Industeel

ArcelorMittal

CromElso™ 22V

Chromium-Molybdenum-Vanadium Steel

Special low alloy (2¼Cr1Mo¼V) steel for high temperature hydrogen service

CromElso™ 22 V is a low alloyed Cr-Mo steel designed for pressure equipment such as hydrotreating reactors operating at elevated hydrogen pressure and temperature. **CromElso™ 22V** is manufactured via the electric arc furnace with dephosphorisation, ladle refining and vacuum degassing to provide reproducible, clean and homogeneous steel. The use of special steelmaking practice with extralow phosphorus levels gives **CromElso™ 22V** improved resistance to temper embrittlement, as well as providing excellent low temperature impact toughness properties.
CromElso™ 22V is particularly suitable for pressure equipment in high temperature hydrogen service (e.g. hydrotreating reactors, exchangers). This steel is available in plate form in thickness up to 250 mm, and can also be provided in single- or multi-piece heads and cores.

Properties

Standards

CromElso™ 22 V is compliant with:

- ASTM/ASME A/SA-542 tpD cl4a (UNS K31835)
- EN 10028-2 13CrMoV9-10 (1.7703)

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 13CrMoV9-10	< 60	455	480-630	18
	60-150	435	460-620	18
	150-250	415	450-600	18
A/SA-542 tpD cl.4a		415	515-690	18

Yield Strength (YS/$Rp_{0.2}$) guaranteed ≤ 620MPa.

Chemical composition

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

C	Mn	Si	Cr	Mo	Ni	V
≤ 0.15	0.30-0.60	≤ 0.10	2.0-2.5	0.90-1.10	≤ 0.25	0.25-0.35

Ultra clean steel : we guarantee J-factor ≤ 80, P ≤ 0.007 wt%, P+Sn ≤ 0.012 wt%
H_2 ≤ 2ppm or even ≤ 1ppm depending on production route, C ≤ 0.14 wt% possible for thickness ≤ 120mm

Specific guarantees

CromElso™ 22V is delivered in heat treated condition with tempering done at 725°C minimum, with mechanical properties guaranteed for maximum PWHT 705°C – 40Hrs.

We guarantee actual tensile properties as per ASME II Part D: 90% UTS (Table U) and 100% YS (Table Y).
Tensile test done at design temperature (min and max PWHT).

Brinell hardness (BHN) ≤ 235 in as-delivered condition (Q+T). BHN ≤ 225 following PWHT.

Welding

Consumables used for the welding of **CromElso™ 22V** shall comply with the following standards.

	SMAW	GMAW	FCAW	SAW (Wire + Flux)
AWS	SFA5.5 E 9018 B3 H4 R	SFA 5.28 ER 90S-B Si	SFA 5.29 E 91T1-B3M-H8	SFA5.23 F11AZ-EB3R-B3
EN	EN ISO 3590-A ECrMo2 B 4 2 H5	EN ISO 21952-A G CrMo2 Si	EN ISO 17643-A T CrMo2 P M21 1 H8	EN ISO 24596-A S S CrMo2 AR + EN ISO 14174 S A AR 1 76 AC H5

Please contact your favorite filler materials supplier for corresponding references.

Delivery conditions

Plates

CromElso™ 22V can be be produced in thicknesses from 5 mm and up to 250 mm (3/16" up to 10").
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™ 22V** 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

This material may be used in all applications requiring service conditions under high temperature and or high pressure of hydrogen.
CromElso™ 22V may be used for the same purposes as conventional **CromElso™ 22 (ASTM/ASME A/SA-387 gr 22)** but for higher service temperature and with the possibility to reduce wall thickness thanks to improved tensile properties for: hydrotreating reactors, hydrodesulfurizers, hydrocrackers (within the limits of API RP 941).

Industeel Belgium
Charleroi Plant
266, rue de Chatelet
B - 6030 Marchienne-au-Pont
industeel.arcelormittal.com

Your contact

Valéry NGOMO
Tel. +33 6 10 49 59 48
valery.ngomo@arcelormittal.com

Technical data and information are to the best of our knowledge at the time of editing. 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.

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™ 22V** for the fabrication of pressure equipment:

- *Evaluation of hydrogen embrittlement in V-modified Cr-Mo steels (API Refining Spring 2009)*
- *Effect of Pre-Strain on Mechanical Properties of Pressure Vessel Grades – Assessment of Stress Relieving / Post Weld Heat Treatments Efficiency to Regenerate Properties. (ESOPE 2013)*
- *Effect of Temper and Hydrogen Embrittlement on Mechanical Properties of 2,25Cr-1Mo Steel Grades – Application to Minimum Pressurizing Temperature (MPT) Issues (IJPVP 2013)*
- *Hydrogen Related Problems in Cr-Mo Pressure Vessel Steels Advantages of V containing grades (DEMAT 2010)*
- *Hydrogen in Cr-Mo(-V) Pressure Vessel Steels (MPC HPV 2009)*
- *How to Prevent Reheat Cracking of Weld Metal A542D (API Refining Spring 2009)*
- *Prevention of Weld Metal Reheat Cracking During CrMoV Heavy Reactors Fabrication (PVP 2009)*
- *Effect of Hydrogen on mechanical behavior for 2,25Cr1Mo grades (standard and Vanadium added) (Nace Corrosion 2008)*
- *Specific problems in refining – high temperature, high pressure and hydrogen – case of 2,25Cr1Mo and 2,25Cr1MoV steels (IIW SSC IX-C Creep 2008)*
- *Overview of Hydrogen Related Problems in Pressure Vessel Steels (DEMAT 2008)*
- *Hydrogen Induced Disbonding: from laboratory tests to actual service conditions (NACE Corrosion 2005)*
- *Numerical simulation of heat treatments of CrMo steels (PVP 2005)*
- *Optimization of ISR and PWHT of CrMo(V) Steels (ESOPE 2004)*
- *Comparison Of Hydrogen Solubility And Diffusivity In CrMo And CrMoV Steels – Hydrogen Induced Disbonding (NACE Corrosion 2012)*
- *Standard reliable testing procedure for 2¼Cr-1Mo-V welding quality control & acceptance – Prevention of SAW Filler Material reheat cracking during fabrication of heavy reactors – MiniJIP Program (PVP2012)*
- *Myth on Tempering Temperature and PWHT Temperature of Cr-Mo Steels (AMPP 2018)*
- *Consideration on Tempering and PWHT Temperatures of C-Mn and Low Alloy Steels Used for the Fabrication of Pressure Vessels – Smart Tuning of Heat Treatment Parameters (PVP 2018)*

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