

CARELSON[®] 60/65 HIC

HIC Resistant Steel for Pressure Equipment in Sour Service

EQUIVALENT STANDARDS

CarElso[®] 60/65 HIC is a special CMn steel adapted for pressure equipment. CarElso[®] 60/65 HIC is manufactured via the electric arc furnace with desulphurisation, dephosphorisation, ladle refining and vacuum degassing to provide a reproducible, clean and homogeneous steel.

The use of special steelmaking practice imparting high steel cleanliness gives CarElso[®] 60/65 HIC excellent resistance to wet H₂S cracking such as HIC. This steel also displays excellent weldability and toughness properties.

This steel is particularly suitable for pressure equipment in refinery applications in sour service conditions, where wet H₂S corrosion can be a problem (e.g. separators, exchangers).

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EN 10028-3 P 275 (NH-NL1-NL2)
ASTM **A 516 gr. 60 / A516 gr.65**
 ASME II Part A SA 516 gr. 60 / SA516 gr.65
 JIS G 3118 Gr. SGV 410

Please consult for multiple certification.

HEAT TREATMENT

Normalising treatment .

PWHT 600°C ± 10°C / 1120°F ± 20°F at 2 minutes per mm or 1 hour per inch.

For other requirements, please consult.

CHEMICAL ANALYSIS

Guaranteed values on heat (Weight %)

	C	Mn	Si	P	S	Ni	Cr	Mo	Cu
CarElso 60/65 HIC	≤ 0.20	0.85-1.20	0.15-0.40	≤ 0.008	≤ 0.002	≤ 0.4	≤ 0.30	≤ 0.12	≤ 0.20

Ceq. ≤ 0.39% for grade 60 and Ceq. ≤ 0.41% for grade 65, thickness ≤ 105mm (≤ 4 inches).

Please consult for higher thickness.

(Ceq (%)) = C + Mn/6 + (Cr+Mo+V)/5 + (Ni+Cu)/15).

MECHANICAL PROPERTIES

Typical transverse tensile values at room temperature after PWHT

Guaranteed values as per applicable National Standard

	YS (MPa / ksi) Min	TS (MPa / ksi)		El.% Min
		Min	Max	
t < 35mm	275 / 40	415 / 60	550 / 80	24
35 < t ≤ 50mm	265 / 38			
50 < t ≤ 70mm	255 / 37			
70 < t ≤ 100mm	235 / 34			
100 < t ≤ 150mm	225 / 33			
150 < t ≤ 250mm	220 / 32			23

Plate soundness guaranteed to ultrasonic levels determined by ASTM A 578 level B or EN 10160-S1E2.

IMPACT PROPERTIES

HIC RESISTANCE

CarElso® 60/65 HIC guarantees reduction in area in through-thickness tensile testing $Z\% \geq 35\%$ average/25% mini as per ASTM A770 / EN 10164 (testing an added extra).

Guaranteed high temperature tensile properties as per P275(NH-NL1-NL2).

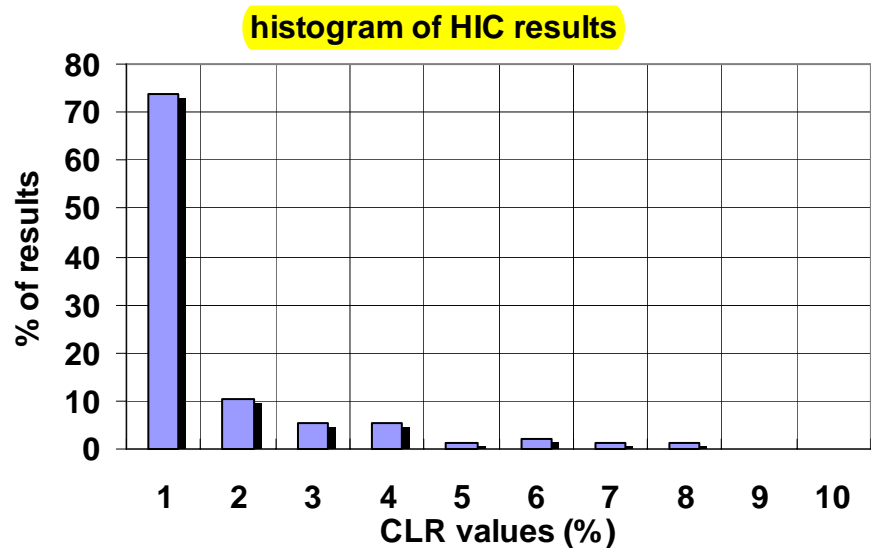
Transverse Charpy toughness values of 20J average / 14J minimum can be guaranteed down to -46°C / -50°F for plates $\leq 150\text{mm}$ for the PWHT conditions given above. Please consult for higher thickness and other impact requirements or PWHT conditions.

CarElso® 60/65 HIC is a reproducible and clean steel with strict limits on impurity elements, giving excellent resistance to Hydrogen-Induced Cracking (HIC).

The mill-certified HIC guarantees on plate are given below. For other acceptance criteria, please consult.

	CLR (%)	CTR (%)	CSR (%)
HR1	5	1,5	0,5
HR2	10	3	1
HR3	15	5	1,5

HIC testing following NACE TM0284-96 in solution A (pH3). Average value of three specimens taken at upper surface, mid-thickness and lower surface.



Histogram of typical values from HIC testing on Industrial production of CarElso® 60/65 HIC.

This excellent level of HIC resistance requires extra low sulfur and oxygen contents in order to reduce the size and number of sulfide and oxide inclusions. These inclusions are known initiation sites for HIC cracks. The ultra-low sulfur and oxygen contents given below mean that additional sulfide shape control measures, such as additional calcium treatment, are not necessary.

In addition, a low phosphorus content is also crucial to reduce the risk of cracking in microsegregated areas. It also results in a less-banded microstructure.

Impurity levels	typical	maximum
P	0.005%	$\leq 0.008\%$
S	0.001%	$\leq 0.002\%$
[O]	10 ppm	≤ 20 ppm

Typical and guaranteed impurity levels necessary to ensure excellent HIC resistance. Supplementary H_2S testing conditions (for example SSC testing according to NACE TM0177-96) are available upon request.

FORMING

Cold forming (+ stress relief for high strains) or hot forming can be applied:

- cold forming (< 500°C/930°F) : to be followed by Post-Weld Heat Treatment (PWHT)
- hot forming (900-1100°C/1650-2010°F) : to be followed by complete heat treatment + PWHT

Please contact us for full heat treatment details.

WELDING CONDITIONS

The reduced carbon equivalent of CarElso® 60/65 HIC means that under typical industrial conditions, pre-heating is not required.

HAZ PROPERTIES

In H₂S service, it is necessary to limit the maximum HAZ hardness to ≤ 22HRC or ≤ 248Hv10 in order to reduce the risk of Sulfide Stress Cracking (SSC). CarElso® 60/65 HIC has been designed to comply fully with these limits imposed by NACE Standard MR 0175/ISO 15156.

In order to control the maximum HAZ hardness, the carbon equivalent must be limited, ideally to ≤ 0.43%, and microalloying additions should be avoided for normalised steels. CarElso® 60/65 HIC, with a carbon equivalent ≤ 0.38%, easily meets these requirements, and the hardness limit can be met under a wide range of welding conditions, even without PWHT.

FILLER MATERIALS

Consumables used for the welding of CarElso® 60/65 HIC must correspond to the following standards:

	SMAW	GMAW	FCAW	SAW wire-flux
EN	EN 499 E 42 X X X H5	EN 440 G 42 X X	EN 758 T 42 X X H5	EN 756/EN 760 S 42 XX
AWS	A5-5 E 70xx	A5-18 ER 70 S-x	A5-20 E 7xT5-x	A5-17 F7P4-Exxx

A non-exclusive list of suitable filler materials is given hereafter:

	SMAW	GMAW	FCAW	SAW	
				Wire	Flux
BOEHLER	Fox Ev 50	EM K7		EM S3	
ESAB	OK 48.00	OK 12 .51	OK 15.00	OK 15.00S	OK 10.71
LINCOLN	Excalibur 7018	SuperArc L-56	Outershield 75C	Lincolnweld L-56	880M
OERLIKON	TENACITO	CARBOFIL 1	FLUXOFIL 31	OE-S3	OP122
SAF	SAFDRY 58	NERTALIC 70A	SAFDUAL 200	AS 36	AS 462
T-PUT	Phoenix SH G K70	Union K56	Union BA70	Union S3	UV 421 TT

This list of filler materials has been determined according to suppliers' data, please confirm this choice with your supplier.

APPLICATIONS

CarElso[®] 60/65 HIC is suitable for pressure vessels where H₂S is present, such as processing equipment in the oil and gas industry. This grade complies with the requirements of all major materials specifications for materials for sour service.

NOTE

This technical data and information represents our best knowledge at the time of printing. However, it may be subject to some slight variations due to our ongoing research program on hydrogen service grades.

We therefore suggest that information be verified at time of enquiry and order. Furthermore, in service, real conditions are specific for each application. The data presented here is only for the purpose of description, and may only be considered as guarantees when our company has given written formal approval.

Further information may be obtained from the following address.

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