

Creusabro®Dual

The high-performance wear resistant steel

Creusabro®Dual is an advanced abrasion-resistant steel with high titanium content (0.6%). This innovative grade is mainly dedicated to severe sliding wear conditions in service for applications where conventional water quenched steels (500HB, 550HB), overlay plates or hard-cast parts are traditionally implemented.

Based on unrivalled Creusabro®8000 metallurgical concept, Creusabro®Dual is exclusively produced by Oil Quenching, which reduces the level of the residual stresses encountered within the plate after heat treatment.

The outstanding wear resistance against severe abrasion combined with high impact cycle load is mainly due to the contribution of the following hardening phenomena:

- a homogeneous precipitation of extra hard primary titanium carbides in the steel matrix leading to a significant improvement of the sliding wear resistance in extreme service conditions.

- a surface hardening obtained by a very efficient work hardening capability in service, governed by a metallurgical phenomenon called TRIP effect (Transformation Induced by Plasticity).

- in addition to a high stress grinding abrasion resistance, ability of forming also remains and allows the processing of curved parts (Pict 1, Pict 2 :

Creusabro®Dual , 2000x300x10mm, Rint=1000mm)



Pict 1



Pict 2

With such high abrasion resistance combined with high resistance to cracking in service, Creusabro®Dual has no competitors.

STANDARD

Creusabro®Dual

PLATE PROCESSING

CHEMICAL ANALYSIS (INDICATIVE VALUES WEIGHT %)

| C | Mn | Ni | Cr | Mo | S | Ti |
|-------|--------|--------|--------|---------|---------|--------|
| ≈0.40 | ≈ 1.30 | ≈ 0.45 | ≈ 0.70 | ≤ 0.340 | ≤ 0.002 | ≈ 0.60 |

MECHANICAL PROPERTIES (INDICATIVE VALUES AS DELIVERED)

| Hardness (HB) | Y.S. 0.2 MPa (KSI) | UTS MPa (KSI) | EI 5.65% | KCVL -20° (-4°F) J (ft.lbs) | E GPa |
|---------------|--------------------|---------------|----------|-----------------------------|-------|
| 480 | 1200 (174) | 1630 (236) | 10 | 18 (13) | 205 |

Hardness ≈ 450/490 HB (typical value)

Physical properties

Expansion coefficient - ($10^{-6}/^{\circ}\text{C}^{-1}$)

| 20/100°C 68/212°F | 20/200°C 68/392°F | 20/300°C 68/572°F | 20/400°C 68/752°F | 20/500°C 68/932°F |
|----------------------|----------------------|----------------------|----------------------|----------------------|
| 11.2 | 12.0 | 12.5 | 13.2 | 13.8 |

Density at +20°C (68°F) : 7.85 kg/dm³

Metallurgical concept

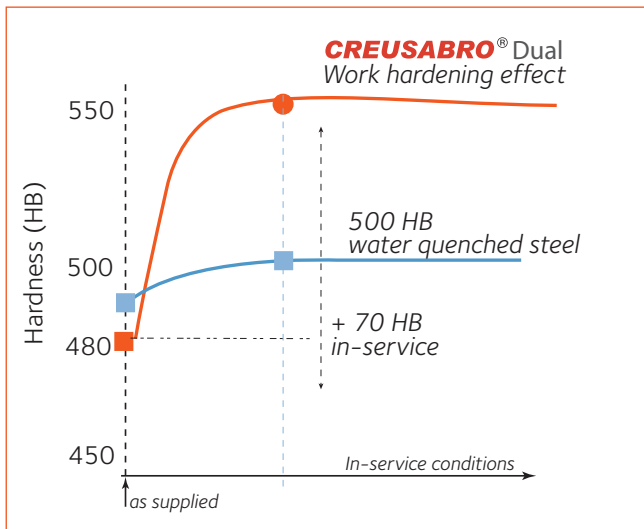
Wear resistance depends not only on the hardness of the steel at delivered state, but also on other properties, such as crack resistance, work hardening effect, strength, ductility, softening resistance, etc.

The performance in service of given wear resistant steel is strongly influenced by the microstructure obtained after thermal processing.

In the case of Creusabro®Dual, a significant improvement of the wear resistance in service is mainly due to the following properties:

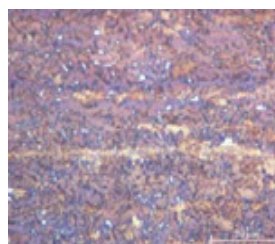
«TRIP effect» : Transformation Induced by Plasticity.

Due to its multiphase structure (a fine-tuned mix of martensite, bainite and retained austenite), Creusabro®Dual has the ability to work-harden when submitted to local plastic deformation in service. Plastic deformation induces a surface hardening phenomenon by transformation of retained austenite into fresh and very hard martensite while the material remains ductile underneath, making it most effective to withstand both sliding abrasion and heavy impact in service.



In addition, the super ductility of the retained austenite contributes to improve the lifetime in service by allowing larger micro shearing and thus delays the ultimate tearing of metal particles from the surface of the material exposed to the abrasive.

Creusabro® grades, the retained austenite grains revealed by means of Klemm reactive etching appear in white.

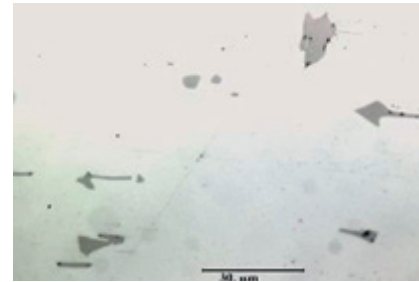


When subjected to plastic deformation in service (impact or high pressure), Creusabro®Dual takes advantage of a surface hardening about 70 HB. On this typical microstructure of a surface hardening about 70HB, whatever the applied strain level

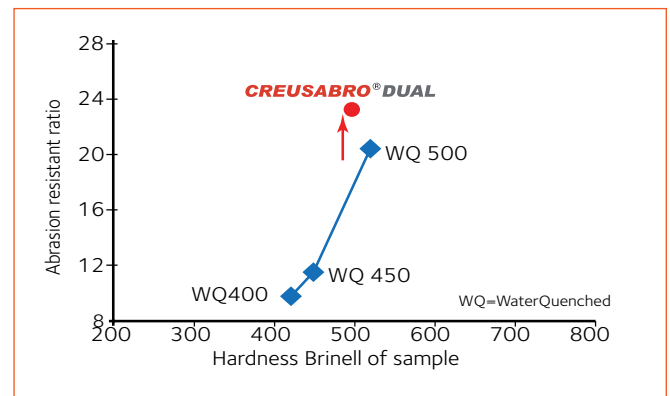
Titanium carbides

The extreme abrasion resistance versus conventional wear resistant steels (500HB, 550HB...) is gained by the presence of the primary titanium carbides which are precipitated during the first stage of the solidification (already present within the semi-products, slab or ingot, before rolling and heat treatment).

These titanium carbides exhibit an average hardness of 3000HV (Vickers hardness) and therefore create numerous hard spots in the steel matrix like crushed gravel in concrete.

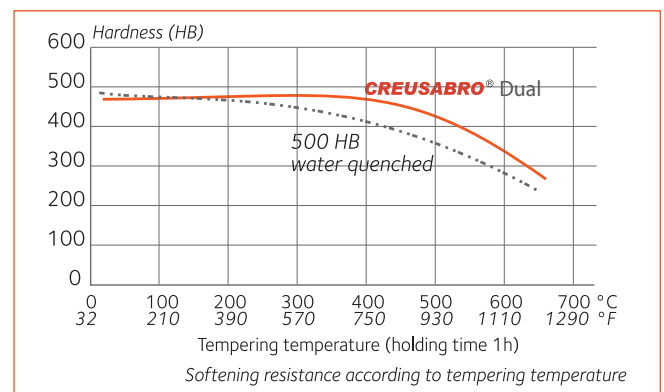


Extremely hard primary titanium carbides homogeneously embedded in the steel matrix



Properties at temperature

Chemical composition of Creusabro®Dual, and specially chromium, molybdenum and huge titanium contents, give a high softening resistance to the material. This property allows using Creusabro®Dual in hot service conditions, at a maximum of 450°C (840°F) while conventional 500 HB water quenched steels are limited to 250°C (480°F).



Service life

Whatever service conditions are, the original metallurgical concept of Creusabro®Dual gives the material an improve of its performance in terms of wear resistance and process ability, compared to other conventional 500 HB water quenched steels, especially for extreme applications, where severe abrasion conditions are combined with huge impact, heat or moderate corrosion.

Processing

Cutting

All classical thermal processes (gas-plasma-laser) can be used. Waterjet or laser processes are specially recommended. They provide increased precision and cutting aspect and avoid or reduce Heat Affected Zone (HAZ).



For flame or plasma cutting, a preheating to 150 °C – 302 °F is recommended over 35mm

Welding

Creusabro®Dual can be welded with all classical processes: manual (SMAW), semi-automatic under gas protection (GMAW), automatic under flux (FCAW).

Welded areas shall be clean, free of grease, water, oxides...

Electrodes and flux shall be dried according to supplier's recommendations.

For welds without preheating, an austenitic welding wire shall be used.

Following welding conditions have been used in our weld tests

| | Solid Wire | Gas |
|------------------------|----------------|----------------|
| Trademark | LNM 307 | ATAL 5A |
| Standard Name | ER307/G18-8-Mn | M21 |
| Supplier | Lincoln | Air Liquide |
| Diameter/Composition | Ø 1.2 mm | 82% Ar+18% CO2 |
| Automatic/Manual | automatic | |
| Welding position | PB | |
| Heat Input (KJ/cm) | 12 - 18 | |
| Voltage (V) | 26 - 28 | |
| Amperage (A) | 220 -270 | |
| Travel speed (cm/min) | 25 - 35 | |
| Polarity | DC+ | |
| Wire feed rate (m/min) | 10 - 12 | |
| Gas flow rate (l/min) | 18 - 24 | |
| Stick-out (mm) | 10 - 20 | |
| Preheating (°C) | 20°C | |
| Interpass temp. (°C) | 40°C | |



If you are using a ferritic welding product, preheating is strongly recommended in order to avoid cold cracking defects...

The following welding conditions have been used in our weld tests

| | Solid Wire | Gas |
|------------------------|--------------|---------------|
| Trademark | Nertalic 70A | ARCAL 12 |
| Standard Name | A5.18/G3Si1 | M12 |
| Supplier | SAF | Air Liquide |
| Diameter/Composition | Ø 1.2 mm | 98% Ar+2% CO2 |
| Automatic/Manual | automatic | |
| Welding position | PB | |
| Heat Input (KJ/cm) | 12 - 18 | |
| Voltage (V) | 26 - 28 | |
| Amperage (A) | 220 -270 | |
| Travel speed (cm/min) | 25 - 30 | |
| Polarity | DC+ | |
| Wire feed rate (m/min) | 7.5 | |
| Gas flow rate (l/min) | 18 - 24 | |
| Stick-out (mm) | 10 - 20 | |
| Preheating (°C) | 175°C | |
| Interpass temp. (°C) | 180°C | |

Forming and Machining

Creusabro®Dual can be machined with tools equipped with inserted or removable carbide tips. Intentional heating operation aimed at a local softening is strictly prohibited.

Experience shows that Creusabro®Dual can be cold formed with an inside radius of 100xThickness, this can be reduced by using hot forming up to 450°C



Applications

The outstanding properties of Creusabro®Dual reserve it to applications where an extreme abrasion resistance combined with high resistance to cracking is required in service, such as:

- Vibratory feeder liners
- Chute liners
- Hopper liners
- Bucket liners for excavator, shovel, loader, dozer, ...
- Cutting edges, stiffeners... for different types of buckets
- Truck tray body liners
- Wear parts for primary and secondary crushers
- Screens
- Trommels
- Pipe elbows
- Cyclones
- Deflectors
- Grinder liners (SAGMill)
- Demolition tools (recycling)
- Pipes for dredging
- Blade liners for heavy duty fans...



Extra-large fans (XXL), extreme service conditions

- cement plants
- incineration plant (waste treatment technology)



Screens
(hot working conditions)

- iron making plant (blast furnace)
- sintering plant
- coking plant



Dimensional program

Creusabro®Dual due to its very specific production way is submitted to certain production limits.

Thickness: 10mm to 50mm, 3/8" to 2".

Max Width 2500mm (100"), max length 8000mm (315").

(Indicative dimensional program)

YOUR CONTACTS

Gilles Hauden

Gilles.hauden@arcelormittal.com

<https://industeel.arcelormittal.com>

Industeel France

Le Creusot Plant

56 rue Clemenceau

F-71202 Le Creusot Cedex

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.

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2. CREUSABRO®DUAL has been developed specifically for its abrasion resistance.

Customer's usage of CREUSABRO®DUAL for any other purposes, not directly resulting from its abrasion resistance, is his own prerogative but won't, in any way, engage INDUSTRIEL's responsibility. In addition to the recommendations given in this document, customer will have to follow the industry standard quality rules for any processing operation performed on this material.