Timken® HS220-27 Steel

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General Information

The Timken Company's HS220-27 steel is a fine-grained alloy steel that combines medium carbon content with a robust balance of chromium, nickel and molybdenum for enhanced hardenability. It was originally developed as an alloy to provide ultra-high transverse strength and toughness for aircraft landing gear. When heat treated, it is specifically designed to meet a diverse range of high-performance applications where the need for toughness and durability is paramount but can be balanced with excellent wear resistance. The superior hardenability makes it better suited for heat treating thicker cross-sections to various strength levels than lower-alloyed grades. It benefits from lower carbon content, enabling a more aggressive quench for optimum mechanical properties.

Timken® steel is produced by the electric arc-furnace method and is further processed in a ladle refiner where pinpoint chemistry control is achieved, while constantly stirring with inert argon under a near-perfect vacuum to float out impurities and to remove harmful gases. During this process, other elements are added to fine-tune the internal grain structure, and the sulfur is extracted to very low levels. After refining, it is teemed into large bottom-poured ingots or continuously cast into large blooms. These ingots or blooms may be rolled into round bars for machining or conversion into seamless tubing, or rounds and square round bars for forging.

Equivalent alloy standards:
AMS 6427, 4330 V Mod, MIL S-8699, 34CrNiMo6V.

Alloy type: Through hardening.

Typical applications:
Drive shafts, crankshafts, connecting rods, mining drill rods and oilfield tools.

	C	Si	Mn	P	S	Cr	Ni	Mo	V	O2 (max)
Wt %	0.30	0.25	0.90	0.012	0.001	0.90	1.80	0.43	0.08	20 ppm

Table 1. Typical chemical composition.

Thermophysical properties	
Density	0.283 lb/in^3, 7.84 g/cm^3
Specific Heat	0.16 Btu/lb/° F, 0.16 cal/g/° C
Modulus of Elasticity	29 x 10^3 ksi, 200 GPa
Poisson's Ratio	0.32

Mechanical properties	
Tensile Properties	See Fig. 1
Hardness	See Fig. 2
Charpy Impact	See Fig. 3
Fracture Toughness	K_{Ic} = 54.2 ksi$\sqrt{in}$ / 59.5 MPa$\sqrt{m}$ at UTS of 225-230 KSI (1569 MPa)
Fatigue	Endurance limit range: 90-110 ksi / 620-760 MPa

Processing	
Welding	Arc weldable
Hot Forging	1950-2255° F (1065-1235° C)
Cold Forging	Should be spheroidize annealed for cold forming
Machining	For best results normalized and tempered at 1250°F (675° C)

Heat treatment	
Bars, tubes and forgings may be air-hardened and tempered or conventionally heat treated by heating; quenching in water, oil or polymer; and then tempered to the desired strength and hardness level. Most commonly, a hardness level of 340 BHN (37 HRC) is considered suitable for many applications, but it is often used at higher strengths.	
Normalize	1600-1700° F (870-925° C) air cool
Anneal	1525-1575° F (830-860° C) furnace cool
Harden	Austenitize 1550-1600° F (845-870° C) water, oil or polymer quench
Temper	Temper to desired strength

Desired UTS	Suggested temper temperature
150-180 ksi (1030-1240 MPa)	1100-1250° F (595-675° C)
180-200 ksi (1240-1380 MPa)	950-1100° F (510-595° C)
200-220 ksi (1380-1520 MPa)	750-950° F (400-510° C)
220-240 ksi (1520-1650 MPa)	625-750° F (330-400° C)

Table 2. Tempering temperatures used to achieve desired ultimate tensile strength.

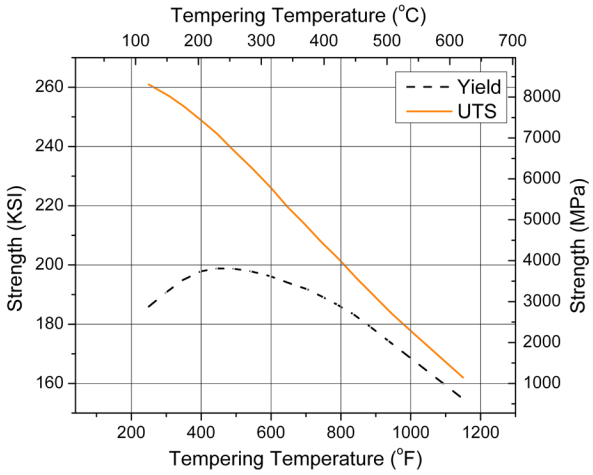

Fig. 1a

Austenitized at 1550-1600° F (845-870° C) and oil quenched. Yield strength and ultimate tensile strength versus tempering temperature.

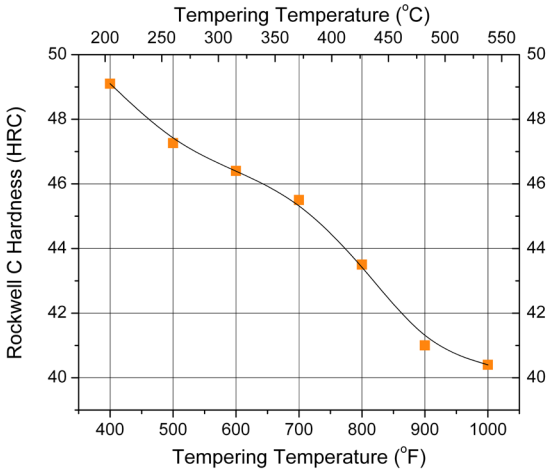

Fig. 2

Representative hardness versus tempering temperature (tempered at 2+2 hrs.).

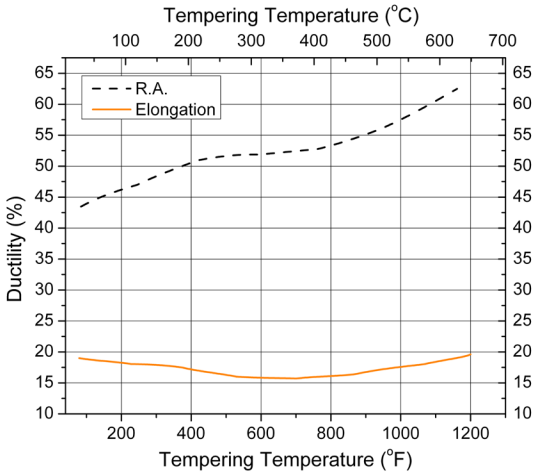

Fig. 1b

Austenitized at 1550-1600° F (845-870° C) and oil quenched. Percent elongation, reduction in area versus tempering temperature.

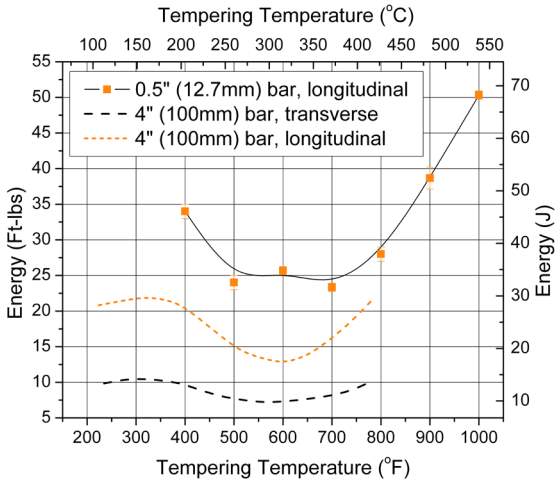

Fig. 3

Room temperature Charpy impact energy versus tempering temperature.

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