	30.5		
93	200		0.101		83		766		30.0		6.6
100	212	425		12.1		127		207		11.9	
200	392	434		13.7		129		200		12.2	
204	400		0.104		96		776		29.0		6.8
300	572	443		15.4		131		196		12.5	
316	600		0.106		105		788		28.3		7.0
400	752	451		17.0		133		190		12.7	
427	800		0.108		119		800		27.4		7.1
500	932	459		18.6		134		185		12.9	
538	1000		0.110		132		806		26.4		7.2
600	1112	464		20.4		133		178		13.1	

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

Mechanical properties

The following properties are applicable to Nicrofer 5923 hMo in the solution-treated condition and indicated size ranges.

Specified properties of material outside these size ranges are subject to special enquiry.

Product	Dimensions		Yield strength $R_{p0.2}$		Yield strength $R_{p1.0}$		Tensile strength R_m		Elongation A_5*
	mm	inches	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi	%
Sheet, strip* cr	0.5 – 6.4	0.018 – 0.25							
Plate hr	5.0 – 30	3/16 – 1 3/16	340	49	380	55	690	100	40
Rod, bar, forgings	≤ 100	≤ 4							
Rod, bar, forgings	> 100	> 4	320	46	360	52	650	94	40

*Elongation values for strip products are normally determined based on an initial gauge length of 50 mm (2 in.). These values are lower, dependent on the alloy, than the corresponding A_5 values by an order of approx. 10 %.

Table 4 – Minimum mechanical properties at room temperature according to VdTÜV data sheet 505.

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Temperature (T)		Yield strength [1] $R_{p0.2}$		Yield strength [1] $R_{p1.0}$		Tensile strength [2] R_m		Elongation A_5
°C	°F	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi	%
93	**200**		≥ 43		≥ 48		95 (91)	
100	212	≥ 290		≥ 330		650 (620)		
200	392	≥ 250		≥ 290		615 (585)		
204	**400**		≥ 36		≥ 42		89 (85)	50
300	572	≥ 220		≥ 260		580 (550)		
316	**600**		≥ 31		≥ 37		84 (80)	
400	752	≥ 190		≥ 230		545 (515)		
427	**800**		≥ 26		≥ 32		77 (74)	
450	842	≥ 175		≥ 215		525 (495)		

[1] For plates above 30 mm and up to 50 mm ($1^{3}/_{16}$ to 2 in.) thickness the yield strength values should be reduced by 20 N/mm² (3 ksi).
[2] Values for rods in brackets.

Table 5 – Mechanical properties at elevated temperatures according to VdTÜV data sheet 505 for thicknesses up to 30 mm ($1^{3}/_{16}$ in.).

Material temperatures		Forgings, rod, sheet & plate, strip	
°C	°F	N/mm²	ksi
38	**100**		25.0
93	**200**		25.0
100	212	172	
149	**300**		24.7
200	392	161	
204	**400**		23.3
260	**500**		22.0
300	572	147	
316	**600**		20.9
343	**650**		20.4
371	**700**		19.8
399	**750**		19.4
400	752	134	

For welded tube and pipe a factor of 0.85 should be applied.

Table 6 – Maximum allowable stress values according to ASME.

ISO V-notch impact toughness

Average values at RT: ≥ 225 J/cm²
at -196 °C (-320 °F): ≥ 200 J/cm²

One of the main reasons why nickel-base alloys are selected is for their performance under corrosive conditions. Though sometimes underestimated, characteristic design data frequently also plays an important role in selecting a particular alloy. As Fig. 1 shows, $R_{p0.2}$ yield strength data for Nicrofer 5923 hMo is up to 20% higher than that of other similar alloys. This allows for a corresponding reduction in wall thickness which results in less material usage and thus in a more cost-effective design.

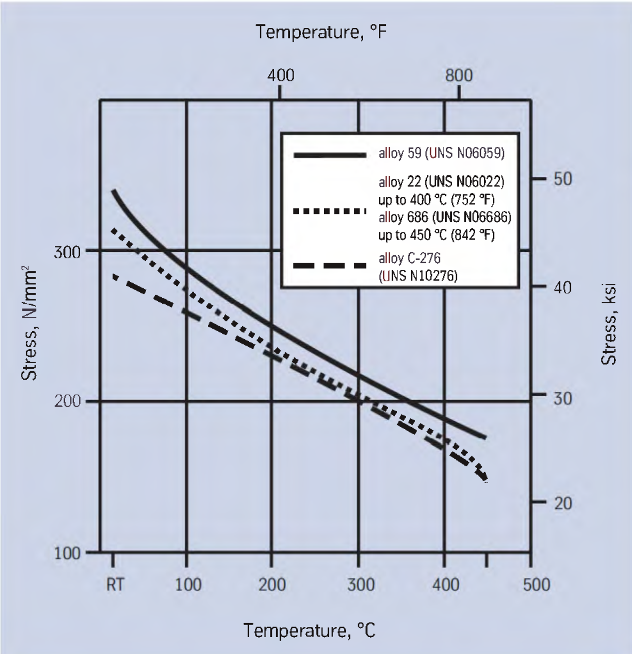

Fig. 1 – $R_{p0.2}$ yield strength for Nicrofer 5923 hMo in comparison with other nickel-base alloys.

Metallurgical structure

Nicrofer 5923 hMo has a face-centered-cubic structure.

Corrosion resistance

The nickel-chromium-molybdenum alloy Nicrofer 5923 hMo with extremely low silicon and carbon contents is not prone to grainboundary precipitation during hot forming and welding. The alloy is therefore suitable for many chemical process applications in both oxidizing and reducing media.

Because of its high nickel, chromium and molybdenum contents, the alloy exhibits excellent resistance to attack by chloride ions.

Most standardized corrosion tests relate to oxidizing conditions, under which Nicrofer 5923 hMo has been demonstrated to be superior to other Ni-Cr-Mo alloys. However, the favorable behavior of Nicrofer 5923 hMo in some reducing media such as, for example, boiling 10% sulfuric acid, in which Nicrofer 5923 hMo exhibits a corrosion rate more than three times lower than that of other well established Ni-Cr-Mo alloys, suggests also promising prospects for the use of this material in reducing media in the CPI. The excellent corrosion resistance of Nicrofer 5923 hMo in hydrochloric acid is shown in Fig. 3.

Optimum corrosion resistance can be obtained only if the material is in the correct metallurgical condition and possesses a clean structure.

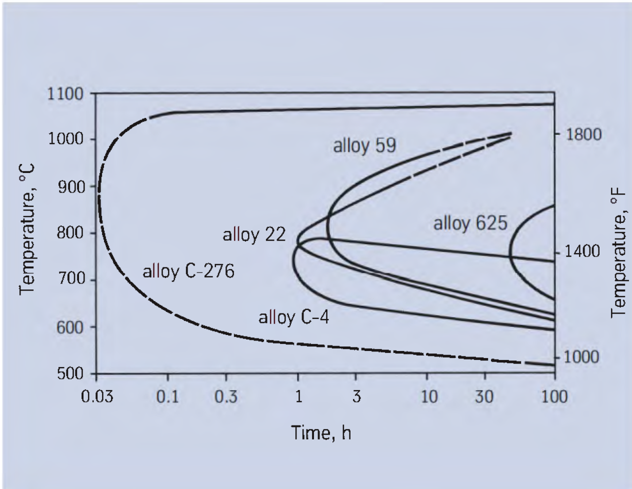

Fig. 2 – Time-temperature-sensitization (TTS) diagrams of nickel-chromium-molybdenum alloys tested according to ASTM G-28 A.

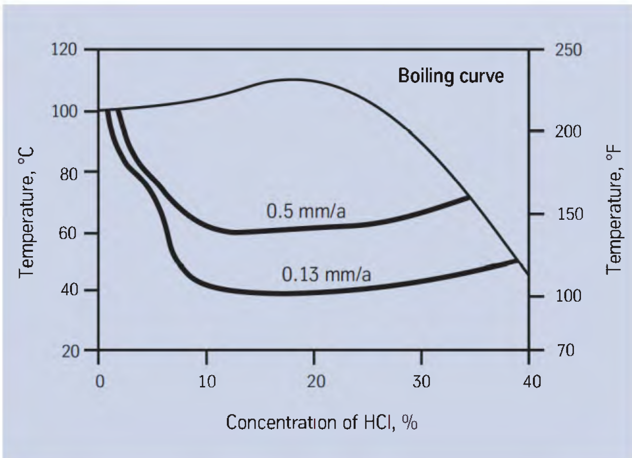

Fig. 3 – Isocorrosion diagram of Nicrofer 5923 hMo in hydrochloric acid based on static immersion test results.

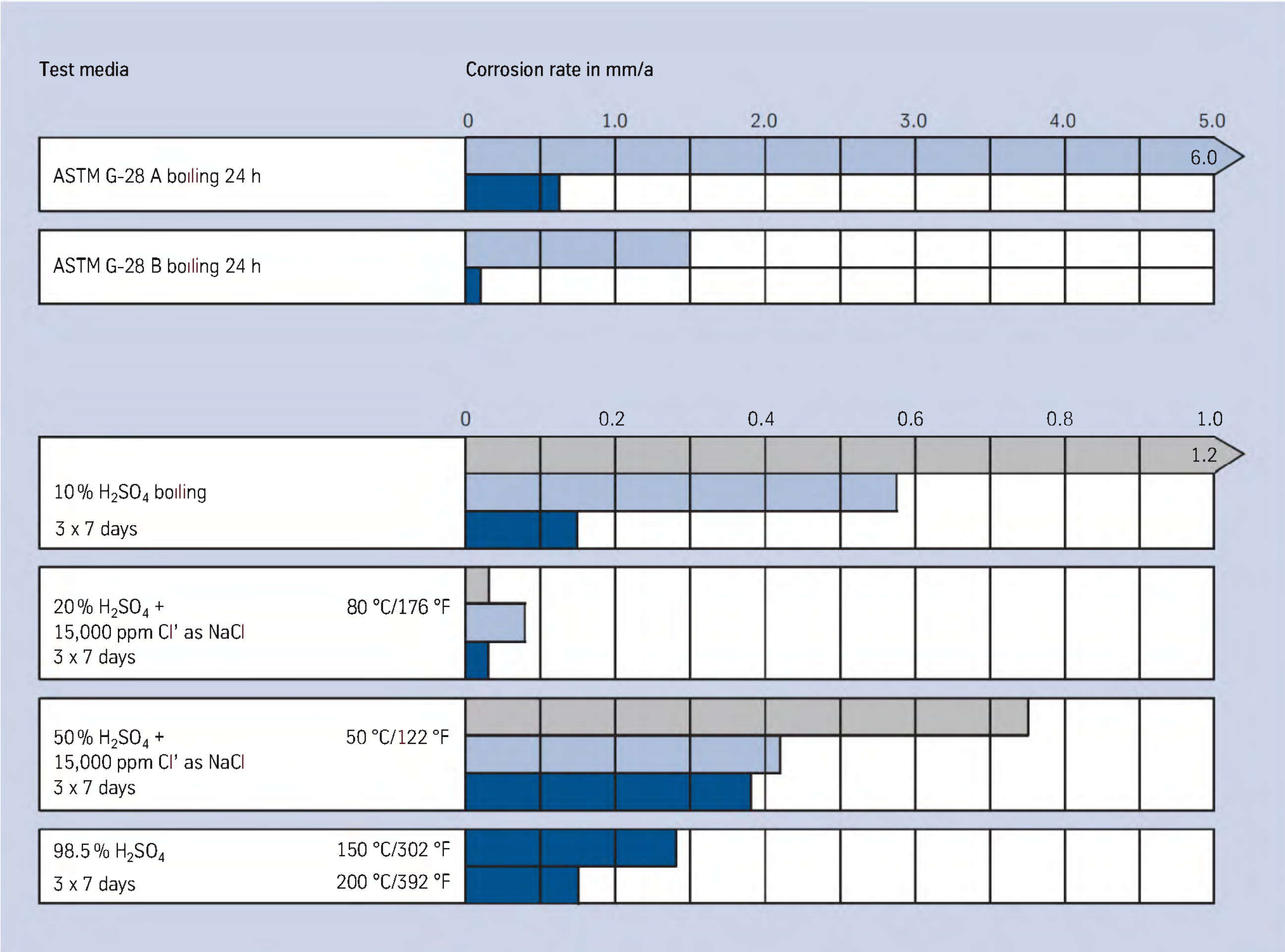

Fig. 4 – Comparison of corrosion rates in a variety of environments: alloy 625 ▭, alloy C-276 ▭, Nicrofer 5923 hMo ▬.

Alloy	CPT	CCT
Nicrofer 5923 hMo – alloy 59	> 120 °C / > 248 °F	110 °C / 230 °F
Nicrofer 5716 hMoW – alloy C-276	115 – 120 °C / 239 – 248 °F	105 °C / 221 °F
Nicrofer 6020 hMo – alloy 625	100 °C / 212 °F	85 – 95 °C / 185 – 203 °F

Table 7 – Critical pitting temperature (CPT) and crevice corrosion temperature (CCT) in 'Green Death' test solution. (7 vol.% H_2SO_4 + 3 vol.% HCl + 1 % $CuCl_2$ + 1 % $FeCl_3$ x 6 H_2O after repeatedly heating for 24 hours using 5 °C (9 °F) temperature increments).

Applications

Nicrofer 5923 hMo has a wide range of applications in the chemical, petrochemical and pharmaceutical industry, in energy production and in pollution control equipment.

Typical applications are:

- components in organic processes involving chlorides, particularly when acid chloride catalysts are employed
- digesters and bleaching plants in the pulp and paper industry
- scrubbers, reheaters, dampers, wet fans and agitators for incinerator gas and flue gas desulphurisation (FGD)
- equipment and components in sour gas service
- reactors for acetic acid and acetic anhydride
- sulphuric acid coolers

Fabrication and heat treatment

Nicrofer 5923 hMo can readily be hot- and cold worked and machined.

Heating

Workpieces must be clean and free from all kinds of contaminants before and during any heat treatment.

Nicrofer 5923 hMo may become impaired if heated in the presence of contaminants such as sulphur, phosphorus, lead and other low-melting-point metals. Sources of such contaminants include marking and temperature-indicating paints and crayons, lubricating grease and fluids and fuels.

Fuels must be as low in sulphur as possible. Natural gas should contain less than 0.1 wt.-% sulphur. Fuel oils with a sulphur content not exceeding 0.5 wt.-% are suitable.

Due to their close control of temperature and freedom from contamination, thermal treatments in electric furnaces under vacuum or an inert gas atmosphere are to be preferred. Treatments in an air atmosphere and alternatively in gas-fired furnaces are acceptable though, if contaminants are at low levels so that a neutral or slightly oxidizing furnace atmosphere is attained. A furnace atmosphere fluctuating between oxidizing and reducing must be avoided as well as direct flame impingement on the metal.

Hot working

Nicrofer 5923 hMo may be hot worked in the temperature range 1180 to 950 °C (2160 to 1740 °F). Cooling after hot working should be by water quenching.

Heat treatment after hot working is recommended to ensure maximum corrosion resistance. For heating up workpieces should be charged into the furnace at maximum working temperature (solution annealing temperature).

Cold working

For cold working the material should be in the annealed condition. Nicrofer 5923 hMo has a higher work-hardening rate than austenitic stainless steels. This should be taken into account when selecting forming equipment.

Interstage annealing may be necessary with high degrees of cold forming. After cold working with more than 15 % deformation solution annealing is required before use.

Heat treatment

Solution heat treatment should be carried out in the temperature range 1100 to 1180 °C (2010 to 2160 °F), preferably at about 1120 °C (2050 °F).

Water quenching or rapid air cooling for thicknesses above 1.5 mm (0.06 in.) is recommended and is essential for maximum corrosion resistance.

For any thermal treatment the material should be charged into the furnace at temperature. Also for any thermal treatment operation the precautions concerning cleanliness mentioned earlier under **'Heating'** must be observed.

Descaling and pickling

Oxides of Nicrofer 5923 hMo and discoloration adjacent to welds are more adherent than on stainless steels. Grinding with very fine abrasive belts or discs is recommended. Care should be taken to prevent tarnishing.

Before pickling which may be performed in a nitric/hydroflouric acid mixture with proper control of pickling time and temperature, the surface oxid layer must be broken up by abrasive blasting or by carefully performed grinding or by pretreatment in a fused salt bath.

Machining

Nicrofer 5923 hMo should be machined in solution-treated condition. As the alloy exhibits a high work-hardening rate only low cutting speeds should be used compared with low-alloyed standard austenitic stainless steels. Tools should be engaged at all times. An adequate depth of cut is important in order to cut below the previously formed work-hardened zone.

Welding

When welding nickel-base alloys, the following instructions should be adhered to:

Workplace

The workplace should be in a separate location, well away from the areas where carbon steel fabrication takes place. Maximum cleanliness and avoidance of draughts are paramount.

Auxiliaries, clothing

Clean fine leather gloves and clean working clothes should be used.

Tools and machinery

Tools used for nickel-base alloys and stainless steels must not be used for other materials. Brushes should be made of stainless material. Fabricating and working machinery such as shears, presses or rollers should be fitted with means (felt, cardboard, plastic sheet) of avoiding contamination of the metal with ferrous particles, which can be pressed into the surface and thus lead to corrosion.

Cleaning
Cleaning of the base metal in the weld area (both sides) and of the filler metal (e. g. welding rod) should be carried out with acetone.

Trichlorethylene (TRI), perchlorethylene (PER), and carbon tetrachloride (TETRA) must not be used.

Edge preparation
This should preferably be done by mechanical means, i. e. turning, milling or planing; plasma cutting is also possible. However, in the latter case the cut edge (the face to be welded) must be finished off cleanly. Careful grinding without overheating is permissible.

Included angle
The different physical characteristics of nickel-base alloys and special stainless steels compared with carbon steel generally manifest themselves in a lower thermal conductivity and a higher rate of thermal expansion. This should be allowed for by means of, among other things, wider root gaps or openings (1 – 3 mm), while larger included angles (60 – 70°), as shown in Fig. 5, should be used for individual butt joints owing to the viscous nature of the molten weld metal and to counteract the pronounced shrinkage tendency.

Striking the arc
The arc should only be struck in the weld area, e. g. on the faces to be welded or on a run-out piece. Striking marks lead to corrosion.

Welding process
Nicrofer 5923 hMo can be joined to itself and to many other metals by conventional welding processes. These include GTAW (TIG), plasma arc, GMAW (MIG/MAG and MAG-Tandem) and SMAW (MMA). Pulsed arc welding is the preferred technique. For the MAG processes the use of a multi-component shielding gas ($Ar+He+H_2+CO_2$) is recommended.

For welding, Nicrofer 5923 hMo should be in the annealed condition and be free from scale, grease and markings. When welding the root, care should be taken to achieve best-quality root backing (argon 99.99), so that the weld is free from oxides after welding the root. Any heat tint should be removed preferably by brushing with a stainless steel wire brush while the weld metal is still hot.

Filler metal
For the gas-shielded welding processes, filler metal with the same composition as the base metal is recommended:

Bare electrodes: Nicrofer S 5923 – FM 59
W.-Nr. 2.4607
SG-NiCr23Mo16
AWS A5.14: ERNiCrMo-13

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

For overlay welding by the electro-slag method (RES):
Weld strip: Nicrofer B 5923 – WS 59
W.-Nr. 2.4607
UP-NiCr23Mo16
AWS A5.14: ERNiCrMo-13

Welding parameters and influences (heat input)
Care should be taken that the work is performed with a deliberately chosen, low heat input as indicated in Table 8 by way of example. Use of the stringer bead technique should be aimed at. Interpass temperature should be kept below 150 °C (300 °F).

The welding parameters should be monitored as a matter of principle.

The heat input Q may be calculated as follows:

$$Q = \frac{U \times I \times 60}{v \times 1000} \text{ (kJ/cm)}$$

U = arc voltage, volts
I = welding current, amps
v = welding speed, cm/min.

Consultation with ThyssenKrupp VDM's Welding Laboratory is recommended.

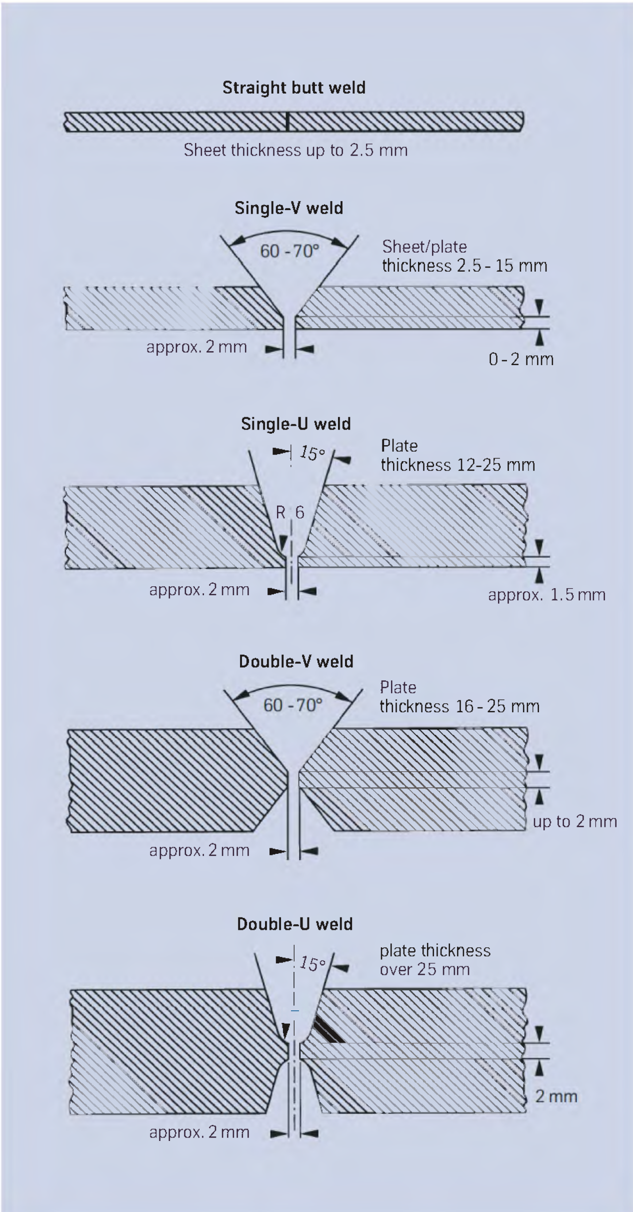

Fig. 5 – Edge preparation for welding of nickel-base alloys and special stainless steels.

Sheet/ plate thick-ness mm	Welding process	Filler metal Diameter mm	Filler metal Speed m/min.	Welding parameters Root pass A	Root pass V	Intermediate and final passes A	Intermediate and final passes V	Welding speed cm/min.	Flux/ shielding gas rate l/min	Plasma-gas rate l/min.	Plasma-nozzle diameter mm
3.0	Manual GTAW	2.0		90	10	110 – 120	11	10 – 15	Ar W3[1] 8 – 10		
6.0	Manual GTAW	2.0 – 2.4		100 – 110	10	120 – 130	12	10 – 15	Ar W3[1] 8 – 10		
8.0	Manual GTAW	2.4		110 – 120	11	130 – 140	12	10 – 15	Ar W3[1] 8 – 10		
10.0	Manual GTAW	2.4		110 – 120	11	130 – 140	12	10 – 15	Ar W3[1] 8 – 10		
3.0	Autom. GTAW	1.2	0.5	manual		150	10	25	Ar W3[1] 15 – 20		
5.0	Autom. GTAW	1.2	0.5	manual		150	10	25	Ar W3[1] 15 – 20		
2.0	Hot wire GTAW	1.0	0.3			180	10	80	Ar W3[1] 15 – 20		
10.0	Hot wire GTAW	1.2	0.45	manual		250	12	40	Ar W3[1] 15 – 20		
4.0	Plasma arc	1.2	0.5	165	25			25	Ar W3[1] 30	Ar W3[1] 3.0	3.2
6.0	Plasma arc	1.2	0.5	190 – 200	25			25	Ar W3[1] 30	Ar W3[1] 3.5	3.2
8.0	MIG/MAG GMAW	1.0	approx. 8	GTAW		130 – 140	23 – 27	24 – 30	MAG[2] MIG: argon 18 – 20		
10.0	MIG/MAG GMAW	1.2	approx. 5	GTAW		130 – 150	23 – 27	20 – 26	MAG[2] MIG: argon 18 – 20		
6.0	SMAW	2.5		40 – 70	approx. 21	40 – 70	approx. 21				
8.0	SMAW	2.5–3.25		40 – 70	approx. 21	70 – 100	aprrox. 22				
16.0	SMAW	4.0				90 – 130	approx. 22				

[1] Argon or argon + max. 3 % hydrogen
[2] For MAG welding use of the shielding gas Cronigon He30S or Argomag-Ni, for example, is recommended.
In all gas-shielded welding operations, ensure adequate back shielding.
These figures are only a guide and are intended to facilitate setting of the welding machines.

Table 8 – Welding parameters (guide values).

Welding process	Heat input per unit length kJ/cm	Welding process	Heat input per unit length kJ/cm
GTAW, manual, fully mechanised	max. 8	GMAW, MIG/MAG, manual, fully mechanised	max. 11
Hot wire GTAW	max. 6	SMAW, manual metal arc (MMA)	max. 7
Plasma arc	max. 10		

Table 9 – Heat input per unit length (guide values).

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Postweld treatment
(brushing, pickling and thermal treatments)

Brushing with a stainless steel wire brush immediately after welding, i.e. while the metal is still hot generally results in removal of heat tint and produces the desired surface condition without additional pickling.

Pickling, if required or prescribed, however, would generally be the last operation performed on the weldment. Also refer to the information on **'Descaling and pickling'**.

Neither pre- nor postweld thermal treatments are required.

Availability

Nicrofer 5923 hMo is available in the following standard product forms:

Sheet & plate
(for cut-to-length availability, refer to strip)

Conditions:
hot or cold rolled (hr, cr),
thermally treated and pickled

Thickness mm	hr / cr	Width[1] mm	Length[1] mm
1.10 – < 1.50	cr	2000	8000
1.50 – < 3.00	cr	2500	8000
3.00 – < 7.50	cr / hr	2500	8000
7.50 – ≤ 25.00	hr	2500	8000[2]
> 25.00[1]	hr	2500[2]	8000[2]

inches		inches	inches
0.043 – < 0.060	cr	80	320
0.060 – < 0.120	cr	100	320
0.120 – < 0.300	cr / hr	100	320
0.300 – ≤ 1.000	hr	100	320[2]
> 1.000[1]	hr	100[2]	320[2]

[1] other sizes subject to special enquiry
[2] depending on piece weight

Discs and rings
Conditions:
hot rolled or forged,
thermally treated,
descaled or pickled or machined

Product	Weight kg	Thickness mm	O. D.[1] mm	I. D.[1] mm
Disc	≤ 10000	≤ 300	≤ 3000	
Ring	≤ 3000	≤ 200	≤ 2500	on request

	lbs	inches	inches	inches
Disc	≤ 22000	≤ 12	≤ 120	
Ring	≤ 6600	≤ 8	≤ 100	on request

[1] other sizes subject to special enquiry

Rod & bar
Conditions:
forged, rolled, drawn,
thermally treated,
descaled or pickled, machined, peeled or ground

Product	Forged[1] mm	Rolled[1] mm	Drawn[1] mm
Rod (o. d.)	≤ 600	8 – 100	12 – 65
Bar, square (a)	40 – 600	15 – 280	not standard
Bar, flat (a x b)	(40 – 80) x (200 – 600)	(5 – 20) x (120 – 600)	(10 – 20) x (30 – 80)
Bar, hexagonal (s)	40 – 80	13 – 41	≤ 50

	inches	inches	inches
Rod (o. d.)	≤ 24	$^5/_{16}$ – 4	$^1/_2$ – 2 $^1/_2$
Bar, square (a)	1 $^5/_8$ – 24	$^{10}/_{16}$ – 11	not standard
Bar, flat (a x b)	(1 $^5/_8$ – 3 $^1/_8$) x (8 – 24)	($^3/_{16}$ – $^3/_4$) x (4 $^3/_4$ – 24)	($^3/_8$ – $^3/_4$) x (1 $^1/_4$ – 3 $^1/_8$)
Bar, hexagonal (s)	1 $^5/_8$ – 3 $^1/_8$	$^1/_2$ – 1 $^5/_8$	≤ 2

[1] other sizes and conditions subject to special enquiry

Forgings
Shapes other than discs, rings, rod and bar are subject to special enquiry. Flanges and hollow shafts may be available up to a piece weight of 10 t.

Strip[1)]
Conditions:
cold rolled,
thermally treated and pickled or bright annealed[2)]

Thickness mm	Width[3)] mm	Coil I. D. mm			
0.04 – ≤ 0.10	4 – 200	300	400		
> 0.10 – ≤ 0.20	4 – 350	300	400	500	
> 0.20 – ≤ 0.25	4 – 750		400	500	600
> 0.25 – ≤ 0.60	6 – 750		400	500	600
> 0.60 – ≤ 1.0	8 – 750		400	500	600
> 1.0 – ≤ 2.0	15 – 750		400	500	600
> 2.0 – ≤ 3.0	25 – 750		400	500	600

inches	inches	inches			
0.0016 – ≤ 0.004	0.16 – 8	12	16		
> 0.004 – ≤ 0.008	0.16 – 14	12	16	20	
> 0.008 – ≤ 0.010	0.16 – 30		16	20	24
> 0.010 – ≤ 0.024	0.20 – 30		16	20	24
> 0.024 – ≤ 0.040	0.32 – 30		16	20	24
> 0.040 – ≤ 0.080	0.60 – 30		16	20	24
> 0.080 – ≤ 0.120	1.0 – 30		16	20	24

[1)] Cut-to-length available in lengths from 250 to 4000 mm (10 to 158 in.)
[2)] Maximum thickness 3 mm (0.125 in.)
[3)] Wider widths subject to special enquiry

Wire
Conditions:
bright drawn, 1/4 hard to hard, bright annealed

Dimensions:
0.01 – 12.0 mm (0.0004 – 0.47 in.) diameter,
in coils, pay-off packs, on spools and spiders

Welding filler metals
Suitable welding rods, wire, strip electrodes and electrode core wire are available in all standard sizes.

Seamless tube and pipe
Using ThyssenKrupp VDM cast materials seamless tubes and pipes are produced and available from DMV STAINLESS Int. Sales, Tour Neptune, F-92086 Paris, La Defence Cedex (Fax: +33-1-4796 8126; Tel.: +33-1-4796 8128).

Welded tube and pipe
Welded tubes and pipes are obtainable from qualified manufacturers using ThyssenKrupp VDM semi-fabricated products.

Technical publications

The following publications concerning Nicrofer 5923 hMo – alloy 59 may be obtained from ThyssenKrupp VDM GmbH:

M. Jasner, W. Herda, M. Rockel:
Crevice corrosion behaviour of high-alloyed austenitic steels and nickel-base alloys in seawater, determined under various test conditions;
Applications of Stainless Steel 92, Lohf. Proc., Stockholm, pp. 446 – 457 (1992)

D. C. Agarwal, U. Heubner, R. Kirchheiner, M. Köhler:
Cost-effective solutions to CPI-corrosion problems with a new Ni-Cr-Mo alloy;
CORROSION ’91, Paper No. 179, NACE International, Cincinnati, Ohio, 1991

R. Kirchheiner, M. Köhler, U. Heubner:
A new highly corrosion-resistant material for the chemical process industry, flue gas desulfurization and related applications;
CORROSION ’90, Paper No. 90, NACE International, Las Vegas, Nevada, 1990

VDM Report No. 17:
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