Nicrofer® 3127 hMo – alloy 31

Material Data Sheet No. 4031
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Corrosion-resistant alloy

A company of ThyssenKrupp Stainless

ThyssenKrupp VDM

ThyssenKrupp

Nicrofer® 3127 hMo – alloy 31

Nicrofer 3127 hMo is an iron-nickel-chromium-molybdenum alloy with nitrogen addition. Developed by ThyssenKrupp VDM, it was designed to fill the gap between existing superaustenitic stainless steels and nickel alloys. Nicrofer 3127 hMo is particularly well suited to applications in chemical and petrochemical industries, environmental engineering, and oil and gas production.

Nicrofer 3127 hMo is characterized by:

- outstanding resistance to corrosion in halide media, both acidic and basic;
- outstanding resistance to sulfuric acid, even highly concentrated;
- outstanding resistance to corrosion and erosion-corrosion in phosphoric acid media;
- excellent resistance to both localized corrosion and general corrosion in chlorine dioxide bleach media;
- excellent resistance to both reducing and oxidizing media;
- ease of fabrication and welding;
- approval for pressure-vessel use involving wall temperatures from -196 to 550 °C (-320 to 1020 °F);
- approved in ISO 15156/MR0175 to Test Level VI for sour gas service;

Designations and standards

Country	Alloy designations	Specification							
National standards		Chemical composition	Tube and pipe seamless	Tube and pipe welded	Sheet and plate	Rod and bar	Strip	Wire	Forgings
D	**W.-Nr. 1.4562** X1NiCrMoCu32-28-7								
SEW		400	400	400	400	400	400	400	400
VdTÜV-Wbl.		509/2	509/2		509				
BAM	Material listed in the BAM list in Sect. 6								
USA	UNS N08031								
ASTM			B 622	B 619/626	B 625	B 581 (Rod) B 649 (Bar)	B 625	B 649	B 564
ASME			SB-622	SB-619/626	SB-625	SB-581 (Rod) SB-649 (Bar)	SB-625	SB-649	SB-564
ISO	Material listed in ISO 15156/MR0175								

Table 1 – Designations and standards.

Chemical composition

	Ni	Cr	Fe	C	Mn	Si	Cu	Mo	N	P	S
min.	30.0	26.0	bal.				1.0	6.0	0.15		
max.	32.0	28.0		0.015	2.0	0.3	1.4	7.0	0.25	0.020	0.010

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

Physical properties

Density	8.1 g/cm^3	0.293 lb/in.^{3}
Melting range	1350 – 1370 °C	2460 – 2500 °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	$\frac{J}{kg \cdot K}$	$\frac{Btu}{lb \cdot °F}$	$\frac{W}{m \cdot K}$	$\frac{Btu \cdot in.}{ft^2 \cdot h \cdot °F}$	$\mu\Omega \cdot cm$	$\frac{\Omega \cdot circ\ mil}{ft}$	$\frac{kN}{mm^2}$	10^3 ksi	$\frac{10^{-6}}{K}$	$\frac{10^{-6}}{°F}$
20	**68**	452	0.108	11.7	81	103	620	198	28.7		
93	**200**		0.111		90		635		27.6		7.9
100	212	463		13.2		106		189		14.3	
200	392	474		15.0		110		183		14.7	
204	**400**		0.113		105		662		26.5		8.2
300	572	483		16.8		113		176		15.1	
316	**600**		0.116		118		683		25.4		8.5
400	752	491		18.5		116		170		15.5	
427	**800**		0.118		132		702		24.2		8.6
500	932	500		20.2		118		163		15.7	
538	**1000**		0.127		144		716		23.3		8.8
600	1112	508		(21.9)		(120)		158		15.9	

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

Mechanical properties

The following properties are applicable to Nicrofer 3127 hMo in the solution-treated condition and the indicated size ranges. Specified properties of material outside these size ranges are subject to special enquiry.

Strip	up to 3 mm	up to 0.12 in.
Sheet & plate	up to 50 mm	up to 2 in.
Rod & bar	up to 300 mm	up to 12 in.
Wire	up to 12 mm	up to 0.47 in.

0.2% Yield strength $R_{p\,0.2}$ N/mm^2	ksi	1.0% Yield strength $R_{p\,1.0}$ N/mm^2	ksi	Tensile strength R_m N/mm^2	ksi	Elongation A_{50} %	Brinell hardness HB
≥ 276	≥ 40	≥ 310	≥ 45	≥ 650	≥ 94	≥ 40	max. 220 For information only)

Table 4 – Minimum mechanical properties for all product forms at room temperature according to ASTM.

Temperature °C	°F	0.2% Yield strength $R_{p0.2}$ N/mm²	ksi	1.0% Yield strength $R_{p1.0}$ N/mm²	ksi	Tensile strength R_m N/mm²	ksi	Elongation A_5 %
20	68	276	40	310	45.0	650	94	40
93	200		30.6		35.5		90.6	50
100	212	210	30.5	240	34.8	630	91	50
200	392	180	26.1	210	30.5	580	84.1	50
204	400		27.5		30.5		83.4	50
300	572	165	23.9	195	28.3	530	76.9	50
316	600		23.3		27.6		76.0	50
400	752	150	21.8	180	26.1	500	72.5	50
427	800		21.3		25.5		71.3	50
500	932	135	19.6	165	23.9	470	68.2	50
538	1000		18.5		23.0		66.7	50
550	1022	125	18.1	155	22.5	450	65.3	50

Table 5 – Minimum short-time mechanical properties for sheet & plate products ≤ 25 mm (1 in.) at elevated temperatures according to VdTÜV-Data Sheet 509.

Temperature °C	°F	Maximum allowable stress N/mm² 1)	N/mm² 1) 2)	ksi	ksi 2)	Temperature °C	°F	Maximum allowable stress N/mm² 1)	N/mm² 1) 2)	ksi	ksi 2)
38	100			23.5	23.5	260	500			17.2	20.4
93	200			22.0	23.5	300	572	114	136		
100	212	150	162			316	600			16.4	19.5
149	300			19.7	22.6	371	700			15.7	18.9
200	392	126	148			400	752	106	129		
204	400			18.3	21.5	427	800			15.2	18.5

1) values determined by interpolation 2) 'conditional' stress values

Table 6 – Maximum allowable stress values in tension according to ASME, Section VIII, Division 1 UNF-23.3. SB-564, 581, 619, 622, 625, 626.

These stresses may result in dimensional changes due to permanent strain and are not recommended for flanges of gasketed joints.

The higher 'conditional' stress values of up to 90 % of the yield strength at temperature may be used for applications in which slightly greater deformation is acceptable.

ISO V-notch impact toughness

Average values	at RT:	≥ 185 J/cm²
	at -196 °C (-320 °F):	≥ 140 J/cm²

Metallurgical structure

Nicrofer 3127 hMo has a face-centered-cubic structure. The 0.2 % nitrogen content stabilizes the austenite and reduces the tendency to precipitation of intermetallic phases.

Comparison of typical short-time data for Nicrofer 3127 hMo – alloy 31 with similar alloys as: Nicrofer 3127 LC – alloy 28 ········ Cronifer 1713 LCN – alloy 317 LN – – – –

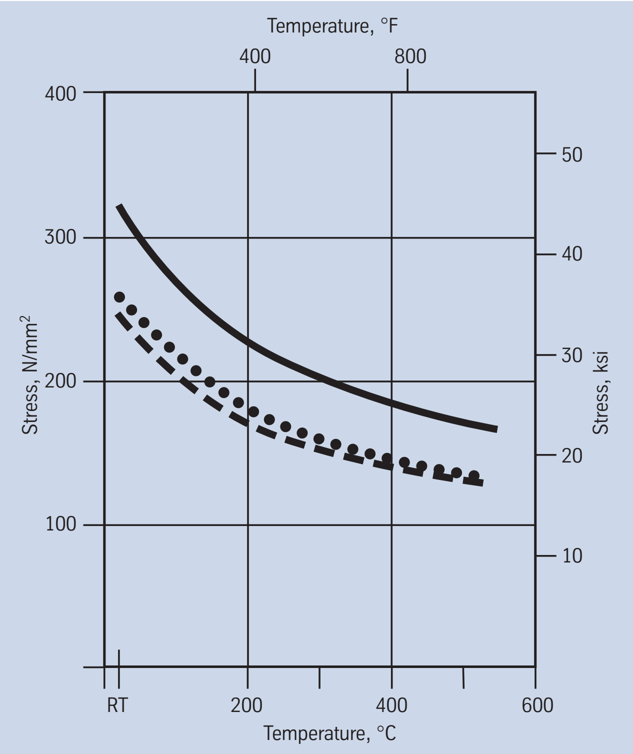

Fig. 1 – Typical short-time 0.2 % yield strength at room and elevated temperatures.

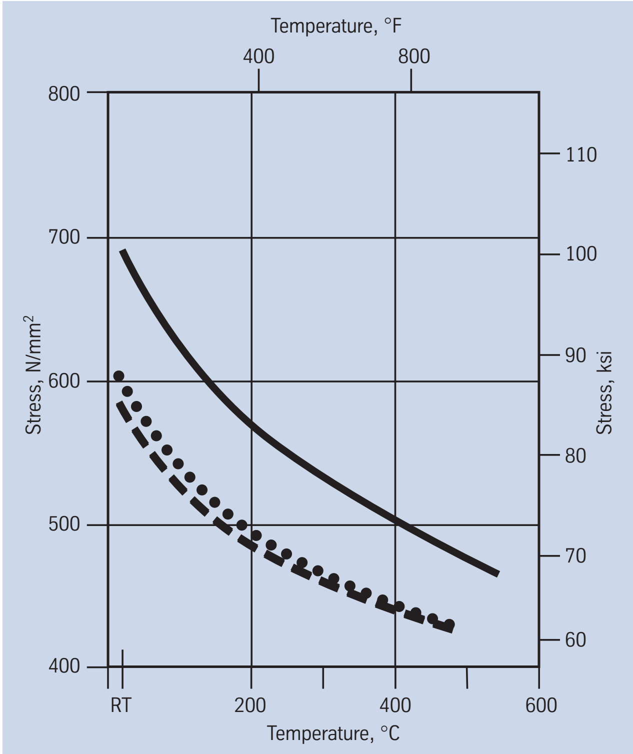

Fig. 2 – Typical short-time tensile strength at room and elevated temperatures.

Corrosion resistance

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

The chemical composition of Nicrofer 3127 hMo is designed to give it particularly high resistance to corrosion in halide media. The alloy also shows outstanding resistance to sulfuric acid, both pure and contaminated, over a wide range of concentrations and at temperatures up to 80°C (176°F). The corrosion resistance in lightly aerated, technical grade sulfuric acid is shown in the ISO-corrosion diagram in Fig. 3.

In the severe erosion-corrosion conditions of wet-process phosphoric acid production, Nicrofer 3127 hMo has demonstrated that it is a true alternative to nickel alloys. Extensive testing in chlorine-dioxide bleach media in the pulp and paper industry has shown that Nicrofer 3127 hMo withstands the most severe service conditions.

Resistance to intergranular corrosion (IG) has been determined according to the ASTM G 28 A test as well as to German Standard Test SEP 1877 II. Fig. 4 shows that Nicrofer 3127 hMo only becomes sensitized after a considerable time period.

Pitting resistance has been determined by potential measurements and by the ASTM G 48 test. Fig. 5 and 6 show the results in comparison to other materials.

Critical pitting and crevice-corrosion temperatures of Nicrofer 3127 hMo compared to other similar, but less corrosion-resistant alloys are shown in Fig. 7

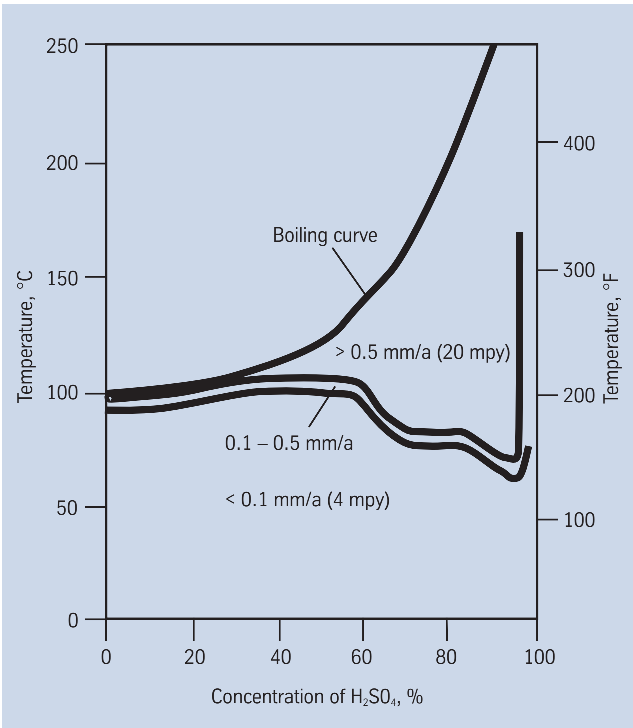

Fig. 3 – ISO-corrosion diagram of Nicrofer 3127 hMo in lightly aerated, technical grade sulfuric acid based on immersion test results over at least 120 h.

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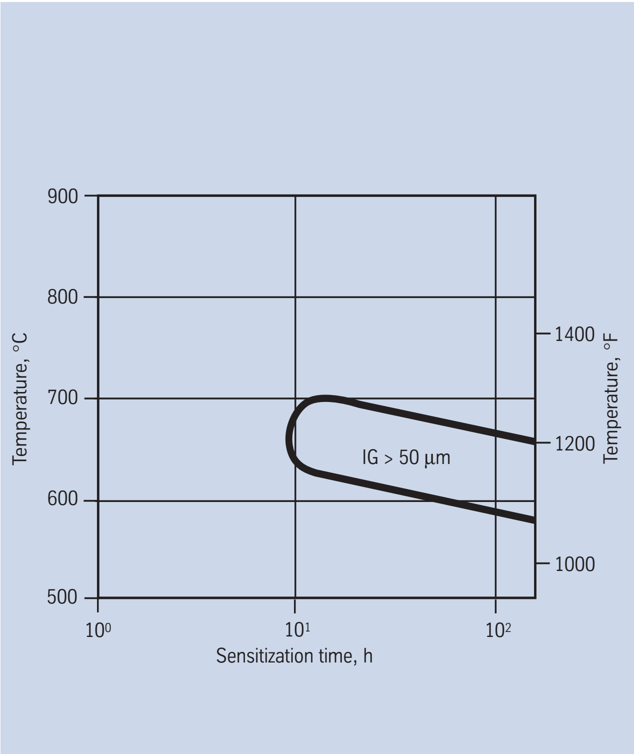

Fig. 4 – Time-temperature-sensitization diagram (TTS), IG according to the ASTM G 28 A test.

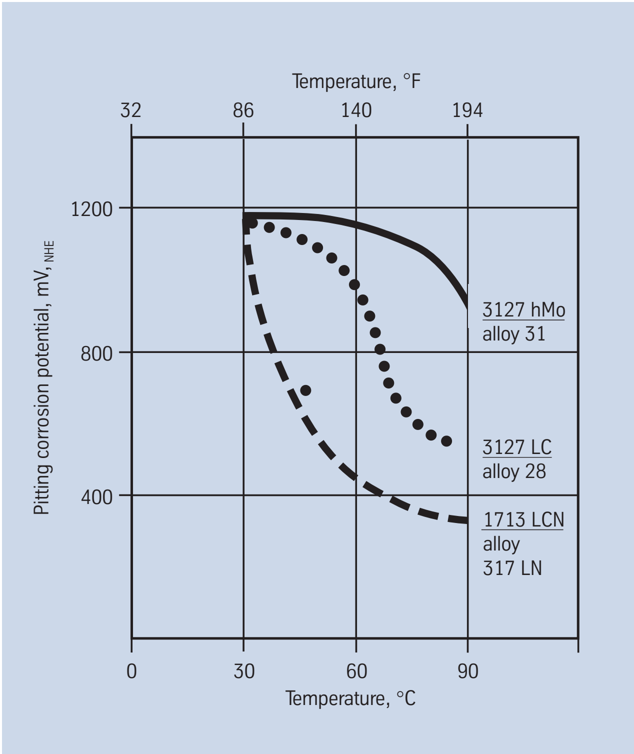

Fig. 5 – Pitting corrosion potential in relation to temperature (ASTM seawater, agitated and air-saturated).

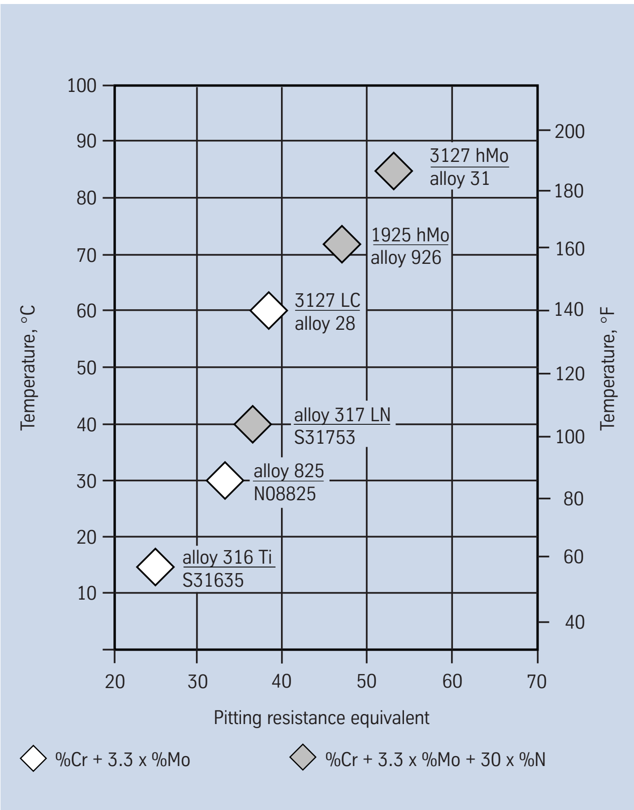

Fig. 6 – Critical pitting temperatures (CPT) in 10 % $FeCl_3$ x $6H_2O$ solution as a function of the respective pitting resistance equivalents (PRE).

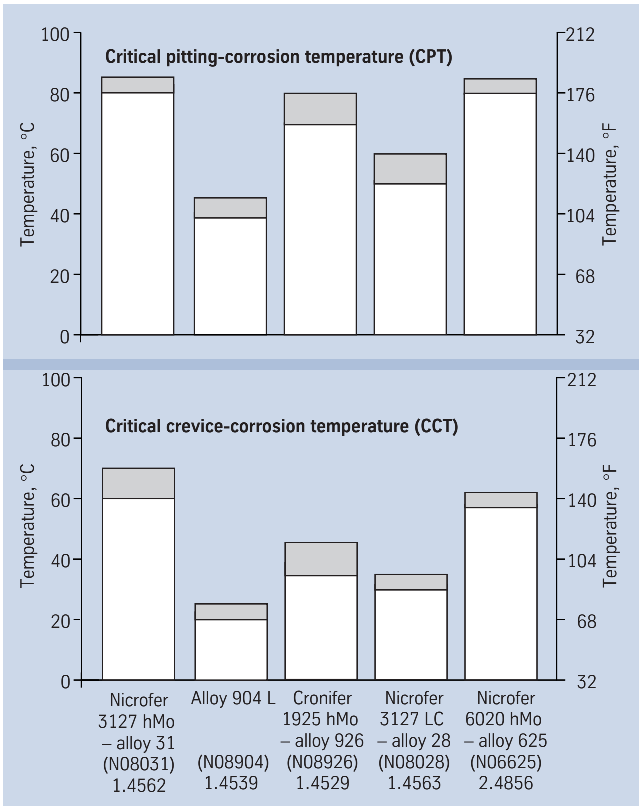

Fig. 7 – Critical pitting and crevice-corrosion temperatures of different alloys in 10 % $FeCl_3$ x $6H_2O$ solution.

In a variety of other corrosive media Nicrofer 3127 hMo also shows clear advantages, as indicated in Fig. 8.

However, the ISO-corrosion diagram in hydrochloric acid in Fig. 9 and other tests at room temperature and at concentrations ranging from 10 to 30 %, showing uniform corrosion rates of up to 0.5 mm/a, clearly indicate that Nicrofer 3127 hMo is only suitable for applications in organic chemical and other processes, where traces or concentrations of hydrochloric acid below approx. 5 % are encountered at room or slightly elevated temperatures.

For hydrochloric acid applications above room temperature and at higher concentrations Nicrofer 3127 hMo is not considered suitable. For such service conditions other materials, in particular Nimofer alloys containig essentially Ni and Mo, are usually selected.

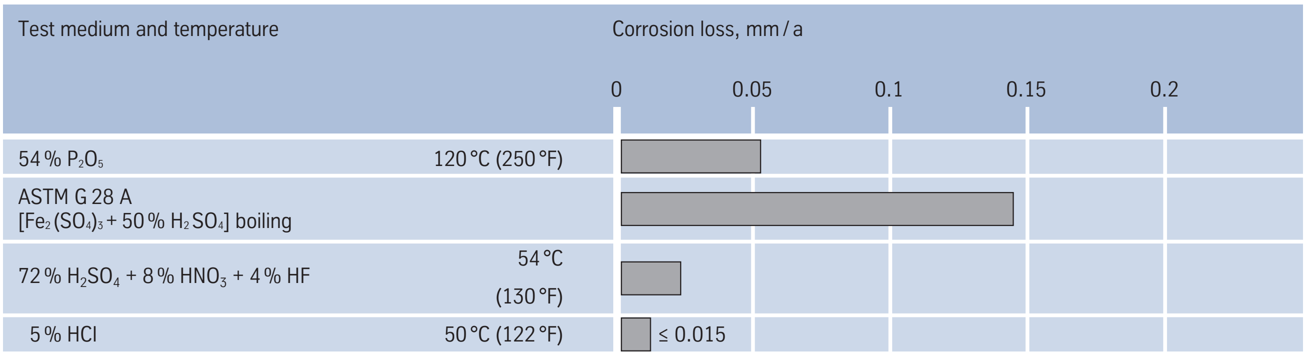

Fig. 8 – Corrosion loss of Nicrofer 3127 hMo in various media and at different temperatures.

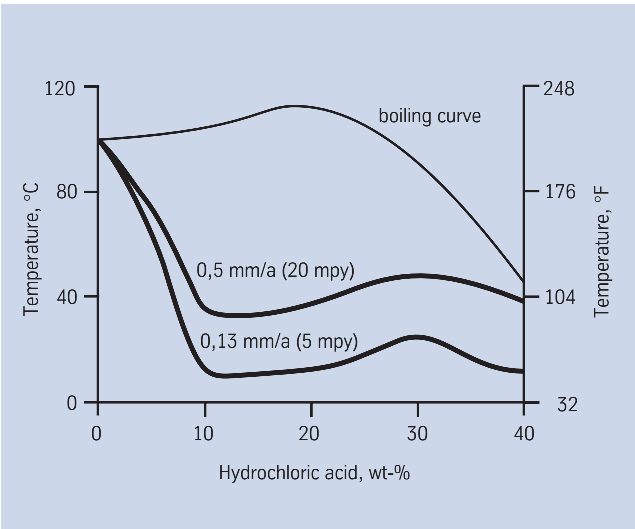

Fig. 9 – ISO-corrosion diagram of Nicrofer 3127 hMo in hydrochloric acid, determined in static immersion tests.

Test media	Critical pitting temperature (CPT)	
	Alloy G-30 (2.4603)	Nicrofer 3127 hMo – alloy 31 (1.4562)
ASTM G 48 A* and MTI 2*	75 – 80 °C (167 – 176 °F)	82.5 °C (180 °F)
4 % NaCl + 0.1 % $Fe_2(SO_4)_3$ + 0.04 % HCl	75 °C (167 °F)	105.5 °C (220 °F)
*Determined using increasing temperature increments and the same test samples for each temperature step.		

Table 7 – Critical pitting temperature (CPT) of alloy G-30 and Nicrofer 3127 hMo.

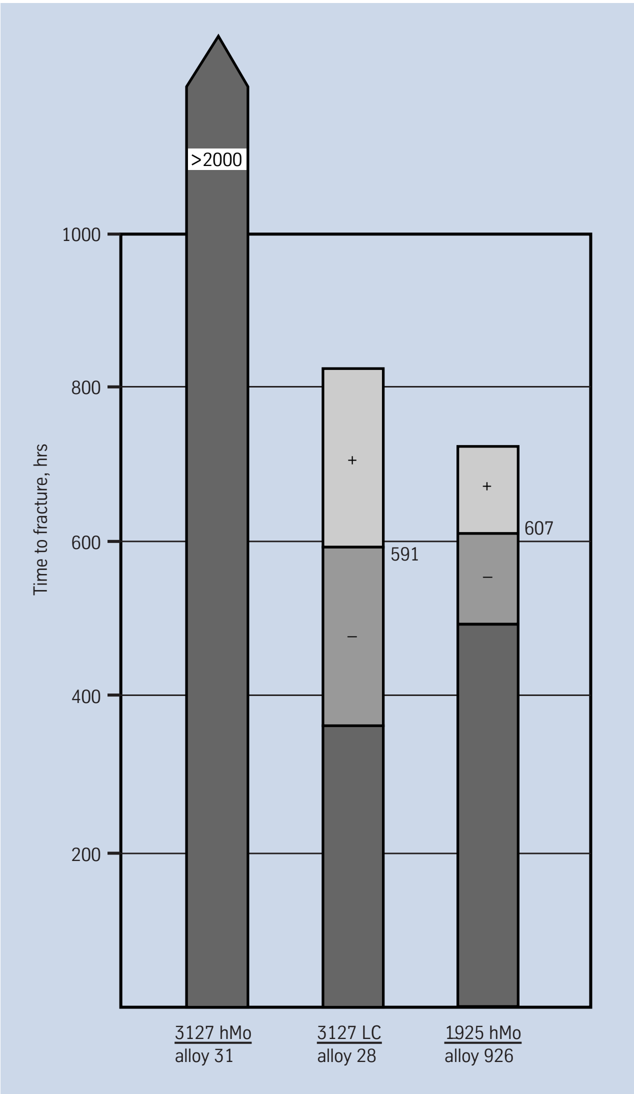

Fig. 10 – Stress corrosion cracking test with U-bend specimens in boiling 62 % $CaCl_2$-solution.

Austenitic stainless steels are susceptible to stress corrosion cracking (SCC). In the ASTM G 30 SCC test, however, Nicrofer 3127 hMo shows excellent resistance to stress corrosion cracking in comparison with other alloys (Fig. 10).

Applications

Typical applications are:

- FGD systems
- pulp and paper industry
- fine chemicals synthesis
- phosphoric acid production
- organic acids and esters synthesis
- waste sulfuric acid recovery
- sea water or brackish water heat exchangers
- ore processing, e.g., HIPAL (high pressure acid leaching technology) of laterite ores
- petroleum production and refining
- pickling plant (H_2SO_4)
- sulfuric acid coolers
- evaporation and crystallization of salts
- tubing and couplings, wire lines and flowline systems in sour gas production. In sour gas environment the alloy is listed in ISO 15156/MR0175 (Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment) as acceptable up to Level VI in the cold-worked condition at a hardness level of 35 HRC max.

Fabrication and heat treatment
Nicrofer 3127 hMo can readily be hot- and cold worked, fabricated and machined.

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

Nicrofer 3127 hMo may become embrittled if heated in the presence of contaminants such as sulfur, 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 sulfur as possible. Natural gas should contain less than 0.1 wt.-% sulfur. Fuel oils with a sulfur 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 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 3127 hMo may be hot worked in the temperature range 1200 to 1050 °C (2190 to 1920 °F), followed by water quenching or rapid air cooling.

Heat treatment after hot working is recommended to obtain optimum properties and to ensure maximum corrosion resistance.

For heating up, workpieces should be charged into the furnace at maximum working temperature (solution-anneal temperature). When the furnace has returned to temperature, the workpieces should be soaked for 60 minutes per 100 mm (4 in.) of thickness. At the end of this period they should be withdrawn immediately and worked within the above temperature range. If the metal temperature of a workpiece falls below 1080 °C (1980 °F), it should be reheated.

Cold working
Cold working should be carried out on annealed material. Nicrofer 3127 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 of Nicrofer 3127 hMo should be carried out in the temperature range 1150 to 1180 °C (2100 to 2160 °F), followed by water quenching or rapid air cooling. Below 1.5 mm (0.06 in.) thickness, rapid air colling only may suffice.

For maximum corrosion resistance, the workpiece must be rapidly cooled from a temperature of at least 1100 °C (2000 °F) down to 500 °C (930 °F) using a cooling rate > 150 °C (300 °F)/min. from the heat treatment temperature.

For any thermal treatment the material should be charged into the furnace at maximum heat treatment temperature observing the precautions concerning cleanliness mentioned earlier under 'Heating'.

Descaling and pickling
Oxides of Nicrofer 3127 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 the surface oxide layer must be broken up by abrasive blasting, by carefully performed grinding or by pretreatment in a fused salt bath. Particular attention should be paid to the pickling time and temperature.

Machining
Nicrofer 3127 hMo should be machined in the heat-treated condition. As the alloy exhibits a high work-hardening rate, only low cutting speeds should be used compared to low-alloyed standard austenitic stainless steels. An adequate depth of cut is important in order to cut below the previously formed work-hardened zone. Tools should be engaged at all times.

Welding
When welding nickel alloys and high-alloyed special stainless steels, the following instructions should be adhered to:

Workplace
The workplace should be in a separate location, well away from 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 machines
Tools used for nickel 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 sheeting) 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 as they are detrimental to health.

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Edge preparation
This should preferably be done by mechanical means, i. e., by turning, milling or planing; abrasive water jet or plasma cutting is also suitable. 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 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. 11, 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, i. e., on the faces to be welded or on a run-out piece. Striking marks lead to corrosion.

Welding process
Nicrofer 3127 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 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 3127 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. Root backing is also recommended for the first intermediate pass following the initial root pass and in some cases even for the second pass depending on the weld set-up. 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, the following filler metals are recommended:

Bare electrodes:	Nicrofer S 5923 – FM 59 (W.-Nr. 2.4607) UNS N06059 AWS A5.14: ERNiCrMo-13 DIN EN ISO 18274: S Ni 6059 (NiCr23Mo16)
	or
	Nicrofer S 3127 – FM 31 (W.-Nr. 1.4562) UNS N08031 X1 NiCrMoCu32-28-7
Covered electrodes:	UNS W86059 AWS A5.11: ENiCrMo-13 W.-Nr. 2.4609 DIN EN ISO 14172: E Ni 6059 (NiCr23Mo16)
	or matching electrode

As the filler metal to be used largely depends on the media conditions the welded component will be exposed to in service, it is recommended that Technical Marketing is consulted when selecting the most suitable filler metal for a specific applications.

For overlay welding by the electro-slag method (RES):

Weld strip:	Nicrofer B 5923 – WS 59 (W.-Nr. 2.4607) UNS N06059 AWS A5.14: ERNiCrMo-13 DIN EN ISO 18274: B Ni 6059 (NiCr23Mo16)

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 9 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.

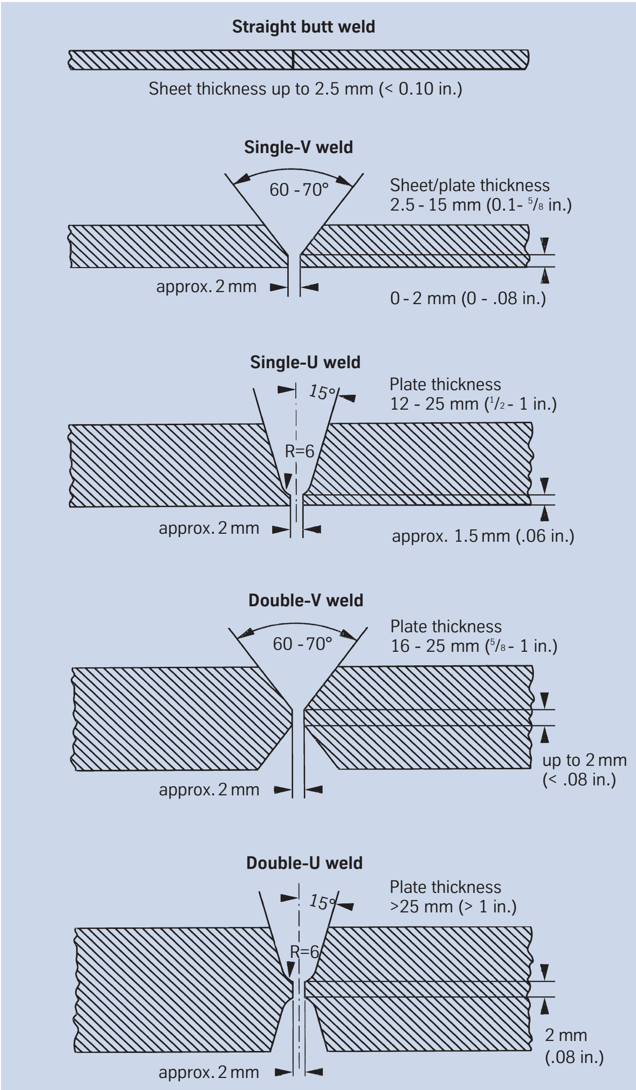

Fig. 11 – Edge preparation for welding of nickel alloys and special stainless steels.

Sheet/ plate thick-ness mm	Welding process	Filler metal Diameter mm	Speed m/min.	Welding parameters Root pass I A	U V	Intermediate and final passes I A	U V	Welding speed cm/min.	Shielding gas Type & rate l/min.	Plasma-gas Type & rate l/min.
3.0	Manual GTAW	2.0		90	10	110 – 120	11	approx. 15	Ar W3[1] 8 – 10	
6.0	Manual GTAW	2.0 – 2.4		100 – 110	10	120 – 140	12	14 – 16	Ar W3[1] 8 – 10	
8.0	Manual GTAW	2.4		100 – 110	11	130 – 140	12	14 – 16	Ar W3[1] 8 – 10	
10.0	Manual GTAW	2.4		100 – 110	11	130 – 140	12	14 – 16	Ar W3[1] 8 – 10	
3.0	Autom. GTAW	1.2	approx. 1.2	Manual GTAW		150	11	25	Ar W3[1] 12 – 14	
5.0	Autom. GTAW	1.2	approx. 1.4	Manual GTAW		180	12	25	Ar W3[1] 12 – 14	
2.0	Hot wire GTAW	1.0				180	11	80	Ar W3[1] 12 – 14	
10.0	Hot wire GTAW	1.2		Manual GTAW		220	12	40	Ar W3[1] 12 – 14	
4.0	Plasma arc	1.2	approx. 1.0	approx. 180	25			30	Ar W3[1] 30	Ar 4.6 3.0
6.0	Plasma arc	1.2	approx. 1.0	200 – 220	26			26	Ar W3[1] 30	Ar 4.6 3.5
8.0	GMAW (MIG/MAG[2])	1.0	6 – 7	Manual GTAW		130 – 140	23 – 27	24 – 30	Ar 4.6[2] 18	
10.0	GMAW (MIG/MAG[2])	1.2	6 – 7	Manual GTAW		130 – 150	23 – 27	25 – 30	Ar 4.6[2] 18	
6.0	SMAW (MMA)	2.5		40 – 70	approx. 21	40 – 70	approx. 21			
8.0	SMAW (MMA)	2.5 – 3.25		40 – 70	approx. 21	70 – 100	approx. 22			
16.0	SMAW (MMA)	4.0				90 – 130	approx. 22			

[1] Argon or argon + max. 3 % hydrogen
[2] For MAG welding the use of the multi-component shielding gas Cronigon Ni10, for example, is recommended.
In all gas-shielded welding operations, adequate back shielding must be ensured.
Figures are for guidance only 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. 8
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 under **'Descaling and pickling'**.

Neither pre- nor postweld thermal treatments are required.

Availability
Nicrofer 3127 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:
Available up to a maximum piece weight of 6 t for discs and 3 t for rings in accordance to drawings and technical feasability.

Rod & bar and billet
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.)	≤ 400	8 – 100	12 – 65
Bar, square (a)	80 – 350	15 – 280	not standard
Bar, flat (a x b)	(40 – 80) x (200 – 400)	(5 – 20) x (120 – 600)	not standard
Bar, hexagonal (s)	40 – 80	13 – 41	≤ 50

	inches	inches	inches
Rod (o. d.)	≤ 16	5/16 – 4	1/2 – 2 1/2
Bar, square (a)	3 1/8 – 13 3/4	10/16 – 11	not standard
Bar, flat (a x b)	(1 5/8 – 3 1/8) x (8 – 16)	(3/16 – 3/4) x (4 3/4 – 24)	not standard
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			
0.02 – ≤ 0.10	4 – 200[4)]	300	400		
> 0.10 – ≤ 0.20	4 – 350[4)]	300	400	500	
> 0.20 – ≤ 0.25	4 – 700		400	500	600
> 0.25 – ≤ 0.60	6 – 700		400	500	600
> 0.60 – ≤ 1.0	8 – 700		400	500	600
> 1.0 – ≤ 2.0	15 – 700		400	500	600
> 2.0 – ≤ 3.0[2)] – ≤ 3.5[2)]	25 – 700		400	500	600

inches	inches	inches			
0.0008 – ≤ 0.004	0.16 – 8[4)]	12	16		
> 0.004 – ≤ 0.008	0.16 – 14[4)]	12	16	20	
> 0.008 – ≤ 0.010	0.16 – 28		16	20	24
> 0.010 – ≤ 0.024	0.24 – 28		16	20	24
> 0.024 – ≤ 0.040	0.32 – 28		16	20	24
> 0.040 – ≤ 0.080	0.60 – 28		16	20	24
> 0.080 – ≤ 0.120[2)] – ≤ 0.140[2)]	1.0 – 28		16	20	24

[1)] Cut-to-length available in lengths from 250 to 4000 mm (10 to 158 in.)
[2)] Maximum thickness: bright annealed - 3 mm (0.120 in.),
cold rolled only - 3.5 mm (0.140 in.)
[3)] Wider widths are subject to special enquiry
[4)] Wider widths up to 730 mm (29 in.) are subject to special enquiry

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

Dimensions:
0.1 – 12.0 mm (0.004 – 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 standard sizes.

Seamless tube and pipe
Using ThyssenKrupp VDM cast materials seamless tubes and pipes are produced and available from DMV STAINLESS Deutschland GmbH, Wiesenstr. 36, D-45473 Mülheim/Ruhr; (Tel.: +49 208 458-2611; Fax: +49 208 458-2641; Email: salesgermany@dmv-stainless.com; Internet: dmv-stainless.com).

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

Nicrofer® 3127 hMo – alloy 31

Technical publications
The following publications concerning Nicrofer 3127 hMo have been published by ThyssenKrupp VDM GmbH:

U. Heubner et al: Alloy 31, A New High-Alloyed Nickel-Chromium-Molybdenum Steel for the Refinery Industry and Related Applications; CORROSION 1991, Paper No. 321, NACE International, Houston, 1991.

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ThyssenKrupp VDM GmbH
Plettenberger Strasse 2
58791 Werdohl
P.O. Box 18 20
58778 Werdohl
Germany
Phone: +49 2392 55-0
Fax: +49 2392 55-2217
Email: vdm@thyssenkrupp.com
www.thyssenkruppvdm.com