Industeel

ArcelorMittal

CromElso™ 92

Special alloy steel (9Cr2W0.5Mo0.2V)

CromElso™ 92: Special alloy steel (9Cr2W0.5Mo0.2V) with EXTRA HIGH temperature creep resistance

CromElso™ 92 is an alloyed martensitic CrMoVNb steel designed for high temperature creep resistance up to about 620°C (1150°F). **CromElso™ 92** is manufactured via the electric arc furnace with dephosphorisation, ladle refining and vacuum degassing to provide reproducible, clean and homogeneous steel.

CromElso™ 92 steel ensures enhanced weldability for pipe, boiler and pressure vessel fabrication. Combining use of special steel making practice and balance of chemical elements as well as controlled ratios of compositional elements permits to guarantee the strong martensitic structure. Impact toughness properties in heat affected zone and high creep resistance properties are also improved.

CromElso™ 92 is available in plate form in thickness up to 75 mm. This steel is particularly suitable for supercritical steam piping for enhanced thermodynamical efficiency in energy generation processes, for heavy section components in thermal power plants and for pressure vessel applications typical of the refining and nuclear.

PROPERTIES

STANDARDS

> ASTM	A1017 grade 92 (UNS K92460)
> ASME	Code Case 2179 (UNS K92460)

CHEMICAL ANALYSIS AND MICROSTRUCTURE

Typical values on heat (weight%).

C	S	P	Si	Mn	Cr	W	Mo	V	Nb	N	Al
0.10	0.002	0.018	0.3	0.4	9.00	1.9	0.40	0.2	0.08	0.05	0.015

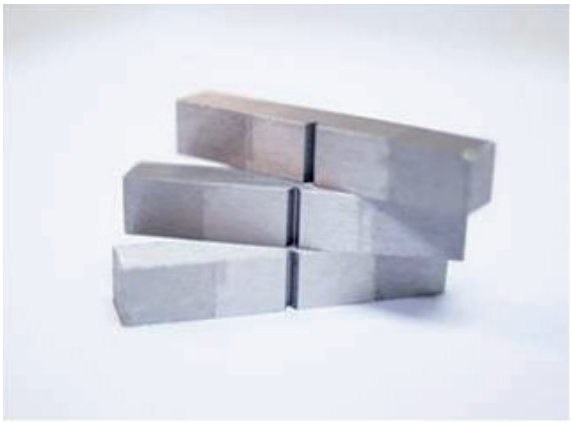
The chemistry is specially balanced to combine good welding and fabrication properties as well as optimised mechanical properties and creep strength.
This is tempered fully martensitic steel with a combination of composition and microstructure that contributes to the creep resistance.

MECHANICAL PROPERTIES

Transverse values at room temperature. According to applicable standards and customer specifications.
Minimum guaranteed values for as-delivered plates are per the following table.

Thickness (mm)	Rp 0.2 (MPa/ksi)	Rm (MPa/ksi)	A (%)	Kv (J) Average		
				-20°C (-4°F)	0°C (32°F)	+20°C (68°F)
t<150	440 (64)	620-840 (90-122)	20	27	34	40

The high-end targeting of plate mechanical properties contribute to creep resistance and gives reserve for the lowering of properties linked with further heat processing during fabrication.
Typical as-delivered conditions transverse Charpy-V impact strength values at -20°C can reach about 100 J; the balanced low carbon martensite possesses sufficient toughness.
As per studies showing a correlation between hardness and creep resistance, **CromElso™ 92** can be guaranteed to possess an as-delivered conditions hardness of minimum 210 and no more than 260 HV10.
Actual high temperature tensile properties can be provided upon request. For information, some of these are described in the material standards.



The internal soundness of the plates is guaranteed in accordance with international standard ASTM A 578 or EN 10160. Other standard can be used upon request.

The surface state delivery condition is generally shot blasted.

CREEP PROPERTIES

Creep resistance is generally considered as the main interesting engineering property of **CromElso™ 92**. It comes from the chemical analysis and the special ladle metallurgy treatment and leads to the synergistic effect of the high strength martensitic structure and the dislocation and grain boundary movements locking features of the steel microstructure. This provides for the targeted high tensile strength as well as hardness, while maintaining acceptable levels of toughness.
A full research program is ongoing to collate most relevant creep data on base materials and weldments. Some historical data of earlier generation materials is also available as basic reference.
ECCC also publishes useful information on creep resistance.

Please enquire for further information.

PLATE PROCESSING

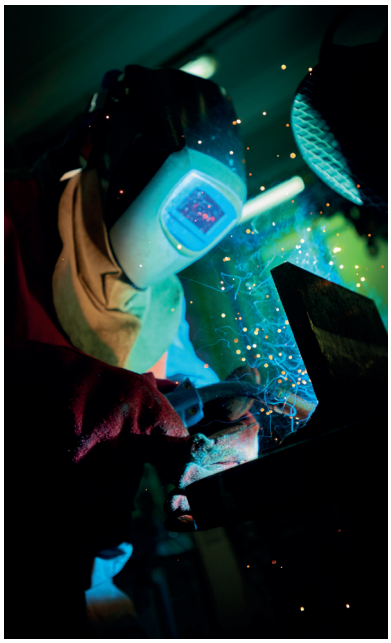
HEAT TREATMENT

Normalising temperature is in the range 1040-1080°C (1904-1976°F) and tempering above 750°C (1382°F).
Tempering temperature must be confirmed with the mill, as a function of required mechanical properties and PWHT.

The total fabrication sequence of the final equipment may necessitate several cycles of heat treatments. The plate steel chemistry is specially designed to support that higher number of heat treatments cycles.
It is furthermore possible to adjust plate tempering parameters to minimize the equivalent time-temperature impact on the material while assuring the suitable level of properties of the welds.

For any special need or application, our specialist will help and assist, please enquire.

FABRICATION AND WELDING CONDITIONS



Cutting of the material can be executed by shear cutting or plasma cutting, or any other suitable method. Care should be taken not to introduce hydrogen in the material, through the gases or the presence of humidity. Thermal cutting will harden the heat affected zone close to the cut edge. Normal practice however does not embrittle the material, but further machining e.g. to bevel the edges before welding may prove to be more demanding on the beveling tools. A pre-heating at 200 °C (392 °F) and post-heating at same temperature for at least 2 hours are advisable. Oxycutting is not preferred due to the high chromium content of the grade.
When no heat treatments are further scheduled in the processing of the CromElso™ 92 plates, then a regeneration heat treatment according to the parameters indicated in the materials certificate is recommended when cold deformation exceeds 5%.
A short stress-relieve cycle may be applied when cold deformation is between 3 and 5%.

Welding consumables should preferably be of chemically matching composition. The following table summarizes typical acceptable standards.

	SMAW	GTAW - GMAW	FCAW	Wire-Flux combination SAW	
				wire	flux
AWS	A5.5: E9015-B9 E9015-B92 E901x-G H4	A5.28: ER 90S-B9 (mod)	A5.36: E91T1-M21PZ-B92	A5.23: F9 PZ EG-G EB91 (mod.)	
EN/ISO	EN ISO 3580-A: E Z CrMoWCoVNb9 0.5 2 1) B 42 H5	EN ISO 21952-A: GZ CrMoWVNb 9 0.5 1.5	EN ISO 17634-B T69 T1-1M-G	EN ISO 24598-A : S S Z CrMoWVNb 9 0.5 1.5	EN ISO 14174: SA FB 2 55 DC

Currently, there are no standards for GMAW and FCAW processing.

The following consumables have been considered by Industeel and are available from various suppliers. This list is not intended to be limitative.

	SMAW	GTAW	GMAW	FCAW	SAW	
					Wire	Flux
METRODE	Chromet 92 (TECHTRODE B92)	9 CrWV (TECHTIG B92)		Supercore F92 (TECHCORE B92)	9CrWV (TECHMERGE S B92)	LA490 (TECHMERGE F LA490)
VABW	Thermanit MTS 616 Thermanit MTS 616 LNi (Mn+Ni ≤1.2)	Thermanit MTS 616	Thermanit MTS 616	Böhler P 92 Ti-FD	MTS 616	Marathon 543
OERLOKON	CROMOCORD 92 CROMO E92	CARBOROD CrMo92	CARBOFIL CrMo92		OE-S1 CRMO 92	OP9W

Preheating should be at least 200 °C (392 °F) whereas interpass temperature should remain below 325 °C (617 °F).

Suggested heat input range is between 1.0 and 2.0 kJ/mm to limit the risks of cold and hot cracking. Care should be taken to avoid hydrogen pick-up in the weld zone and when considering temporary attachments.
PWHT should be sufficient to remove welding stress while at the same time avoiding a drop of mechanical properties below the minimum of the required standards.

Due to the need for heat treatment in the weld metal most user requirements demand relatively high values of the time-temperature parameter: $P=T(K)\ [20+\log(t(hr))]/1000$

Extensive testing and research made by Industeel shows that CromElso™ 92 plate material can keep P up to 21.5 or slightly higher in certain circumstances, resulting from specially targeted metallurgy and optimized heat treatment cycles.

APPLICATIONS

CromElso™ 92 is suitable for ultra-superheated/supercritical steam piping of power and co-generation plants. As it is a plate material, it allows for fabricating larger pipes than the usual seamless materials. It is also very suitable to fabricate the pipe support systems.

It can also be used for some pressure vessel applications as well as for certain valve systems in the oil & gas and other chemical and processing industry. It can also find applications in solar and other renewable thermal power applications.

Furthermore, it is a candidate material for vessel fabrication in nuclear power plants as well as future radioactive waste disposal nuclear reactor designs or parts of nuclear fusion reactors. It's very low molybdenum and nickel contents compared to standard austenitic stainless steels or other 9%Cr steels make it less prone to activation under irradiation.

For any information for specific applications, please consult .

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