



## F460 TMCP toughcore

**Transport larger quantities of LCO<sub>2</sub> more economically over long distances and benefit from significant cost savings throughout the service life of the vessel.**

Qualified by renowned classification societies, voestalpine Grobblech presents the most efficient carbon steel solution for highest LCO<sub>2</sub> cargo volumes.

The increased ultimate tensile strength of minimum 590 MPa allows for an increased tank capacity of up to 40% with equal material thickness.

By utilizing the outstanding combination of high strength and excellent toughness properties, such as CVN @ -85 °C as well as CTOD @ -55 °C design temperature - even in the heat affected zone - the LCO<sub>2</sub> cargo volume to tank weight ratio can now be maximized.

The so increased tank capacity by up to 40 % leads to further remarkable reduction of operational costs related to the energy consumption per transported volume unit. Significant advantages, which allow for an enhanced economic and sustainable life cycle approach.

### **Convincing advantages**

- » Increased cargo volume
- » Lower operating costs
- » Reduced wall thickness
- » Ultra-low nickel content
- » High strength material
- » Higher safety margin



Premium quality  
with reduced carbon footprint

**toughcore®**  
greentec steel

### Chemical composition

Heat analysis in mass % acc. standard

Steel grade	Plate thickness [mm]	C max.	Si max.	Mn max.	P max.	S max.	Al max.	Cr max.	Mo max.	Ni max.	Nb max.	Ti max.	CE max.	PCM max.
F460 TMCP toughcore	≤ 50	0.08	0.50	1.60	0.015	0.005	0.04	0.25	0.25	0.60	0.05	0.05	0.43	0.23

### Mechanical properties: Notch impact energy <sup>1)</sup>

Values in as-delivered condition acc. standard

Steel grade	Plate thickness [mm]	Test temperature [°C]	Notch impact energy	
			Testing direction transversal A <sub>v</sub> min. [J]	Testing direction longitudinal A min. [J]
F460 TMCP toughcore	≤ 40	-75	46	32
	> 40 ≤ 45	-80	46	32
	> 45 ≤ 50	-85	46	32

<sup>1)</sup> Testing will be carried out in transverse direction acc. to DNVGL Rules for Classification Ships, Part 2 respectively DNVGL OS-B101. Additional testing in the simulated stress relieved condition can be agreed that a temperature of max. 580 °C.

### Mechanical properties: Tensile test <sup>2)</sup>

Values in as-delivered condition acc. standard

Steel grade	Yield strength R <sub>p0.2</sub> [MPa] min. t ≤ 50 mm	Tensile strength R <sub>m</sub> [MPa] t ≤ 50 mm	Fracture elongation A5 L <sub>0</sub> = 5.65 √ S <sub>0</sub> [%] min. t ≤ 50 mm	Ratio max.
F460 TMCP toughcore	460	590 – 680	19	0.9

<sup>2)</sup> Testing will be carried out in transverse direction acc. to DNVGL Rules for Classification Ships, Part 2 respectively DNVGL OS-B101. Additional testing in the simulated stress relieved condition can be agreed that a temperature of max. 580 °C. Yield strength ratio of max. 0.87 upon request.

### Welding Pre-Qualification

Pre-Qualification	Welding process	Test location	Test temperature [°C]
CTOD	SAW 1.5 kJ/mm	FL / FL + 1 mm	min. 0.2 mm / -55
CVN			-85

### Available dimensions <sup>3)</sup>

Steel grade	Plate thickness [mm]	Max. width [mm]	Max. length [mm]	Max. weight [t]	As-delivered condition
F460 TMCP toughcore	≤ 50	3,850	18,000	20	TMCP toughcore

<sup>3)</sup> Additional dimensions upon request.

# OUR PATH TO A GREENER FUTURE

## Premium products in the greentec steel Edition

With greentec steel, voestalpine is pursuing an ambitious step-by-step plan in the long-term decarbonization of steel production. The declared objective is to achieve carbon-neutral production by 2050, and the initial steps have already been taken. Process-optimized production operations already prevent up to 10% of the direct CO<sub>2</sub> emissions at the Linz site. The material and processing properties of the steel are not affected in any way in this production route. Each voestalpine heavy plate product is available in premium quality in the greentec steel Edition with a reduced carbon footprint and unique benefits.



Premium quality with reduced carbon footprint

**toughcore®**  
greentec steel

Heavy plates (excl. heads and clad plates) – greentec steel Edition

Max. carbon footprint 2.21 kg CO<sub>2</sub>e per kg of steel <sup>1)</sup>

<sup>1)</sup> per EN 15804+A2 (EPD methodology) cradle to gate

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