



# NESSteel Inc.

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## Shock Resisting Tool Steel AISI S-7

S-7 is an air- or oil-hardening tool steel with a nice combination of exceptional toughness and wear resistance properties. S-7 is an excellent choice for blanking and die forming applications, as well as applications needing shock and impact resistant tools. Typical analysis is shown in the chart below:

Carbon	Silicon	Manganese	Chromium	Molybdenum
0.50%	0.25%	0.75%	3.25%	1.40%

S-7 is used in both cold and hot tooling applications. Typical applications include:

- Chisels
- Punches
- Moil Points
- Blanking & Forming Dies
- Engraving Dies
- Plastic Mold Dies
- Shear Blades
- Low-Temp Die-Casting Dies

### Heat Treatment

#### Forging:

- Preheat slowly to 1700° F until piece is thoroughly heated through, then increase heat to 1950°F - 2050°F.
- DO NOT hot work S-7 below 1700°F.
- After forging, allow S-7 to cool slowly, packed in lime or other insulating material.
- Anneal as soon as possible.

#### Annealing

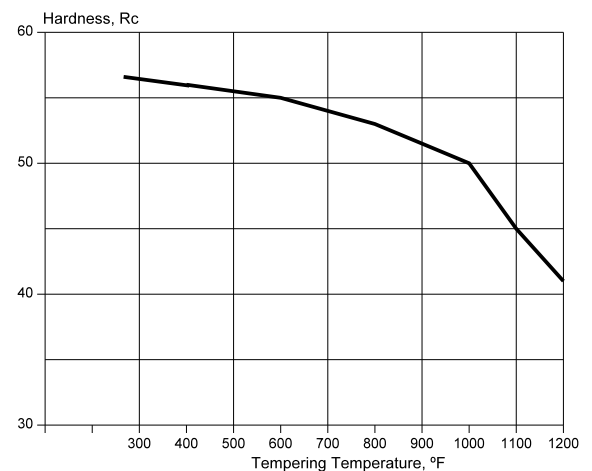
- Surface protection - Anneal in controlled atmosphere furnace or pack in an inert material.
- Slowly heat S-7 to 1500° - 1550°. Hold at temperature for one hour per inch of smallest dimension of the container. Annealed hardness range is 187 - 223 Brinell.

#### Hardening:

- Pack in inert mat'l or use controlled atmosphere furnace to control decarburization.
- Pre-heat slowly to 1200°F - 1300°F, and ensure equal temperature throughout the piece.
- Increase heat more rapidly to 1700°F-1750°F.
- Hold steel at temperature for one half hour per inch of maximum thickness, up to 2.5", and then air-quench. Pieces larger than 2.5" thick should be oil-quenched until black, followed by air-cooling.
- Temper immediately after the piece has cooled to 125°F.

#### Tempering

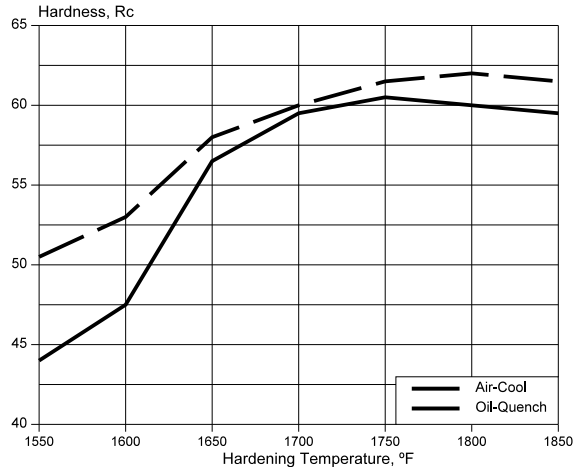
- Temper immediately when piece reaches 150°F or when comfortably hand-held.
- For cold work applications, tempering temperature is usually in the range of 400°F - 500°F; for hot working tools, the range is 900°F - 1000°F.
- Heat slowly to temperature, hold tools at heat for 2 hours before air cooling.



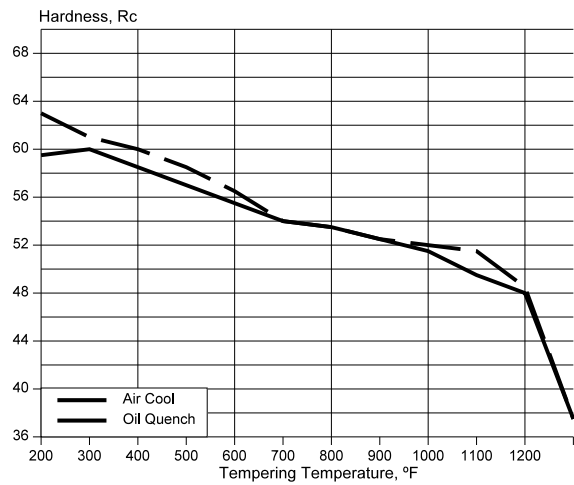
#### Physical & Mechanical Properties (approx)

- Density, lb per cu in: .2813
- Specific gravity 7.786
- Critical points:
  - Heating (Ac) 100°/hr - begins 1440°F; ends 1508°F
  - Cooling (Ar) 50°/hr - begins 1346°F; ends 1270°F

## Hardening - Air Cool or Oil Quench



## Temperature Effect on Tempering Response



Test samples 1" round x 2" long were hardened by air and oil quenching from 1725°F and tempered at the indicated temperatures. Resulting hardness is shown above.

## Sub-Zero Treatment

- Chilling to -60°F after cooling from hardening temperature results in very high hardness.
- Dimensions expand approximately 0.002 inches.
- Tempering at 300°F or 400°F result in Rc 65 or 63.

## Mean Thermal Coefficient of Expansion

Range °F	Coefficient, in./in./°F	Range, °F	Coefficient, in./in./°F
70-200	5.77 x 10 <sup>-6</sup>	70-900	6.86
70-300	6.09	70-1000	6.99
70-400	6.36	70-1100	7.09
70-500	6.40	70-1200	7.17
70-600	6.51	70-1300	7.24
70-700	6.75	70-1400	7.29
70-800	6.85	70-1499	<b>7.41</b>

## IZOD Impact Properties

- Test samples prepared from 1/2 inch square annealed bars.
- Samples were tempered for 20 minutes at 1850°F and air-cooled.
- Samples were wet-ground to .394 inch square, and were tested in a 120 ft-lb machine. Each value is an average of 4 individual tests.

## Maximum Shock Resistance

- Charpy impact specimens preheated to 1300°F
- Air-quenched from 1725°F
- Tempered at increasing rates (see table)

Tempering Temperature, °F	Rockwell C	Charpy Ft.-lb.
As quenched	60	15.7
300	59	143.5
350	58.5	100.3
400	58	Past machine cap.
500	56	220.1
600	55	219.7
700	54	221.8
800	53	209
900	52	189.8
1000	51	213.6
1100	47	Past machine cap.
1200	38	Past machine cap.
1300	31	Past machine cap.