

CarElso™ SOHIC

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Stress Oriented Hydrogen Induced Cracking Resistant Steel for Pressure Equipment in Severe Sour Service

CarElso™ SOHIC is a special low carbon Quenched and Tempered (QT) or Normalized with Accelerate Cooling and Tempered (NACT) CMn steel adapted for pressure vessel.

Steel is designated for use in oil refining and gas treatment applications under severe sour service conditions, where **high Sulfur content and existing stress** cause damages.

CarElso™ SOHIC is the steel with guaranteed resistance to wet H₂S cracking mechanisms.

The manufacturing is made via the electric arc furnace with desulfurization, dephosphorisation, ladle refining and vacuum degassing to provide a reproducible, clean and homogeneous structure. Industeel controls and guarantees:

- the segregation mitigation during casting
- the deep deoxidation to avoid inclusions,
- extra low sulphur level to control and guarantee the inclusion shape
- the ultralow phosphorus levels for enhanced in-service resistance

This steel is weldable and show very good toughness properties.

Industeel produces, tests and guarantees CarElso™ SOHIC resistant steel from 6 to 105 mm thick with maximum unit weight of 20T issued from continuous casting, and from 60 to 250 mm thick with maximum weight 70t from ingot casting route.

PROPERTIES

STANDARDS

- > ASME / ASTM SA/A 516 grade 60 or 65 or 70 NACT
- > EN 10028 - 6 P 265 Q to 355 Q - series

Multiple certification may be considered, please consult us.

CHEMICAL ANALYSIS - WEIGHT %

C	Mn	Si	P	S	Ni	Cr	Mo	Cu
≤ 0.20	0.85 - 1.20	0.15 - 0.40	≤ 0.008	≤ 0.002	≤ 0.4	≤ 0.30	≤ 0.25	≤ 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).

HEAT TREATMENT

Plate are delivered after quality heat treatment Quenching and Tempering (QT) or Normalized with Accelerate Cooling and Tempering (NACT).

MECHANICAL PROPERTIES

Transverse tensile values at room temperature are guaranteed and performed as per applicable Standards. Optional High temperature test can be performed when required, with minimum guaranteed values in accordance with applicable standard ASME II Part D or EN 10028-6.

CarElso™ SOHIC is delivered with min Z35% guaranties as per ASTM A770/EN10164 and max hardness 22HRC / 248HV10 (*through-thickness tensile test Z and hardness HRC/HV10 test can be performed upon request*).

Impact tests and other supplementary guaranties can be agreed before order, as per specification need.

Please consult for higher thickness and other impact requirements or PWHT conditions.

CORROSION PROPERTIES

NACE MR0175/ISO 15156 is the applicable standard governing the selection of materials and warranties, depending on the severity level of the equipment's operating environment.

HYDROGEN INDUCED CRACKING (HIC) RESISTANCE GUARANTEE

Test will be performed only upon request.

HIC resistance is guaranteed as per NACE MR0175/ISO15156.

Test can be performed upon request, please consult for acceptance criteria.

SOHIC RESISTANCE TEST

Through its uniform microstructure, low carbon content and excellent resistance to both SSC (Sulfide Stress Cracking) and HIC, CarElso™ SOHIC was designed to proves the high resistance to SOHIC phenomenon.

SOHIC resistance is checked by Supplementary H₂S testing, such as SSC testing according to NACE TM0177 Method A. Evaluation follows NACE test method as per MR0175/ISO 15156-2 Annex B.4.2.2.a.

Please consult for test details and acceptance criteria.

Test method as per NACE TM0316 can be performed upon request.

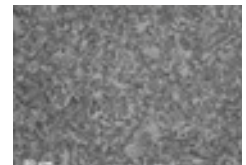


PLATE PROCESSING

STRESS RELIEVE / POST-WELD HEAT TREATMENT

Test coupons are simulated with Post-Weld Heat Treatment (PWHT) with parameters as recommended by Table UCS-56 of ASME II Part D, or EN 10028: nominal temperature is between 610°C and 630°C (1130°F-1166°F) and soaking time during 2 minutes per mm or 1 hour per inch.

For other requirements, please consult.

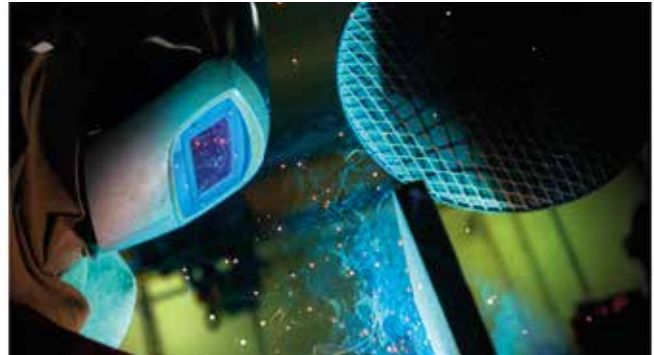
FORMING

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

WELDING CONDITIONS

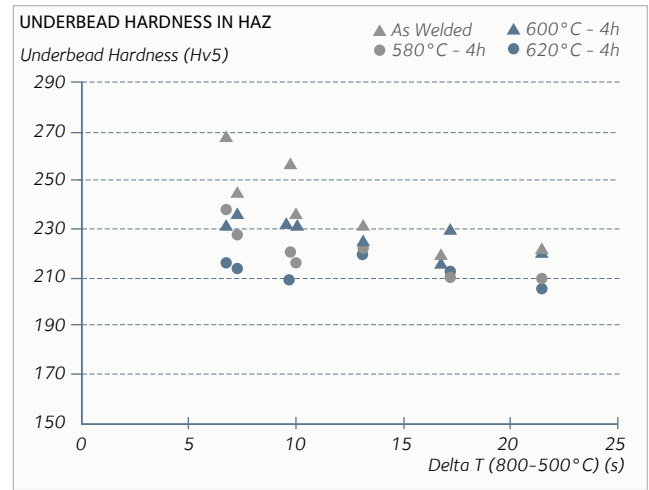
Implant testing according to the French standard. NFA 89100 shows that preheating is not required for a high hydrogen rate, if the load is 400 MPa and the heat input is 1 kJ / mm. Therefore, CarElso™ SOHIC can be welded without preheating, under typical industrial conditions.



HAZ PROPERTIES

As per Standard NACE MR 0175/ISO 15156 it is mandatory to limit the HAZ hardness to maximum 22HRC (248HV10) for carbon steel used in H₂S service, to reduce the risk of Sulfide Stress Cracking (SSC).

CarElso™ SOHIC has been designed to comply fully with these limits. Accelerated cooling heat treatment allows the carbon content as low as possible, to guarantee the necessary strength. Consequently, the HAZ hardness, both as welded and after PWHT, is situated under necessary maximum level (22 HRC). In such cases, the hardness limit can be met for CarElso™ SOHIC under a wide range of welding conditions, even without PWHT.



HAZ hardness as a function of heat input for CarElso™ SOHIC

Example of the excellent toughness (J) in the welded joint of CarElso™ SOHIC on plate thickness 20 mm. Results obtained on a butt welded joint with FCAW process (1.2 KJ/mm) and located in the lower cap.

	As welded		After 620°C/4h	
	- 40	- 60	- 40	- 60
Temperature (°C)	- 40	- 60	- 40	- 60
Fusion Line	207	62	101	20
FL + 0.5 mm	238		277	
FL + 2 mm	99	63	256	266
FL + 5 mm	270		252	

FILLER MATERIALS

Consumables used for the welding of CarElso™ SOHIC 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

FILLER MATERIALS FILLER MATERIALS

Following non-exclusive list of suitable filler materials has been determined according to suppliers' data:

	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	SAFDRIY 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

DELIVERY CONDITIONS

Plates are supplied in QT or NACT heat-treated conditions.
Dimensions are in accordance with A/SA20 or EN 10029, as applicable.
Marking is low stress die as per A/SA20.

OPTIONAL

Both surfaces can be shot blasted Sa2.5 as per ISO 8501.

Internal soundness: plates can be ultrasonic controlled as per A/SA435, A/SA578 or EN 10160 standards.

Supplementary SERVICES can be agreed, as per attached Annex.

YOUR CONTACTS

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Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.

READY TO ASSEMBLY PHILOSOPHY

Our Industeel Dunkirk unit developed over the years a high level of know-how and became an undisputed partner for the delivery of project parts direct on site.

Unit is located on the quay allowing the loading on barge, has a connection with the railway and a fast connection to the motorway.

Main special prefabrication operations and standard tolerances are shown hereafter:



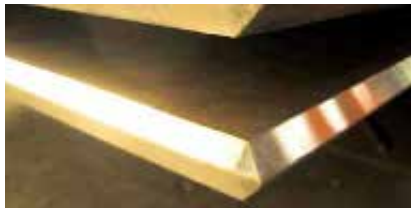
CUTTING

from 4 to 250 mm



MECHANICAL BEVELING:

straight or angle bevel with max length of 16



COLD FORMING:

Max thickness: 105 mm
Max width: 10 000 mm



TRANSPORT:

Special pack



SHELL AND THERMAL CORNER PROTECTION		
Measuring	tolerance	Measuring profile
Width : W (before bending)	+/-1,5mm	
Lenght : L (before bending)	+/-1,5mm	
Diagonal : C1-C2 (before bending)	≤3mm	
Bevel angle	+/-2,5°	
Root face : N,M	0/+1mm	
Deviation from roundness :X	0 to 3 mm	
Warpage : Y 2 M measurements has 200mm extremities of the plate	11mm	
SECONDARY/PRIMARY ANNULAR + STIFFENERS + EMBEDDED PLATE + TEST PLATE		
Measuring	tolerance	Measuring profile
Width : W	+/-1,5mm	
Lenght : L	+/-1,5mm	
Diagonal : C1-C2	≤3mm	
Bevel angle	+/-2,5°	
Root face	0/+1mm	
Deviation on tempate radius	+/-3mm	
INNER AND SECONDARY BOTTOM (other laping assembly)		
Measuring	tolerance	Measuring profile
Width : W (before bending)	0/+20mm	
Lenght : L (before bending)	0/+20mm	

Additional services like Mechanical drilling, Surface preparation, Non-destructive inspection, Welding, etc may be considered, please consult us.

Big storage facility is available, for just in time delivery.