Industeel

ArcelorMittal

CromElso™ 91

Chromium-Molybdenum Steel

Special alloy (9Cr1MoVNb) steel for high temperature creep service

CromElso™ 91 is an alloyed martensitic CrMoVNb steel designed for high temperature creep resistance up to about 600°C (1100°F). **CromElso™ 91** is manufactured via the electric arc furnace (EAF) with dephosphorisation, ladle refining and vacuum degassing to provide reproducible, clean and homogeneous steel.

Combining use of special steel making practice and balance of chemical elements as well as controlled ratios of compositional elements permits to guarantee adequate martensitic structure. **CromElso™ 91** steel ensure enhanced weldability for pipe, boiler and pressure vessel fabrication, improved impact toughness properties in heat affected zone and high creep resistance properties.

CromElso™ 91 is available in plate form in thickness up to 200 mm and is particularly suitable for supercritical steam piping. Heavy sections can be found in thermal power plants and for various pressure vessel applications in refining and nuclear industries.

Properties

Standards

CromElso™ 91 is compliant with:

- ASTM/ASME A/SA-387 gr91 Type 1 or Type 2 cl2 (UNS K90901)
- EN 10028-2 X10CrMoVNb9-1 (1.4903)

For other standard compliancy, please consult.
Multiple certifications are possible on request.

Tensile properties

Guaranteed transverse tensile properties at room temperature. *(Measured on every plates):*

Standard	Plate thickness (mm)	Yield Strength (MPa)	Ultimate Tensile Strength (MPa)	Minimum Elongation (%)
EN 10028-2 X10CrMoVNb9-1	< 60	≥ 445	580-760	18
	60-150	≥ 435	550-730	
	150-250	≥ 435	520-700	
A/SA-387 gr91 type 2 cl.2		≥ 415	585-760	18

Chemical composition

Ladle analysis – Expressed in weight percent (wt%) as per above standards

C	S	P	Si	Mn	Cr	Mo	Ni	V	Nb	N/Al
0.10	0.002	0.018	0.3	0.4	9.00	1.00	0.2	0.2	0.08	≥ 4

The above chemistry is suitable for welded steam piping and can be adjusted according to intended use and product size.

Specific guarantees

Creep resistance is the driving engineering property for choosing 9%Cr Creep Strength Enhanced Ferritic (CSEF) steel. It is provided by a finely tuned chemical analysis linked to a stringent control of the heat treatments. Creep properties of **CromElso™ 91** are achieved by complex and multiscale microstructural features.

Typical strength of **CromElso™ 91** is generally targeted on the high-end when creep resistance is required. The balanced low carbon martensite possesses sufficient toughness: for as-delivered conditions transverse Charpy-V impact strength values at -20°C can reach about 100 J.

Welding

Consumables used for the welding of **CromElso™ 91** shall comply with the following standards.

	SMAW	GMAW	FCAW	SAW (Wire + Flux)
AWS	SFA5.5 E 9015-B91 H14	SFA 5.28 ER 90S-B9	SFA 5.29 E 91T1-B9-H4	SFA5.23 EB9 + F9PX
EN	EN ISO 3590-A ECrMo91 B 4 2 H5	EN ISO 21952-A G CrMo91	EN ISO 17643-A T 69T15 1G 9C1MV	EN ISO 24596-A S S Z CrMo91 FB + EN ISO 14174 S A FB 1 55 DC H4

Please contact your favorite filler materials supplier for corresponding references.

Delivery conditions

Plates

CromElso™ 91 can be be produced in thicknesses from 5 mm and up to 200 mm (3/16" up to 8").
Maximum plate weight: 20 tons per unit for continuous casting route and up to 80+ tons for ingot route.

Prefabrication

By special agreement, prefabricated pieces can be delivered according to drawings. The following operations can be performed: beveling, bending, rolling of shell to radius, cutting to shape, fabrication of stiffeners and annular plates, pre-welding. *(Non exhaustive list, please consult)*

XCarb®

On request, **CromElso™ 91** plates can be delivered with **XCarb®** certificate that guarantees steels with a low carbon footprint, made through the electric arc furnace using recycled scrap and renewable electricity. Product carbon footprint is third-party verified.

Applications

CromElso™ 91 is suitable for 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.
Furthermore, it is a potential 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. Its low molybdenum and nickel contents compared to standard austenitic stainless steels make it less prone to activation under irradiation.

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Technical Literature

A non-exhaustive list of publications is provided below. These papers can be provided on request, only within the framework of discussions linked to projects that may consider the use of **CromElso™ 91** for the fabrication of pressure equipment:

- *Creep behaviour of Cr-Mo(V) Steels and their welds - Metallurgical and environment aspects - Extrapolation laws (ICPVT10)*
- *Industeel Experience With P91 - Feedbacks From Fields (EPRI)*
- *Hydrogen in Cr-Mo(-V) Pressure Vessel Steels (MPC HPV 2009)*
- *Thick Plates In Grade 91 For Fourth Generation Nuclear Reactor (PVP2010)*
- *Hydrogen and High Temperature Resistant V-Modified 9Cr-1Mo Heavy Plates Devoted to New Generation High Performance Petrochemical Reactors. (PVP2011)*
- *Development and Production of Creep and Hydrogen Resistant Grade 91 (9Cr1MoV) - Heavy Plates for New Generation High Efficiency Refining Reactors (NACE Corrosion 2013)*
- *On the possible use of 9Cr-1Mo-VNb for the fabrication of refining pressure vessels A review of available data and points to overcome (API Refining Spring 2016)*

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