Industeel

ArcelorMittal

SuperElso® 500HR

SuperElso® 500HR: Quenched and tempered High Strength Steel for Pressure Equipment in Wet H_2S Service

SuperElso® 500HR (SE 500HR) is a quenched and tempered adapted for pressure equipment operating under wet H_2S service condition. SE 533 is manufactured via the electric arc furnace route, with dephosphorization, ladle refining and vacuum degassing to provide a reproducible, clean and homogeneous steel.
The chemistry of SE 500HR has been carefully adapted to combine high strength, good weldability and excellent impact properties at low temperature (down to -60°C / -76°F). It is designed to meet the requirements of NACE standard MR0175 / ISO15156.
SuperElso® 500HR is particularly suitable for pressure equipment in wet H_2S service in the offshore oil and gas industry, where its high strength allows significant weight and cost reduction.

PROPERTIES

STANDARDS

> EN 10028 Part 6 P500Q - QH - QL1 - QL2
Note: this grade exists also in ASTM / ASME standard under SuperElso® 533E

CHEMICAL ANALYSIS (MASS WEIGHT %)

Typical heat analysis

C	Mn	Si	P	S	Ni	Cr	Mo
≤ 0.10	1.15 -1 .70	≤ 0.40	≤ 0.007	≤ 0.002	≤ 1 .0	≤ 0.60	0.25 - 0.60

Nb+V ≤ 0.02% (in order to allow adequate softening of the HAZ during PWHT).

DELIVERY CONDITION

Water quenched and tempered. Delivery in the as-rolled condition is possible if heat treatment has to be done after forming.

MECHANICAL PROPERTIES

Tensile properties at room temperature as per EN10028-6 are guaranteed after Post Weld Heat Treatment (PWHT):

Tensile properties of ASTM A533 Type E Class 2 / ASME SA-533 Type E Class 2

Temperature	YS mini		UTS mini		UTS maxi		Elongation mini
	Mpa	ksi	Mpa	ksi	Mpa	ksi	%
t ≤ 50 mm	500	72	590	86	770	112	17
50 < t ≤100 mm	480	70	590	86	770	112	17
t > 100 mm	440	64	540	78	720	104	17

Tensile properties at high temperatures are available on request.

Impact properties with Charpy-V transverse test specimens:

Impact test according to ASTM A370

Test temperature °C (°F)	Average impact value in Joules
-5o (-58)	≥ 60

The specified value is the average of three tests. Impact properties are guaranteed both at quarter-thickness and mid-thickness. Toughness requirements at other temperatures can be agreed upon on the inquiry.

SOUR SERVICE PROPERTIES

SuperElso® 500HR is designed to meet following requirements:

- **> Hardness requirements as per NACE MR0175 / ISO 15156-2**
- **> Other requirements upon agreement.**

PLATE PROCESSING

FORMING

SuperElso® 500HR can be processed by cold forming or hot forming:

Cold or warm forming

Any forming that is performed at a temperature below 705°C (1300°F)

Hot forming

Any forming that is performed at or above a temperature of 705°C (1300°F).

If forming is done at a temperature above the tempering temperature indicated in the plate certificate, a subsequent full heat treatment (quenching and tempering) may be necessary.
Please consult us in order to get recommendations on heat treatment.

HEAT TREATMENT

Austenitizing and tempering treatment

Austenitizing at 900°C – 950°C (1650°F – 1800°F), water quenching. Tempering after water quenching according to the manufacturer 's recommendations.

Stress relieving treatment (post weld heat treatment)

At 600°C – 635°C (1110°F – 1175°F).

WELDING

Filler materials

A non-exclusive list of suitable filler materials is provided below:

Supplier	SMAW	FCAW	SAW
OERLIKON	TENACITO 70	FLUXOFIL MI 41	UP OE-SD3Mo / OP42TT FLUXOCORD 41 /OP121TT (* / **)
ESAB / PHILARC	-	OK 15.24/ PZ 61 45 / PZ6138	OK 13.24 -OK 15.28 OK Flux 10.62

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

* successfully tested by Industeel.

** Ni content is greater than 1%

Welding conditions

The reduced carbon content of SuperElso® 500HR allows the use of low preheating temperatures.

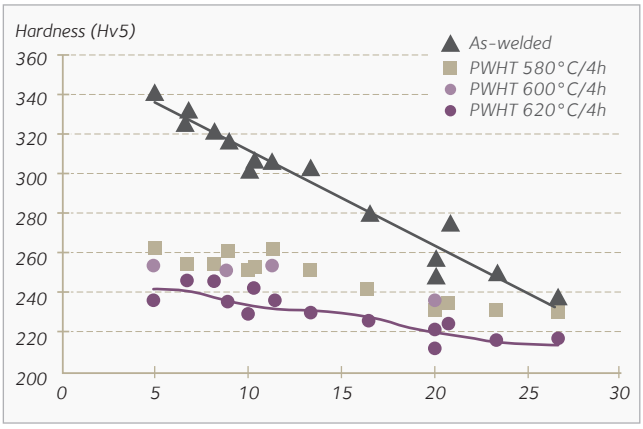
Heat Input	Hydrogen content	Preheating temperature	Post-heating
1.0 kJ/mm	3 < H2 < 5ml/100 g (SAW, SMAW)	100°C	Yes *
1.0 kJ/mm	H2 ≤ 3 ml/100 g (FCAW, GMAW)	75°C	Yes *
1.5 kJ/mm	H2 ≤ 3 ml/100 g (FCAW, GMAW)	No Preheating**	No Post-heating**

**: to be determined according to the plate thickness (min 150°C/2h). **: when the plate temperature is higher than 10°C.*

These welding conditions have been determined for highly clamped welds (Implant tests, NFA 89100). When the stresses are lower, SuperElso® 500HR can be welded with no preheating (results of CTS according to EN10225).

Underbead hardness

Compared to other quenched and tempered grades, SuperElso® 500HR low carbon content ensures good HAZ softening properties with PWHT in the range 600 - 620°C (1120-1150°F), allowing the 22HRC limit of NACE MR0175/ISO15156.



Underbead hardness for 25 mm thick SE 500HR as a function of the cooling rate (Δt 800/500 - (s)).

HAZ properties

The following results have been obtained on SAW welds performed with OERLIKON SAW combination Fluxocord 41/ OP121TT

Tests conditions		Toughness results			
State	Test location	Av. KV WM (J)	Av. KV FL (J)	Av. KV FL+2 (J)	Av. KV FL+5 (J)
As welded	Cap - 60°C	79	66	4243	295
	Root -60°C	140	123	297	296
PWHT 620°C / 4h	Cap - 60°C	99	222	246	292
	Root -60°C	99	192	286	298
As welded	Cap - 40°C	87	30	293	267
	Root -40°C	124	135	291	286
PWHT 620°C / 4h	Cap - 40°C	68	173	271	290
	Root -40°C	60	173	282	291

APPLICATIONS

SuperElso® 500HR is suitable for pressure vessels where H_2S is present, such as gas processing equipment (separators, scrubbers etc.) in the oil and gas industry. It is particularly aimed at offshore applications where its high mechanical properties allow significant wall thickness reduction.

SuperElso® 500HR can be supplied as plates, shells and heads, with or without stainless or alloy cladding.

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