TIMKENSTEEL

HS220-27 Alloy Steel Technical Data

Want Enhanced Hardenability for Your Critical Applications? Talk to the TimkenSteel Experts.

Alloy Description

Our HS220-27 fine-grained alloy steel combines medium carbon content with a robust balance of chromium, nickel and molybdenum for enhanced hardenability.

We originally developed HS220-27 to provide ultra-high transverse strength and toughness for aircraft landing gear. In addition, when heat-treated, HS220-27 meets the needs for a diverse range of high-performance applications where toughness and durability – balanced with excellent wear resistance – is paramount.

The superior hardenability makes it better suited for heat-treating thicker cross-sections to various strength levels than lower-alloyed grades. HS220-27 benefits from lower carbon content than common thru-hardening grades, enabling a more aggressive quench for optimum mechanical properties.

We produce HS220-27 steel by the electric arc-furnace method. After the melting process, we transfer the molten steel to a ladle refiner for alloy adjustments and vacuum de-gassing. By performing inert gas stirring under a near-perfect vacuum, we remove impurities and harmful gases. This melting and refining process path reduces levels of elements such as phosphorus and sulfur. We control refining and inclusion engineering practices to optimize strength and toughness properties in both the longitudinal and transverse directions of the final product. It also enhances resistance to sulfide stress corrosion.

After refining the steel, we teem it into large bottom-poured ingot molds or continuously cast into large blooms. We can roll these ingots and blooms into solid rounds for machining and forging applications, and billets for piercing into seamless mechanical tubing.

Typical applications include drive shafts, crankshafts, connecting rods, drill-string components, aircraft landing gear, drill bits, and oilfield tools.

Equivalent Alloy Standards

AMS 6427, 4330 V Mod, MIL S-8699, 34CrNiMo6V.

Alloy Type

Through hardening.

Typical Chemical Composition

	C	Si	Mn	P	S	Cr	Ni	Mo	V	O2 (max)
Wt %	0.30	0.25	0.90	0.012	0.005	0.90	1.80	0.43	0.08	20 ppm

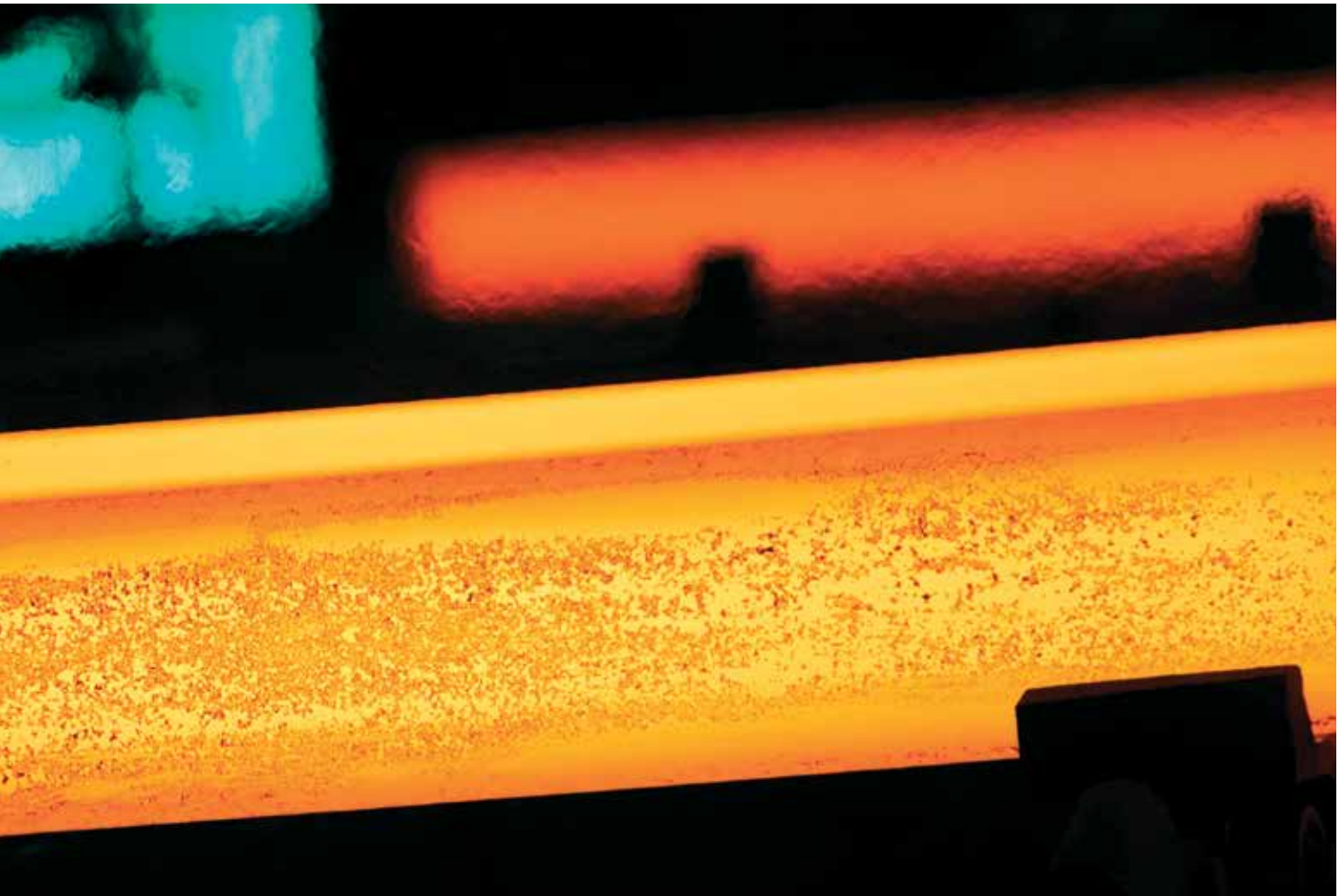
HS220-27 is an excellent choice for high-performance applications where there is a critical need for toughness and durability. Two examples:

Suggested base mechanical properties for drill rod

	ksi (TS MPa)	ksi (YS MPa)	Elongation	RA	CVN J (lbs-ft)	Hardness
Minimum	150 (1030)	140 (960)	15%	45%	59 (80)	320/370 BHN

Suggested base mechanical properties for drive subs

	ksi (TS MPa)	ksi (YS MPa)	Elongation	RA	CVN J (lbs-ft)	Hardness
Minimum	165 (1140)	150 (1030)	13%	40%	52 (70)	340/390 BHN



Procedure and Results

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. 1a & 1b, Fig. 2a & 2b, and Fig. 7
Hardness	See Fig. 3 and Fig. 4
Charpy Impact	See Fig. 5 and Fig. 6
Fracture Toughness	K_{Ic} = 54.2 ksi√in / 59.5 MPa√m at UTS of 225-230 KSI (1569 MPa)
Fatigue	Endurance limit: 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)

Tempering temperatures used to achieve desired ultimate tensile 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)

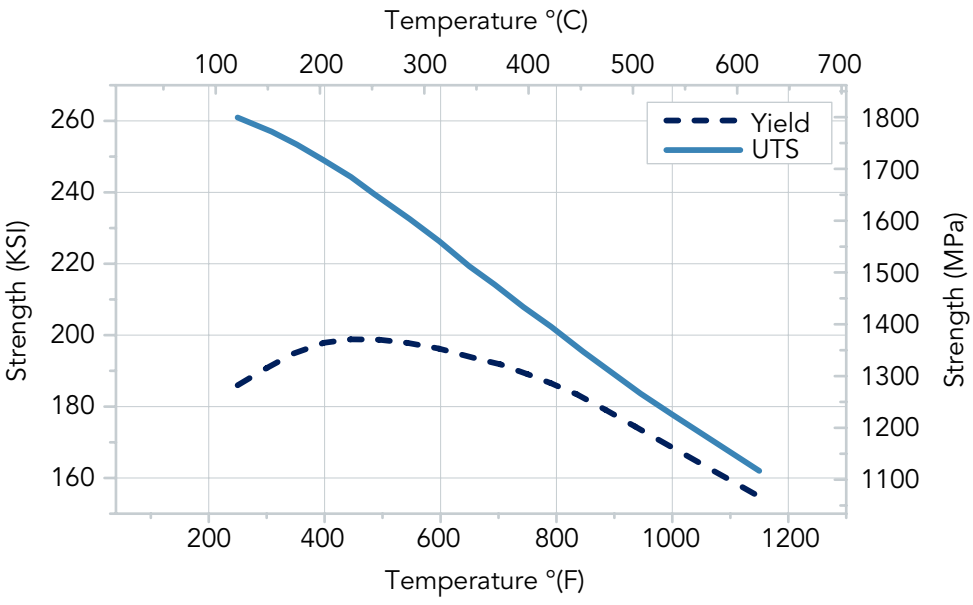
Heat Treatment

You may air-harden and temper or conventionally heat-treat bars, tubes and forgings by heating, followed by quenching in water, oil or polymer, and then temper to the desired strength and hardness level. Most commonly, we consider a hardness level of 340 BHN (37 HRC) suitable for many applications, but customers often use it at higher strengths.

Generally, we recommend that customers normalize and temper or anneal the product to a lower hardness such as 235 BHN (22 HRC) to improve machining.

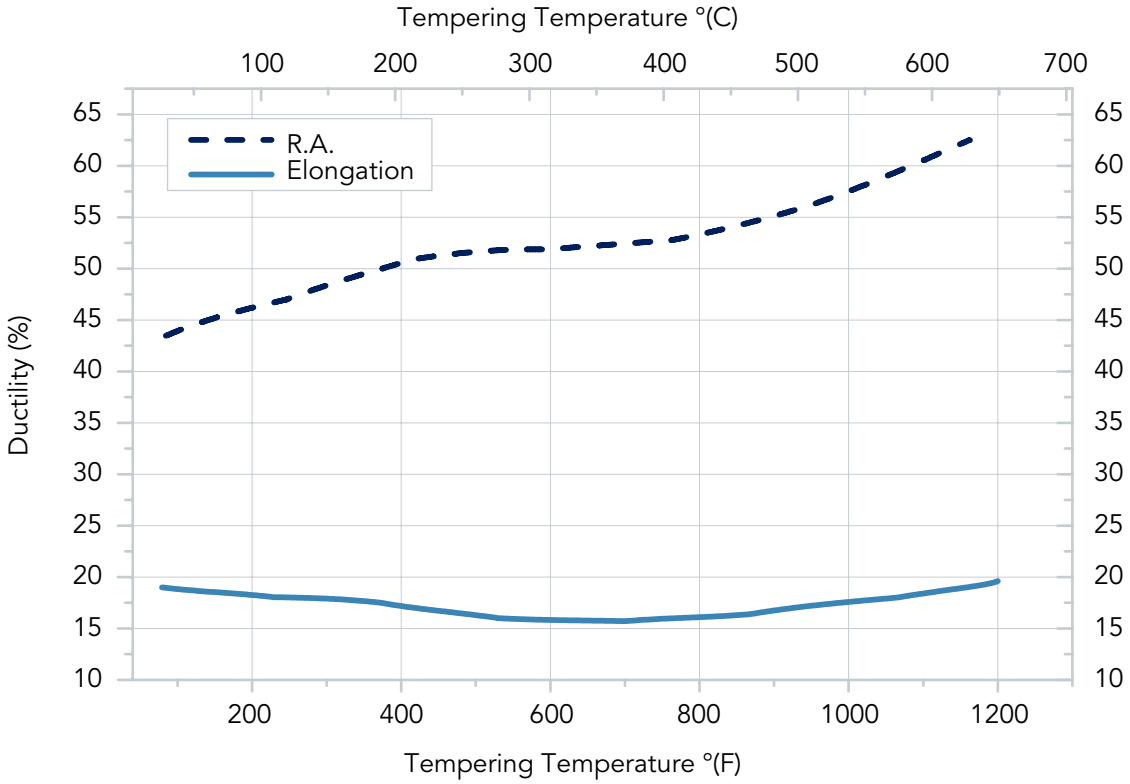
Normalize	1600-1700°F (870-925°C) air cool
Anneal	1525-1575°F (830-860°C) furnace cool
Harden	Austenitize 1550-1600°F (845-870°C) water, oil or polymer quench
Temper	Temper to desired strength

Fig. 1a



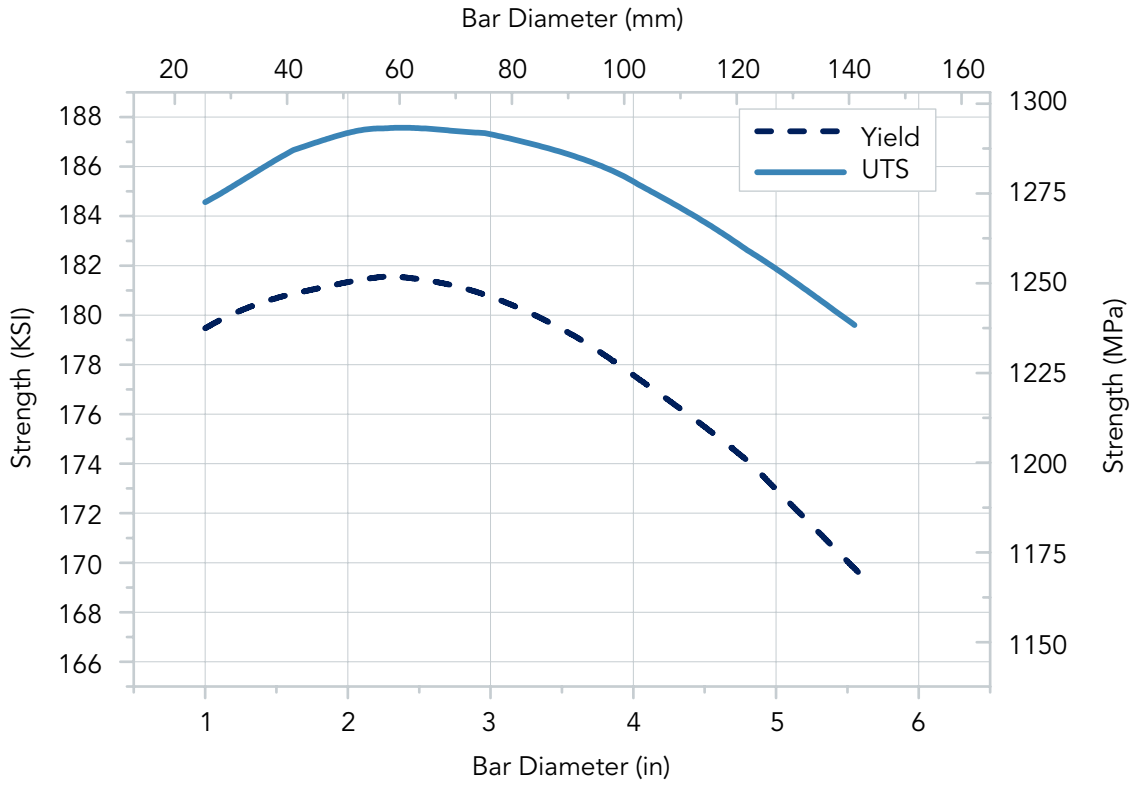
Yield strength and ultimate tensile strength versus tempering temperature. Austenitized at 1550-1600°F (845-870°C) and oil quenched.

Fig. 1b



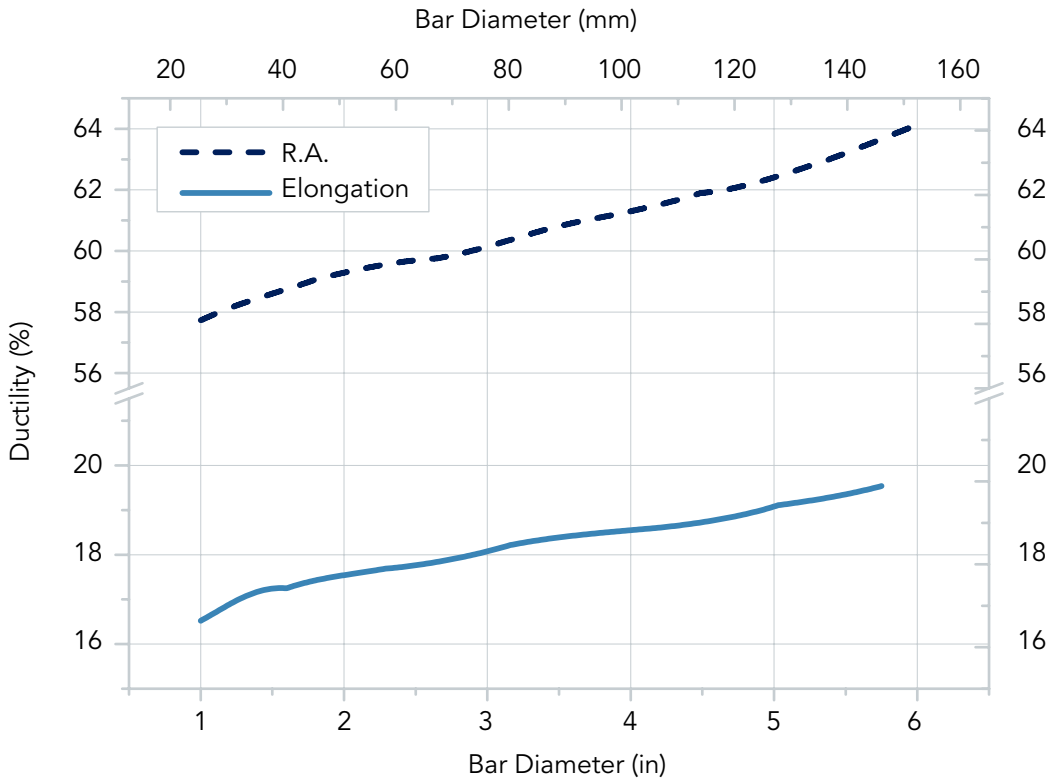
Percent elongation and reduction in area versus tempering temperature. Austenitized at 1550-1600°F (845-870°C) and oil quenched.

Fig. 2a



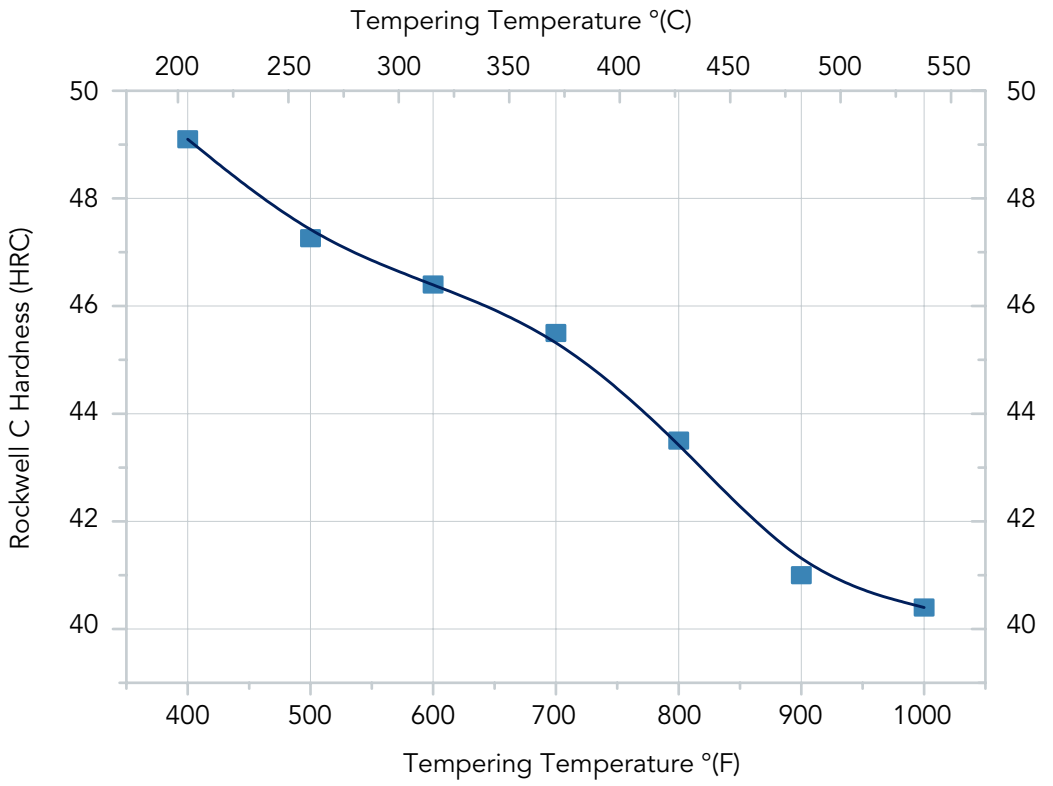
Effect of bar diameter on strength for HS220-27. Austenitized at 1550-1600°F (845-870°C), oil quenched, and tempered at 1000°F (540°C).

Fig. 2b



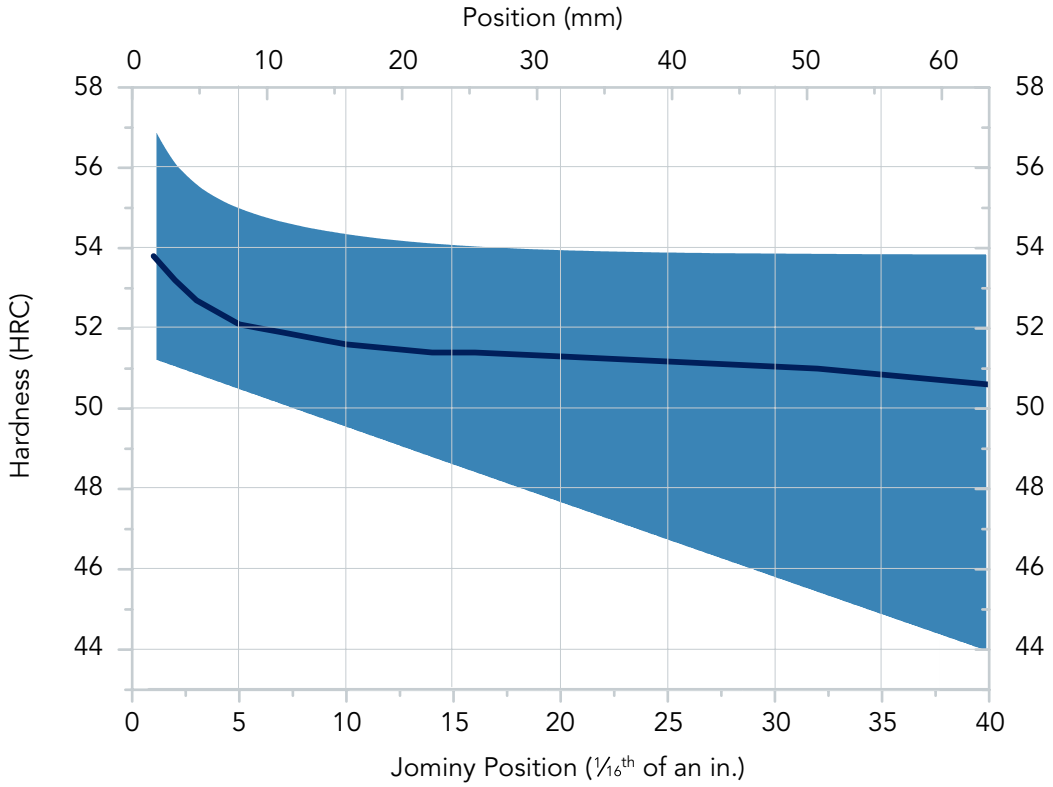
Effect of bar diameter on ductility for HS220-27. Austenitized at 1550-1600°F (845-870°C), oil quenched, and tempered at 1000°F (540°C).

Fig. 3



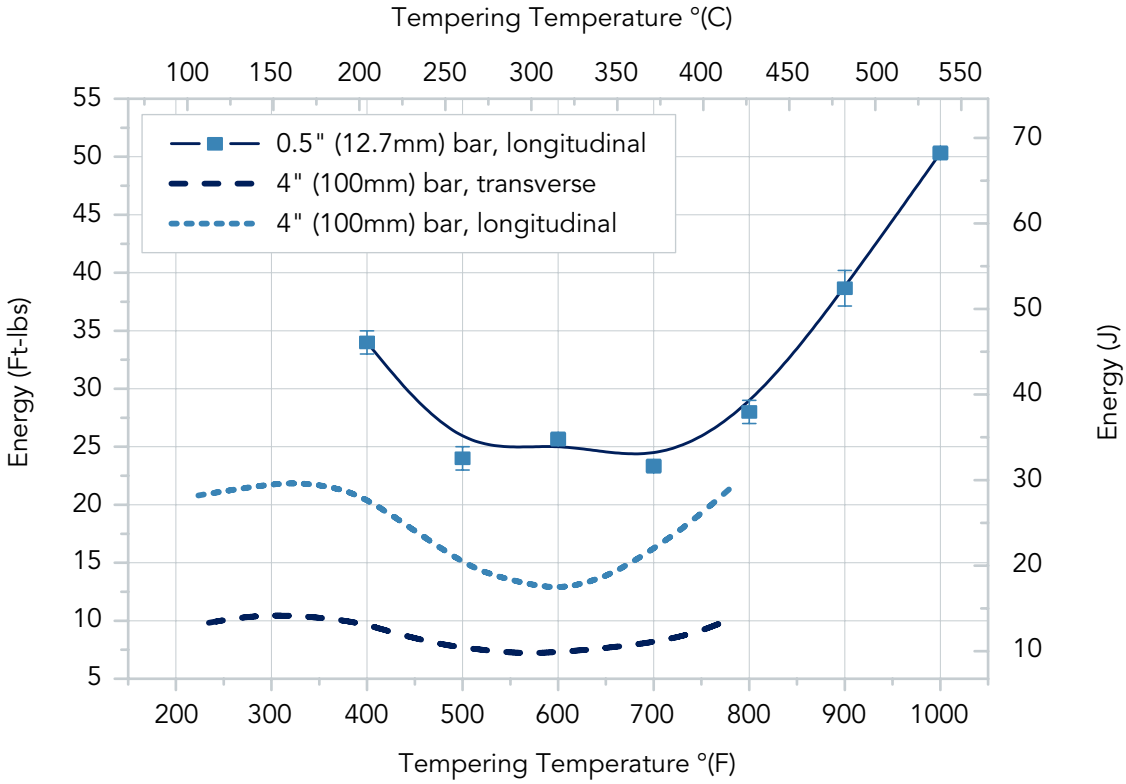
Representative hardness versus tempering temperature (tempered at 2+2 hrs.).

Fig. 4



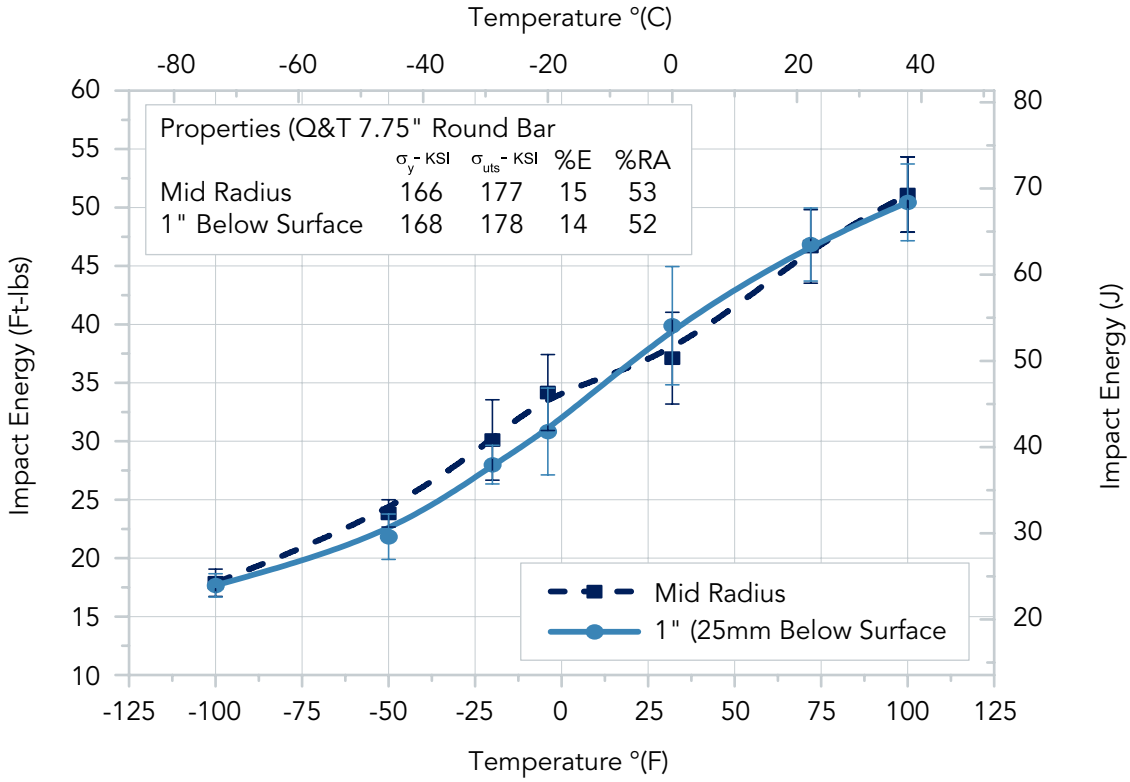
Jominy hardenability band - austenitized at 1550-1600°F (845-870°C) and water quenched.

Fig. 5



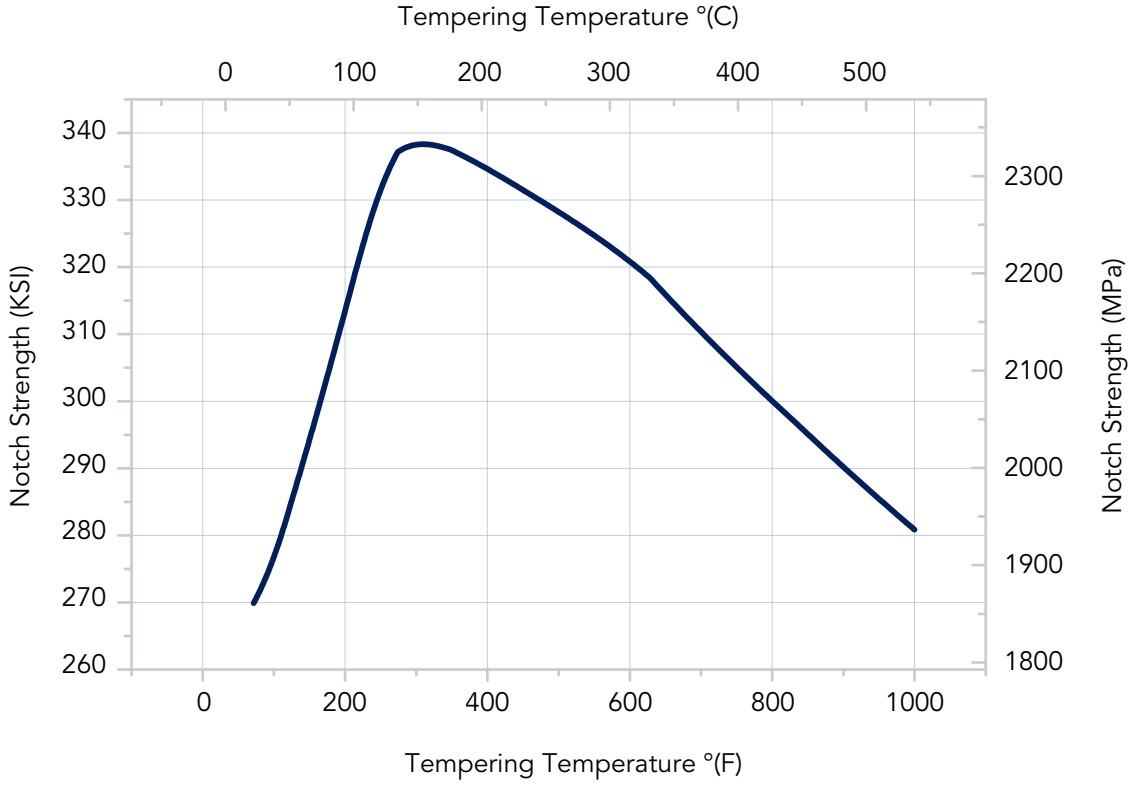
Room temperature Charpy impact energy versus tempering temperature.

Fig. 6



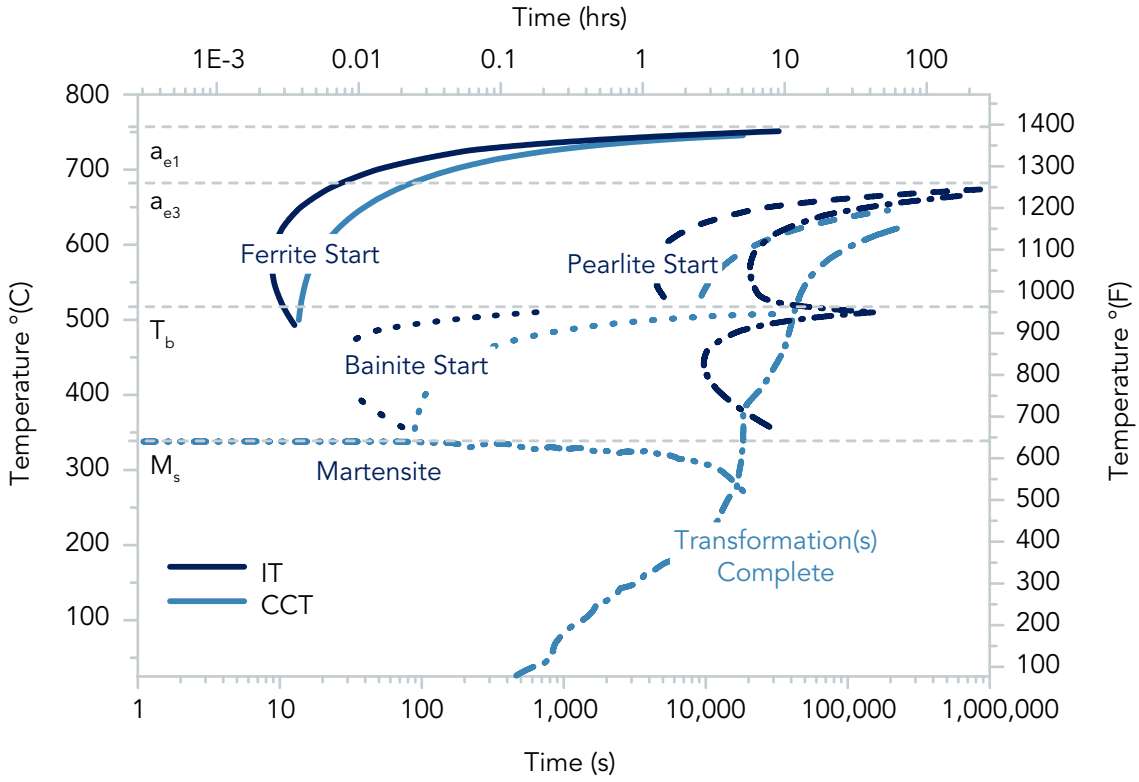
Charpy impact energy as a function of temperature. This 7.75 in (197 mm) bar was quenched and tempered at 1150°F (620°C) to nominal UTS of 175-180 KSI (1225MPa).

Fig. 7



Notch strength by tempering temperature of HS220-27. Austenitized at 1550-1600°F (845-870°C) and oil quenched.

Fig. 8



Predicted isothermal and continuous cooling transformation diagrams calculated with MCASIS.

Answering Customers' Toughest Challenges

We customize every product and service we deliver to meet customers' specific needs. Our focus is on improving performance by addressing the toughest challenges, whether that requires a special bar quality (SBQ) steel bar or seamless mechanical tube, a value-added component, honing, drilling or thermal-treatment services or a supply chain solution.

Our engineers are experts in materials, processing and applications, so we can work closely with each customer to deliver flexible solutions related to our products as well as their applications and supply chains. We believe few others in our industry can consistently deliver this kind of breadth, customization and responsiveness.

TIMKENSTEEL

For more information, visit **www.timkensteel.com** or call us at 866.284.6536 (USA), +44 1455 826320 (Europe), +52 (55) 5876 9888 (Latin America), +52 (81) 8123-6147 (Mexico) and 021-60231080 (China).

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