



HIGH STRENGTH AND HIGH TOUGHNESS STEEL PLATES FOR TANKS & PENSTOCKS

Product Description

High strength and tough steel are being used for penstocks which plays the role of leading water stored in the dam to the generator in hydropower stations. With the increase in scale of dams, the conduit head for hydropower stations has increased, causing the internal pressure of penstocks to rise. Accordingly, the wall thickness and strength of penstocks required to be increased. PENSTAR steel is specifically designed to withstand high pressure under severe environmental conditions. This class of steel includes Thermomechanical controlled rolled (TMCP) and quenched and tempered steel plates normally characterized by high strength and toughness with good weldability.

Product Application

Steel can be used in storage tanks and penstocks.



Product Key Salient Features

- Plates are manufactured with state-of-art steelmaking, hot rolling and heat treatment facilities meeting the customized project requirements.
- Clean steel technology ensures the steel to be lower in tramp elements and impurities (S&P). Vacuum degassing for removal of dissolved gases and Ca-treatment for steel cleanliness.
- Thermo-mechanical controlled rolling process ensures the fine grained steel microstructure for better strength and toughness. Process control during quenching and tempering process ensure homogeneous structures of steel for heavy gauges resulting in high strength and toughness.
- Steel plates will be edge trimmed, UT tested with customized length and good surface quality as per the requirement with prior agreement. The plates can be supplied in shot blasted and primer coated condition as per requirements.

Grade Designation

PENSTAR steel plates are manufactured in TMCP rolled condition and quenched and tempered condition. They are designated according to their process of manufacturing followed with the grade number as given in table below:

Grade Name	Specification			
PENSTAR TM	Plate manufactured through TMCP rolling condition			
	PENSTAR TM 540 6.0 - 40.0mm	PENSTAR TM 570 6.0 - 40.0mm	PENSTAR TM 600 6.0 - 40.0mm	
PENSTAR QT	Plate manufactured through Q&T process condition			
	PENSTAR QT 537 6.0 - 80.0mm	PENSTAR QT 517 6.0 - 80.0mm	PENSTAR QT 560 6.0 - 80.0mm	PENSTAR QT 610 6.0 - 80.0mm
	PENSTAR QT 650 6.0 - 80.0mm	PENSTAR QT 710 6.0 - 80.0mm	PENSTAR QT 780 6.0 - 80.0mm	PENSTAR QT 950 6.0 - 80.0mm

Capability & Dimensions

Product Category	Thickness	Width
PENSTAR TM	6.0 to 40.0 mm	Up to 3000mm; higher width can be provided with case to case basis, depending on thickness
PENSTAR QT	6.0 to 80.0 mm	Up to 3500mm; higher width can be provided with case to case basis, depending on thickness

Individual size (Thick x Width) capability can be assessed based on the actual sizes.

Delivery Condition	
Thermo-Mechanical/ Control Process (TMCP)/ Quenching & Tempering (Q&T)	The plates are delivered with sheared or thermally cut edges. Plates can be delivered in shot blasted and primer coated surface condition.

Chemical Composition (Ladle Analysis)

Grade	C Max%	Mn Max%	P Max%	S Max%	Si Max%	Cr Max%	Ni Max%	Mo Max%	V Max%	CU Max%	NB Max%	TI Max%	B Max%	CE ⁵ Max
PENSTAR TM 540	0.15	1.60	0.020	0.010	0.50	0.25	0.60	0.30	0.10	0.35	0.10	0.030	-	0.45
PENSTAR TM 570	0.15	1.70	0.020	0.010	0.50	0.30	0.90	0.50	0.10	0.40	0.10	0.030	-	0.45
PENSTAR TM 600														0.47
PENSTAR QT 537	0.20	1.60	0.020	0.010	0.50	0.25	0.25	0.08	0.040	0.35	0.020	0.030	-	0.52
PENSTAR QT 517	0.20	1.50	0.020	0.010	0.80	2.00	1.50	0.60	0.08	0.50	0.06	0.10	0.0050	0.47
PENSTAR QT 560	0.20	1.70	0.020	0.010	0.80	1.50	2.00	0.70	0.12	0.50	0.06	0.05	0.0050	
PENSTAR QT 610														Thk (mm) upto 50:0.50 >50-80:0.55
PENSTAR QT 650														Thk (mm) upto 50:0.55 >50-80:0.60
PENSTAR QT 710														Thk (mm) upto 50: 0.60 >50-80: 0.65
PENSTAR QT 780														Thk (mm) upto 50: 0.65 >50-80: 0.70
PENSTAR QT 950														

Remarks

- All elements mentioned in the table are in weight %.
- Micro-alloying elements Nb, V and Ti can be as per ASTM A841 limits as per the respective grades.
- Carbon equivalent CE = $C + Mn/6 + (Cr+Mo+V)/5 + (Cu + Ni)/15$

Mechanical Properties

Product Name	Equivalent Specification	Yield strength (MPa)	Tensile strength (MPa)	%Elongation* (Lo=50 mm)	Impact at-20°C* (In Joules) Avg.
PENSTAR TM 540	EN10025 - 4, ASTM A841	415 (min)	540 - 710	20 (min)	47
PENSTAR TM 570		450 (min)	570 - 710	20 (min)	47
PENSTAR TM 600		500 (min)	600 - 730	20 (min)	47
PENSTAR QT 537	ASTM A537 Class II	415 (min)	550 - 690	22 (min)	30
PENSTAR QT 517	ASTM A517 Gr F	690 (min)	795 - 930	16 (min)	30
PENSTAR QT 560		460 (min)	550 - 720	17 (min)	30
PENSTAR QT 610		500 (min)	590 - 770	17 (min)	30
PENSTAR QT 650	EN10025 - 6 S460 to S890	550 (min)	640 - 820	16 (min)	30
PENSTAR QT 710		620 (min)	700 - 890	15 (min)	30
PENSTAR QT 780		690 (min)	770 - 940	14 (min)	30
PENSTAR QT 950		890 (min)	940 - 1100	11 (min)	30

Orientation of tensile specimen is Transverse and Impact is longitudinal to rolling direction.

*Specific requirement can be taken on case-to-case basis.

Cold Forming:

PENSTAR steel exhibits good cold formability. The below table mentions grade wise cold bendability of the steel:

Product name	Bend angle	Sample orientation Transverse to rolling	Sample orientation Parallel to rolling
PENSTAR TM 540 / 570 / 600	180°	3.0 x plate thickness	4.0 x plate thickness
PENSTAR QT 560 / 610 / 650 / 710 / 780	180°		
PENSTAR QT 950	90°		

*Specific requirement can be taken on case-to-case basis with prior agreement.

Dimensional Tolerances & Surface Quality


Thickness	Thickness tolerance as per ASTM A6 / EN 10029
Length and Width	Tolerance as per the requirements of ASTM A6 / EN 10029
Flatness	Tolerance as per the ASTM A6 / EN 10029
Surface Properties	Tolerances as per the requirements of EN 10163 - 2, Class A Subclass 1
Internal Quality by Ultrasonic test	As per ASTM 578 / EN 10160

ArcelorMittal Nippon Steel India

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