

# Nickel Base Alloys

## DATA SHEET

## D-31

METRODE PRODUCTS LTD  
 HANWORTH LANE, CHERTSEY  
 SURREY, KT16 9LL  
 Tel: +44(0)1932 566721  
 Fax: +44(0)1932 565168 Sales  
 Fax: +44(0)1932 569449 Technical  
 Fax: +44(0)1932 566199 Export  
 Email: info@metrode.com  
 Internet: http://www.metrode.com

## CORROSION RESISTANT ALLOY 59

### Alloy type

Ni-23%Cr-16%Mo alloy commonly known as alloy 59.

### Materials to be welded

#### Alloy 59 and similar:

**ASTM/UNS** N06059  
**DIN** 2.4605 (NiCr23Mo16Al)  
**Proprietary** Microfer 5923hMo (Krupp VDM).  
 Inconel™ Alloy 686 (Special Metals)  
 +W.  
 Hastelloy™ Alloy C-2000™ (Haynes  
 International Inc) +Cu.

#### Alloy C22 and similar:

**ASTM/UNS** N06022  
 A494 Grade CX2MW (cast)  
**DIN** 2.4602 (NiCr21Mo14W)  
 2.4811, 2.4836 (NiCr20Mo15)  
 2.4697 (G-NiCr20Mo15) (cast)  
**Proprietary** Hastelloy™ Alloy C-22™ (Haynes  
 International Inc)  
 Microfer 5621hMoW (Krupp VDM)

#### Superaustenitics including:

**ASTM/UNS** S32654, S31254, S34565  
**Proprietary** 654SMO (Avesta Polarit)  
 Uranus B66 (Usinor Industeel)

Also dissimilar joints between any combination of the above and dissimilar joints between them and superduplex stainless steels.

### Applications

The weld deposit composition of 59%Ni-23%Cr-16%Mo is designed to match the nickel base corrosion resistant alloy commonly known as alloy 59. The high level of Mo is similar to alloys C276 and C4 but performance in a wide range of more oxidising media is significantly enhanced by increasing Cr to 23% in alloy 59. Total alloying exceeds the level typically present in alloy C22; it is therefore considered suitable for welding this group of alloys.

Alloy 59 consumables also provide strong, tough Nb-free weld metal for **dissimilar** welds in superaustenitic and superduplex stainless steels or combinations of these with nickel base alloys. Some authorities do not allow or have discontinued use of 625 type consumables for such applications, where deleterious Nb-rich precipitates may form in diluted or partially mixed regions around the fusion boundary. Alloy C276 is possibly a more economic alternative depending on the required properties in this situation.

Applications of alloy 59 in aggressively corrosive media include **scrubbers** for **flue gas desulphurisation (FGD)**, **digesters** and **papermaking equipment**, **chemical process plants**, **corrosion resistant overlays** and in severe **offshore** and **petrochemical** environments.

### Microstructure

Solid-solution strengthened high nickel austenite, with some microsegregation typical of as-deposited weld metal.

### Welding guidelines

No preheat required, heat input <1kJ/mm and interpass temperature 100°C maximum are desirable to minimise precipitates which may reduce corrosion resistance and ductility of the weld metal.

### Related alloy groups

The alloy C22 is related and covers many of the same applications and base materials.

### Products available

Process	Product	Specification
MMA	<b>Nimrod 59KS</b>	AWS ENiCrMo-13
TIG/MIG	<b>HAS 59</b>	AWS ERNiCrMo-13

# NIMROD 59KS

Basic all-positional pipe-welding electrode for alloy 59

<b>Product description</b>	<p>MMA electrode with special basic flux covering on high purity NiCrMo core wire to give clean homogenous weld metal. Very low levels of C and Si minimise the occurrence of deleterious precipitates in the as-welded condition. The special flux coating provides exceptional operability, optimised for DC+ welding in all positions including fixed pipework in the ASME 5G/6G positions. The electrode is equally suitable for general fabrication welds.</p> <p>Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.</p>																										
<b>Specifications</b>	<b>AWS A5.11</b> <b>BS EN 14172</b> <b>DIN 1736</b>		ENiCrMo-13 E Ni6059 EL-NiCr22Mo16 (2.4609)																								
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 43																										
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Fe	Cu																
	min	--	--	--	--	--	22.0	57.0	15.0	--	--																
	max	0.02	1.0	0.2	0.010	0.015	24.0	bal	16.5	1.5	0.50																
	typ	0.01	0.5	0.15	0.006	0.01	23	60	15.5	1	0.01																
<b>All-weld mechanical properties</b>	As welded					min		typical																			
	Tensile strength					MPa		690	750																		
	0.2% Proof stress					MPa		350	520																		
	Elongation on 4d					%		30	32																		
	Elongation on 5d					%		25	30																		
	Reduction of area					%		--	30																		
	Impact energy					- 50°C		J	50																		
<b>Operating parameters</b>	DC +ve 																										
	ø mm	2.5		3.2		4.0																					
	min A	60		75		100																					
	max A	80		120		155																					
<b>Packaging data</b>	ø mm	2.5		3.2		4.0																					
	length mm	250		300		350																					
	kg/carton	10.5		13.5		15.0																					
	pieces/carton	714		480		297																					
<b>Storage</b>	<p><b>3 hermetically sealed ring-pull metal tins</b> per carton, with unlimited shelf life. Direct use from tin is satisfactory for longer than a working shift of 8h. Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.</p> <p>For electrodes that have been exposed:  <b>Redry</b> 250 – 300°C/1-2h to restore to as-packed condition. Maximum 350° C, 3 cycles, 10h total.  <b>Storage</b> of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended. Recommended ambient storage conditions for opened tins (using plastic lid): &lt; 60% RH, &gt; 18°C.</p>																										
<b>Fume data</b>	Fume composition, wt % typical: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Fe</th> <th>Mn</th> <th>Ni</th> <th>Cr</th> <th>Mo</th> <th>Cu</th> <th>F</th> <th>OES (mg/m<sup>3</sup>)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>4</td> <td>10</td> <td>5</td> <td>6</td> <td>0.2</td> <td>16</td> <td>1</td> </tr> </tbody> </table>											Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m <sup>3</sup> )	1	4	10	5	6	0.2	16	1
Fe	Mn	Ni	Cr	Mo	Cu	F	OES (mg/m <sup>3</sup> )																				
1	4	10	5	6	0.2	16	1																				

# HAS 59

Solid wire for TIG and MIG welding of alloy 59

<b>Product description</b>	Solid wire for TIG and MIG.											
<b>Specifications</b>	<b>AWS A5.14</b> <b>BS EN ISO 18274</b> <b>DIN 1736</b>			ERNiCrMo-13 SNi6059 SG-NiCr23Mo16 (2.4607)								
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 43											
<b>Composition (wire wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Fe	Co	Al
	min	--	--	--	--	--	22.0	56.0	15.0	--	--	0.1
	max	0.010	0.5	0.10	0.005	0.015	24.0	Bal	16.5	1.5	0.3	0.4
	typ	0.003	0.2	0.03	0.003	0.003	23	60	15.6	0.4	0.1	0.3
<b>All-weld mechanical properties</b>	Typical values as welded						TIG					
	Tensile strength					MPa	730					
	0.2% Proof stress					MPa	510					
	Elongation on 4d					%	34					
	Elongation on 5d					%	32					
	Impact energy				+ 20°C	J	140					
Hardness					HV	240						
<b>Typical operating parameters</b>				TIG				MIG				
	Shielding			Argon *				Argon or Ar-He				
	Current			DC-				Pulsed				
	Diameter			2.4mm				1.2mm				
	Parameters			100A, 12V				160A, 28V (mean)				
* Also required as a purge for root runs.												
<b>Packaging data</b>	ø mm	TIG				MIG						
	1.2	--				15kg spool						
	1.6	To order				--						
	2.4	2.5kg tube				--						
<b>Fume data</b>	MIG fume composition (wt %) (TIG fume negligible)											
		Fe	Mn	Cr <sup>3</sup>	Ni	Mo	Cu	OES (mg/m <sup>3</sup> )				
		1	1	17	50	11	<0.5	1				