Nicrofer® 3127 LC – alloy 28

Material Data Sheet No. 4005
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Corrosion-resistant alloy

A company of ThyssenKrupp Stainless

ThyssenKrupp VDM

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Nicrofer 3127 LC is an austenitic low carbon iron-nickel-chromium-molybdenum alloy with the addition of approximately 1 % copper. Due to the extra low carbon and high chromium content combined with molybdenum and copper, the alloy has very good corrosion resistance for general purposes and is exceptionally resistant to pitting and crevice corrosion.

Nicrofer 3127 LC is characterized by:

- good resistance to a variety of corrosive media including contaminated mineral acids and organic acids; exceptional resistance to phosphoric acid
- excellent resistance to pitting, crevice and intergranular corrosion and to stress corrosion cracking
- good mechanical properties

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 SEW VdTÜV	W.-Nr. 1.4563 XlNiCrMoCuN31 27 4	400 483	400 483	400	400	400 483	400	400	400
F AFNOR	ZINCDU 31.27								
UK BS									
USA ASTM ASME	UNS N08028	B 668/709 SB 668/709	B 668 SB 668		B 709 SB 709		B 709 SB 709		
ISO	FeNi31Cr27Mo3,5Cul								

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	3.0	0.04		
max.	32.0	28.0		0.015	2.0	0.7	1.4	4.0	0.07	0.020	0.010

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

Physical properties

Density	8.0 g/cm³	0.29 lb/in.³
Melting range	1330 – 1370 °C	2430 – 2500 °F
Permeability at 20 °C/68 °F (RT)	1.0025	

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	442	0.105	10.8	75	99	595	195	28.3		
93	200		0.110		83		626		27.7		8.3
100	212	462		12.0		105		190		15.0	
200	392	490		13.8		111		185		15.4	
204	400		0.117		96		668		26.6		8.5
300	572	510		15.8		115		177		15.8	
316	600		0.122		116		698		25.4		8.8
400	752	525		17.9		118		170		16.2	
427	800		0.126		128		716		24.4		9.0
500	932	540		20.0		120		162		16.5	

Table 3 – Typical physical properties at room temperature or as indicated.

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Mechanical properties
The following properties are applicable to Nicrofer 3127 LC in the solution-treated condition and the indicated size ranges. Specified properties for material outside these size ranges are subject to special enquiry. The values are valid for longitudinal and transverse specimens.

Form		Dimensions		Tensile strength R_m		Yield strength $R_{p0.2}$		Yield strength $R_{p1.0}$		Elongation A_5	Brinell hardness (inform.)
		mm	inches	N/mm²	ksi	N/mm²	ksi	N/mm²	ksi	%	HB
Strip, sheet		≤ 5	≤ 0.2			220	31.9	250	36.3		
Plate		> 5 – 20	> 0.2 to 2			210	30.5	240	34.8		
Rod, bar		≤ 250	≤ 10	500	72.5	210	30.5	240	34.8	35	≤ 220
Tube	s	≤ 5	≤ 0.2			220	31.9	250	36.3		
	s	> 5	> 0.2			210	30.5	240	34.8		

Table 4 – Minimum mechanical properties at room temperature.

	0.2 % Yield strength					1.0% Yield strength				
Temperature °C	100	200	300	400	500	100	200	300	400	500
N/mm²	190	165	150	135	120	220	195	180	165	150
Temperature °F	200	400	600	800	1000	200	400	600	800	1000
ksi	28.1	23.9	21.2	18.9	16.7	29.6	28.2	25.8	23.2	21.2

Table 5 – Minimum mechanical properties at elevated temperatures.

ISO V-notch
Average values at RT: longitudinal ≥ 100 J/cm²
transverse ≥ 120 J/cm²

Metallurgical structure
Nicrofer 3127 LC has a face-centred cubic structure.

Corrosion resistance
Nicrofer 3127 LC has high resistance to crevice and pitting corrosion. Reference to the pitting index based on the formula:

Pitting index = % Cr + 3.3 x % Mo

shows this alloy to be one of the most resistant of the common high-nickel alloys and type 300 stainless steels. General corrosion resistance and resistance to chloride-ion stress corrosion are good. Nicrofer 3127 LC is also highly resistant to intergranular corrosion.

In the wet process production of phosphoric acid, materials are subject to corrosion by halide impurities in the phosphate ore. Nicrofer 3127 LC has been found to be the most resistant of all the austenitic alloys commonly used in the digestion and filtration stages of this process.

It also shows good resistance to sulphuric and nitric acids, to organic acids such as acetic and formic and to mixtures of such acids.

Resistance to hydrochloric, hydrofluoric and fluosilicic acids is such that the alloy may be used in processes where these corrosives are present as contaminants.

Good resistance is also shown to flowing seawater.

Applications

Typical applications include:

- equipment used in the manufacture of phosphoric acid by the 'wet' process: in particular, heat exchangers in the concentration unit where resistance to phosphoric acid contaminated with free halides is needed
- overhead condensers in oil refineries
- tubing and heat exchangers handling sulphuric acid contaminanted with chlorides
- piping, condensers, coolers, etc. carrying seawater
- production tubes, casings and liners in deep sour-gas wells used in cold-worked condition to give high mechanical strength
- caustic soda evaporation plant, to resist erosion – corrosion by sodium hydroxide and salt crystals

Fabrication and heat treatment

Nicrofer 3127 LC is easily hot or cold formed, machined and joined by manual metal arc, TIG and MIG welding.

Heating

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

Nicrofer 3127 LC 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 sulphur are satisfactory.

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

Nicrofer 3127 LC may be hot-worked in the range 1200 to 1050 °C (2200 to 1920 °F). Cooling should be by water quenching or as fast as possible.

Annealing is recommended after hot working to ensure maximum corrosion resistance.

For hot working, the material may be charged into the furnace at maximum working temperature.

Cold working

Cold working should be carried out on solution-treated material. Nicrofer 3127 LC has a much 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.

After cold reduction of more than 15 %, annealing has to be repeated.

Heat treatment

Solution treatment should be carried out in the temperature range 1080 to 1150 °C (1980 to 2100 °F). Water quenching or rapid air cooling is recommended for thicknesses above about 1.5 mm (0.06 in.) and is essential for maximum corrosion resistance.

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

Descaling

Oxides of Nicrofer 3127 LC and discoloration adjacent to welds, are more adherent than on stainless steels. Grinding with very fine abrasive belts or discs is recommended.

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

Nicrofer 3127 LC 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-alloyed standard austenitic stainless steel. Tools should be engaged at all times. Heavy feeds are important in getting below the work-hardened 'skin'.

Joining

Nicrofer 3127 LC can be welded by all the 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 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 150 °C (300 °F).

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

The following welding products are recommended:

GTAW/GMAW	Matching material
	or
Nicrofer S 6020	W.-Nr. 2.4831 SG-NiCr21Mo9Nb AWS A5.14 ERNiCrMo-3
SMAW	Matching material
	or
	W.-Nr. 2.4621 EL-NiCr20Mo9Nb AWS A5.11 ENiCrMo-3

For optimum corrosion resistance, argon-arc welding, i.e. GTAW is preferred.

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Availability
Nicrofer 3127 LC is available in the following standard mill product forms:

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

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

Thickness mm	hr / cr	Width* mm	Length* mm
1.20 – < 1.50	cr	2000	6000
≥ 1.50 – < 6.0	cr	2500	8000
≥ 6.0 – < 10.0	cr	2500	8000
≥ 6.0 – < 10.0	hr	2500	8000
≥ 10.0 – < 20.0	hr	3000	8000
≥ 20*	hr		

inches		inches	inches
0.047 – < 0.060	cr	80	240
≥ 0.060 – < 1/4	cr	100	320
≥ 1/4 – < 3/8	cr	100	320
≥ 1/4 – < 3/8	hr	100	320
≥ 3/8 – < 3/4	hr	120	320
< 3/4*	hr		

*other sizes subject to special enquiry

Forgings
Shapes other than discs, rings, rod and bar are subject to special enquiry.

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

Product	Weight kg	Thickness mm	OD* mm	ID mm
Disc	≤ 5000	≤ 300	≤ 3000	–
Ring	≤ 3000	≤ 200	≤ 2500	on request

	lb	inches	inches	inches
Disc	≤ 11000	≤ 12	≤ 120	–
Ring	≤ 6600	≤ 8	≤ 100	on request

*other sizes subject to special enquiry

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

Product		forged* mm	rolled* mm	drawn* mm
rod	d	≤ 350	8 – 75	12 – 65
square	a	40 – 300	15 – 100	12 – 65
flat a x b		40 – 80 x 200 – 600	5 – 20 x 120 – 600	10 – 20 x 30 – 80
hexagon	s	25 – 80	13 – 50	12 – 60

		inches	inches	inches
rod	d	≤ 14	0.32 – 3	1/2 – 2 1/2
square	a	1 5/8 – 12	5/8 – 4	1/2 – 2 1/2
flat a x b		1 5/8 – 3 1/8 x 8 – 24	3/16 – 3/4 x 5 – 24	3/8 – 3/4 x 1 1/4 – 3 1/8
hexagon	s	1 – 3 1/8	1/2 – 2	1/2 – 2 5/8

*other sizes subject to special enquiry

Strip*
Conditions:
cold rolled, solution treated and pickled
or bright annealed**

Thickness mm	Width mm	Coil I D mm				
0.04 – ≤ 0.10	30 – 120	100	300			
> 0.10 – ≤ 0.20	4 – 200		300	400		
> 0.20 – ≤ 0.25	4 – 400		300	400		
> 0.25 – ≤ 0.60	5 – 635		300	400		
> 0.60 – ≤ 1.0	8 – 635			400	500	
> 1.0 – ≤ 2.0	15 – 635			400	500	600
> 2.0 – 3.0	25 – 635			400	500	600

inches	inches	inches				
0.0016 – ≤ 0.004	1.20 – 5	4	12			
> 0.004 – ≤ 0.008	0.16 – 8		12	16		
> 0.008 – ≤ 0.010	0.16 – 16		12	16		
> 0.010 – ≤ 0.024	0.20 – 25		12	16		
> 0.024 – ≤ 0.04	0.32 – 25			16	20	
> 0.04 – ≤ 0.08	0.60 – 25			16	20	24
> 0.08 – ≤ 0.12	1.0 – 25			16	20	24

*cut-to-length available in lengths from 500 to 3000 mm (20 to 120 in.)
**maximum thickness 3.0 mm (1/8 in.)

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

Dimensions:
0.01 – 12.7 mm (0.0004 – 1/2 in.) diameter
in coils, pay-off packs, on spools and spiders.

Welding filler metals
Suitable welding rods and wire, wire electrodes and electrode core wire of Nicrofer S 3127 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 SAS, Tour Neptune, F-92086 Paris, La Défense Cedex (Fax: +33-1-4796 8141; Tel,: +33-1-4796 8140; E-mail: dmv-hq@dmv-stainless.com).

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

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