



## CromElso™ 22V SA-542 Type D class 4a

### CromElso™ 22V: Special low alloy (2¼Cr1Mo¼V) steel for high temperature hydrogen service

**CromElso™ 22V** 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

- > EN 10028-2      13CrMoV9-10 (W 1.7703)
- > ASTM            A542 Type D class 4a
- > ASME            SA-542 Type D class 4a

#### CHEMICAL ANALYSIS - WEIGHT %

C	Mn	Si	P	S	Cr	Mo	V
≤ 0.15	< 0.6	< 0.13	≤ 0.007	≤ 0.004	2.0-2.5	0.9-1.10	0.25-0.35

Heat analysis in weight % (Typical values). With the following additional requirements:

(P+S) ≤ 0.012% ; J factor\* ≤ 100

\*J = (Si+Mn).(P+Sn) x 10<sup>4</sup> (elements in wt.%)

#### DELIVERY CONDITION

All plates are heat treated as follows:

- > Thickness < 100 mm: Quenching and Tempering
- > Thickness >100 mm: Normalising + Quenching and Tempering

#### MECHANICAL PROPERTIES

Guaranteed transverse tensile values at room temperature after PWHT according to applicable Standard. These values are guaranteed for a total Larsen-Miller parameter (LMP)\* = 21000 (including tempering and PWHT)

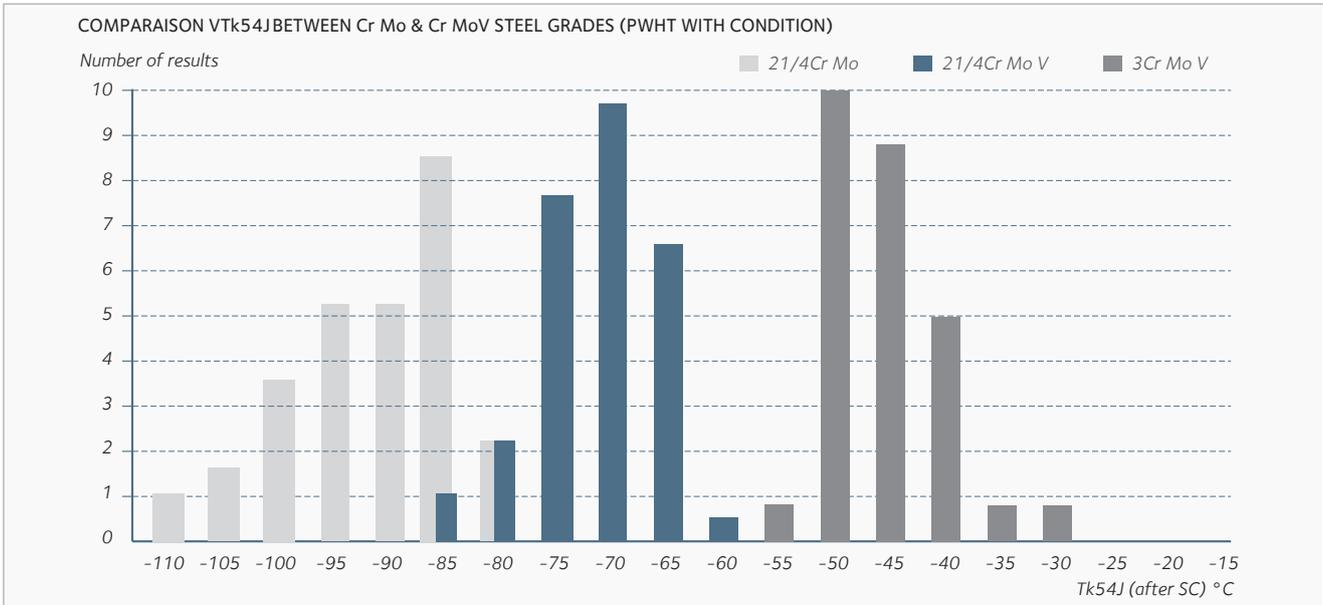
		TS (MPa/[ksi])		Elongation%
		Min	Max	Min
EN 10028-2	< 60 mm	600 / [87]	780 / [113]	18
	60-150 mm	590 / [85]	770 / [111]	18
ASTM A542 Type D class 4a		585 / [85]	760 / [110]	18

Higher tensile properties is a driving force for development of this grade. It leads to reduce wall thickness and cost savings in transportation and on site erection. High temperature tensile properties can be provided upon demand.

\* LMP = T (20 + log t) with T as the temperature in K and t as the duration in hours

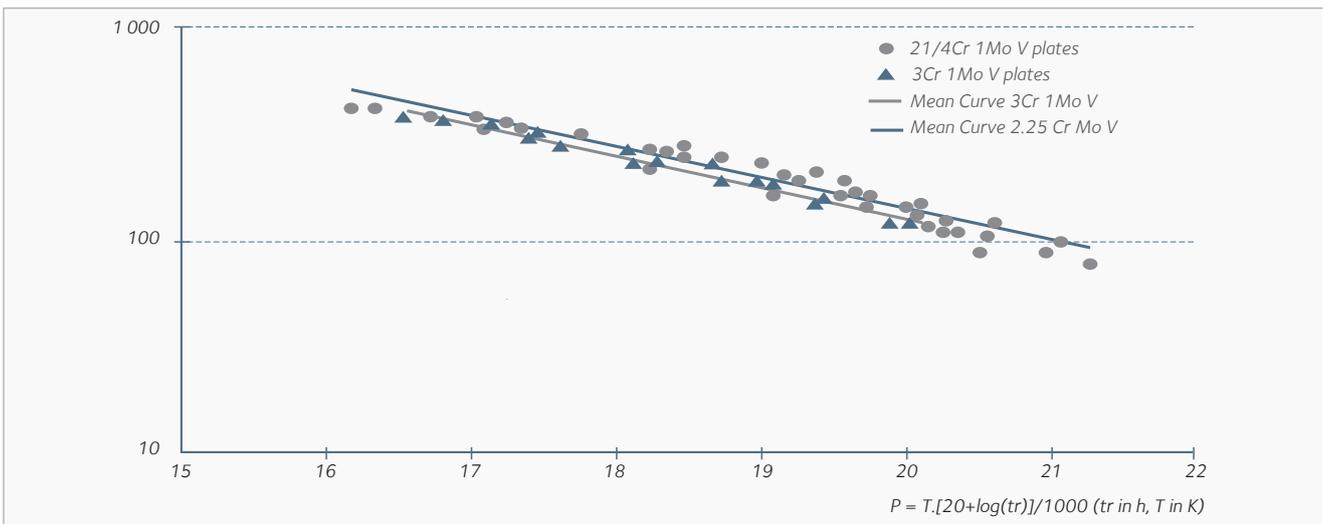
### Impact properties

The impact properties of CromElso™ 22V depend upon temperature and duration of heat treatment (tempering and PWHT) as well as plate thickness. As for ASTM A387 grade 22, the chemical composition and mainly the parameter % (P+Sn) has a major influence on the TK 54J level. CromElso™ 22V toughness properties are excellent and closer to ASTM A387 grade 22 than 3CrMoV grade.



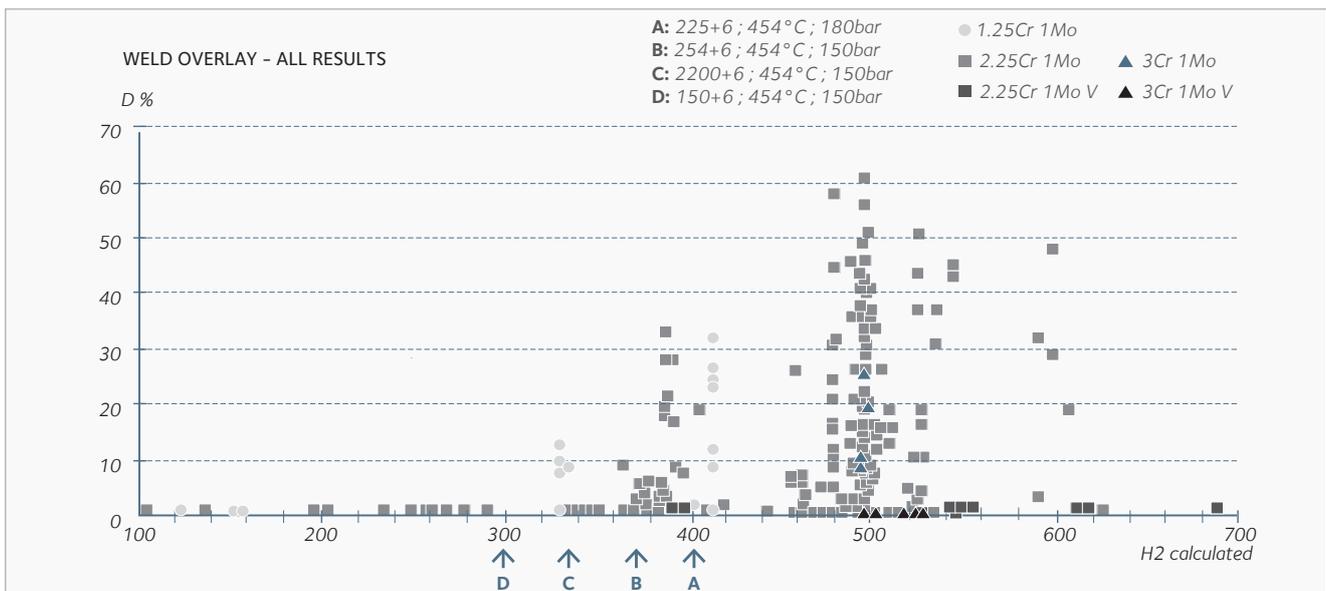
### CREEP PROPERTIES

The creep properties of CromElso™ 22V are as given in table C-1 of EN 10028-2. Creep properties of CromElso™ 22V have been assessed and found to be slightly better than those of 3CrMoV grade as illustrated on the graph below.



## DISBONDING

Hydrogen Induced Disbonding Resistance is often required for hot hydrogen service. Disbonding resistance depends on the overlay conditions, and PWHT, however it has been shown that a limitation of C content in the parent material is effective to reduce the sensitivity. In order to help its customer to define testing conditions representative of service Conditions, Industeel has developed numerical simulation tools, which allow the determination of hydrogen profiles through the wall of reactors or in laboratory test specimens. A laboratory test condition representative of actual service conditions gives the same level of hydrogen at the interface. It has been demonstrated these CromElso™ 22V gives an improved disbonding resistance, particularly for thick reactor as illustrated in the graph below.



## PLATE PROCESSING

### FORMING

Cold forming (+ stress relief for high strains) or hot forming can be applied:

> cold forming (< 500°C/930°F)

> hot forming (900-1100°C/1650-2010°F): to be followed by complete heat treatment (water quench and tempering)

*Please consult for full heat treatment details.*

### HEAT TREATMENT

Austenitizing at 910°C - 970°C (1670°F - 1780°F), water quenching and tempering (for plates over 100 mm thick, prior normalizing treatment is required).

Tempering temperature (> 675°C/1250°F) is adjusted depending on the required final PWHT.

For other requirements, please consult.

## WELDING

### Filler materials

Consumables used for the welding of CromElso™ 22V shall correspond to the following standards:

	SMAW	SAW
		Wire + Flux
AWS	A5-5 E 9015-G	A5-23 EG EB3R
EN	EN 1599 EZ CrMo2V B 4 2 H5	EN 12070 SZ CrMoV2 + EN 760 SA FB 1 55/65 AC

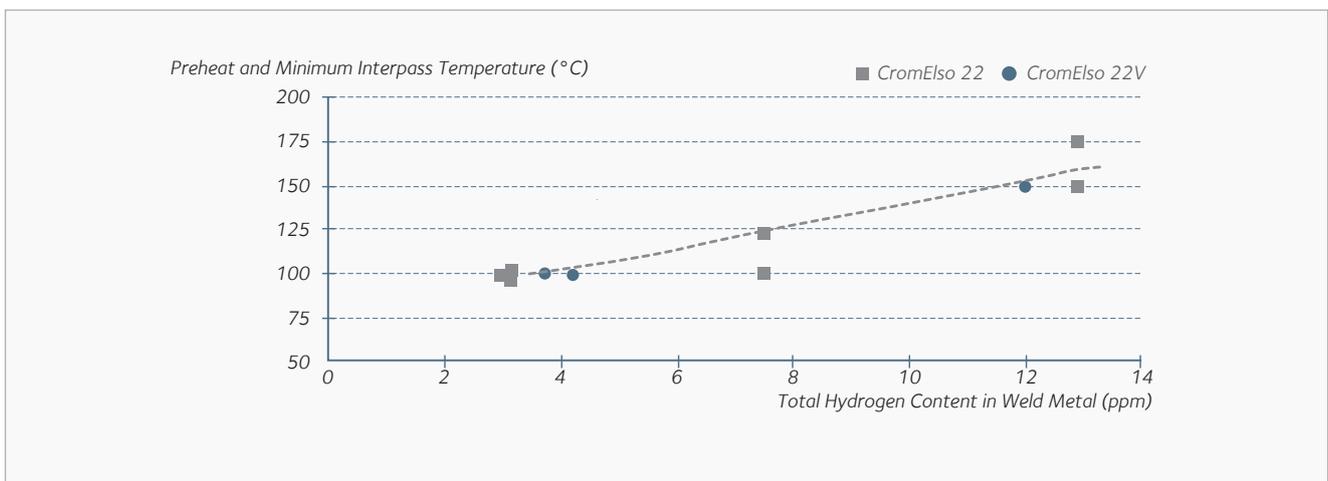
A non-exclusive list of suitable filler materials is given hereafter:

	SMAW	SAW	
		Wire	Flux
KOBELCO	CMA 106 H	US 521 H	PF 500
ALW	ALCROMO E225V	ALCROMO S 225V	ALCROMO F537
T-PUT	Phoenix Chromo 2V	Union S1 CrMo2 V	UV430TTR-W

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

### Welding conditions

The determination of preheat and minimum interpass temperature conditions can be done using the implant test of standard ISO 17642-3. It is recommended to use a preheat and minimum interpass temperature close to 125 °C for typical welding conditions.

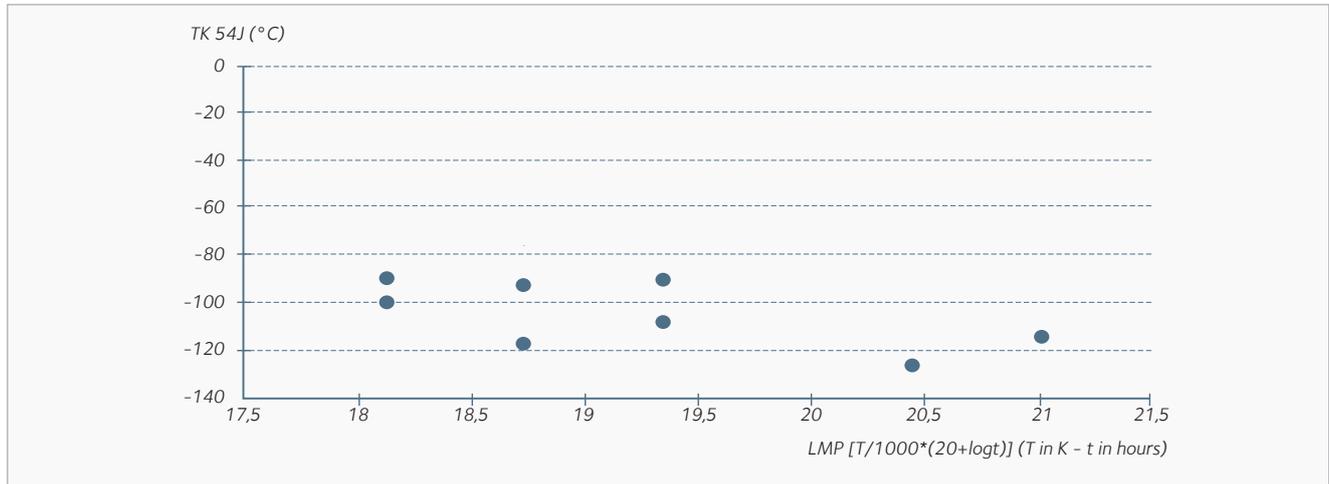


However, the risk of cold cracking is known to occur in the weld metal more frequently than in the HAZ. Therefore, a preheat and minimum interpass temperature of 200 °C is recommended for thickness higher than 30 mm\*. After welding a Dehydrogenation Heat Treatment ≥ 300 °C is recommended.

\* Document CEN (European Committee for Standardization): «Welding Guidelines: part 6: avoidance of hydrogen cracking for low alloy creep resisting steels» (CEN-TC121-WG4-SG1-N34)

### HAZ properties

CromElso™ 22V is designed for hot hydrogen service and therefore meets the HAZ hardness requirements of API 934. Tempering and PWHT combination can be optimized to soften HAZ below 250HV while respecting other mechanical properties. Extra-low levels of impurity elements (P,S,O) help ensure excellent toughness properties in the HAZ, even after step-cooling.



### APPLICATIONS

This material may be used in all applications requiring service conditions under high temperature and high pressure of hydrogen.

CromElso™ 22V may be used for the same purposes as conventional grade 22 (ASTM A387 grade 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).

### 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.