Industeel

ArcelorMittal

CarElso™ 70 HIC
SA-516 gr. 70

CarElso™ 70 HIC: HIC Resistant Steel for Pressure Equipment in Sour Service

CarElso™ 70 HIC is a special high strength normalised CMn steel adapted for pressure equipment. CarElso™ 70 HIC is manufactured via the electric arc furnace with desulfurisation, dephosphorisation, ladle refining and vacuum degassing to provide a reproducible, clean and homogeneous steel.
The use of special steelmaking practice giving high steel cleanliness gives CarElso™ 70 HIC excellent resistance to wet H_2S cracking such as HIC. This steel also displays excellent weldability and toughness properties.
This steel is particularly suitable for pressure equipment in both refinery and gas treatment applications under sour service conditions, where wet H_2S corrosion can be a problem (e.g. high pressure separators).

PROPERTIES

STANDARDS

> EN 10028 - 3	P 355 (N - NH - NL1 - NL2)
> ASTM	A 516 gr. 70
> ASME II Part A	SA 516 gr. 70

Please consult for multiple certification

CHEMICAL ANALYSIS - WEIGHT %

C	Mn	Si	P	S	Ni	Cr	Mo	Cu
≤ 0.22	0.85 - 1.20	0.15 - 0.40	≤ 0.008	≤ 0.002	≤ 0.4	≤ 0.30	≤ 0.12	≤ 0.20

Guaranteed values on heat.
Ceq. ≤ 0.43% for thickness ≤ 105 mm (≤ 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)	TS (MPa /ksi)		Elongation%
	Min	Min	Max	Min
t < 35 mm	355 / 52	490 / 71	580 / 84	21
35 < t ≤ 50 mm	345 / 50	490 / 71	580 / 84	21
50 < t ≤ 70 mm	325 / 47	490 / 71	580 / 84	20
70 < t ≤ 100 mm	315 / 46	485 / 70	575 / 83	20
100 < t ≤ 150 mm	295 / 43	485 / 70	575 / 83	20
150 < t ≤ 250 mm	295 / 43	485 / 70	575 / 83	19

Plate compacity guaranteed to ultrasonic levels determined by ASTM A 578 level B or EN 10160 - S1E2. CarElso® 70 HIC guarantees reduction in area in through - thickness tensile testing Z% ≥ 35% average/25% mini as per ASTM A770/EN10164 (testing an added extra). Guaranteed high temperature tensile properties as per EN 10028 - 3 P355 (N - NH - NL1 - NL2).

IMPACT PROPERTIES

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

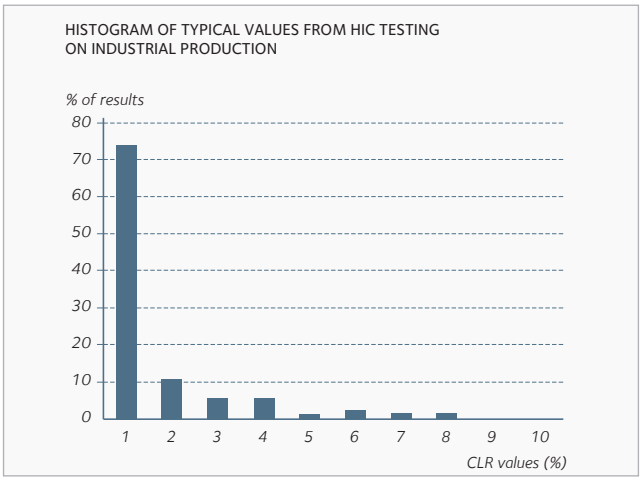
HIC RESISTANCE

CarElso™ 70 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.

HIC testing according to NACE TM0284 solution A (pH3). Average value of all specimens.

	CLR (%)	CTR (%)	CSR (%)
HIC 1	5	1.5	0.5
HIC 2	10	3	1
HIC 3	15	5	1.5

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.



Typical and guaranteed impurity levels necessary to provide excellent HIC resistance.

Impurity Levels	Typical	Maximum
P	0.005%	≤ 0.008%
S	0.001%	≤ 0.002%
[0]	10 ppm	≤ 20 ppm

Supplementary H_2S testing conditions (for example SSC testing according to NACE TM0177) are available upon request.

HEAT TREATMENT

Normalising treatment. PWHT 600°C ± 10°C / 1120°F ± 20°F during 2 minutes per mm or 1 hour per inch.
For other requirements, please consult.

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

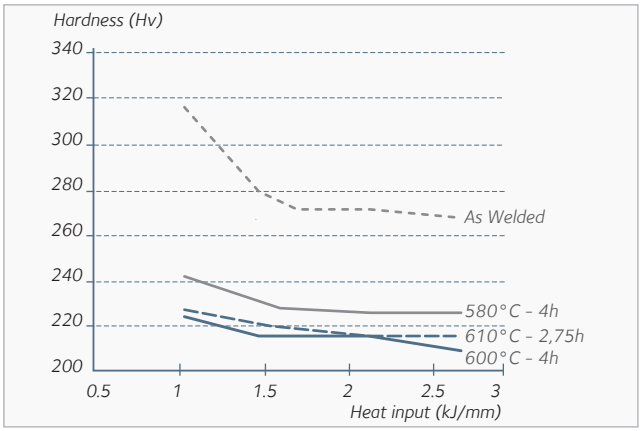
The reduced carbon content allows the use of low preheating temperatures.

Heat Input	Hydrogen Content	Preheating Temperature	Post - heating
1.0 - 2.0 kJ/mm	$3 \leq H_2 < 5$ ml/100 g (SAW, SNAW)	100°C	100°C / 2h
1.0 - 1.5 kJ/mm	$H_2 \leq 3$ ml/100 g (FCAW, GMAW)	100°C	100°C / 2h

Minimum preheating temperature as defined by implant testing (NFA 89100).

HAZ PROPERTIES

In H_2S 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® 70 HIC has been designed to comply fully with these limits imposed by 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. In such cases, the hardness limit can be met for CarElso™ 70 HIC after PWHT under a wide range of welding conditions. The following typical hardness values have been measured in the HAZ (Fusion Line + 1 mm) in the as - welded and PWHT conditions.



The toughness of the HAZ is excellent, as shown by the following results obtained across the weldment in the as - welded condition (impact values in Joules).

Temperature	Fusion line		FL + 1 mm		AC1	
0°C (32°F)	200 218 176	Av 198				
- 40°C (- 40°F)	110 148 180	Av 146	208 222 220	Av 217	222 166 170	Av 186

FILLER MATERIALS

Consumables used for the welding of CarElso™ 70 HIC must correspond to the following standards:

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

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

	SMAW	GMAW	FCAW	SAW	
				Wire	Flux
BÖHLER	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 K 70	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™ 70 HIC is suitable for pressure vessels where H_2S is present, such as processing equipment in the oil and gas industry. This grade complies with all major materials specifications for materials for sour service.

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