# NESSteel Inc.

83 Gerber Drive, Tolland, CT 06084

800-654-2901 • Fax: (860) 875-4900 sales@nessteel.com


# 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 1950ºF - 2050ºF.
- DO NOT hot work S-7 below 1700ºF.
- After forging, allow S-7 to cool slowly, packed in lime or other insulating material.
- Anneal as soon as possible.

**Annealing**

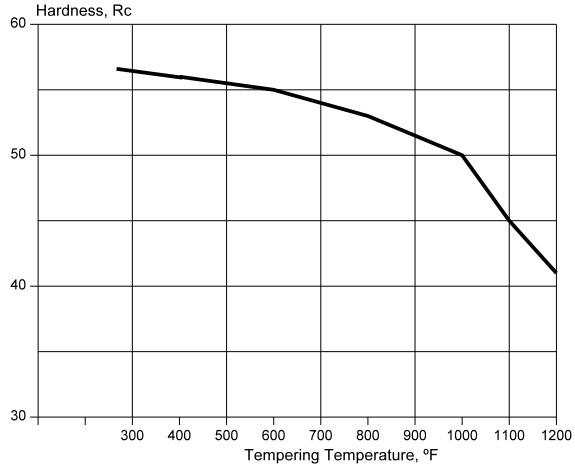
- Surface protection - Anneal in controlled atmosphere furnace or pack in an inert material.
- Slowly heat S-7 to 1500° - 1550°. Hold at temperature for one hour per inch of smallest dimension of the container. Annealed hardness range is 187 - 223 Brinell.

**Hardening:**

- Pack in inert mat'l or use controlled atmosphere furnace to control decarburization.
- Pre-heat slowly to 1200ºF - 1300ºF, and ensure equal temperature throughout the piece.
- Increase heat more rapidly to 1700ºF-1750ºF.
- 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 125ºF.

**Tempering**

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



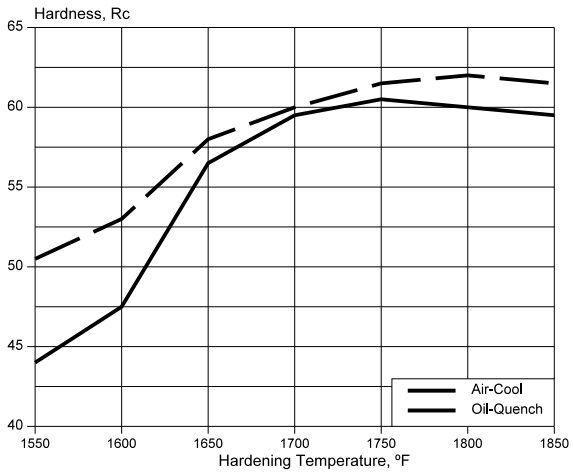

**Physical & Mechanical Properties (approx)**

- Density, lb per cu in: .2813
- Specific gravity 7.786
- Critical points:

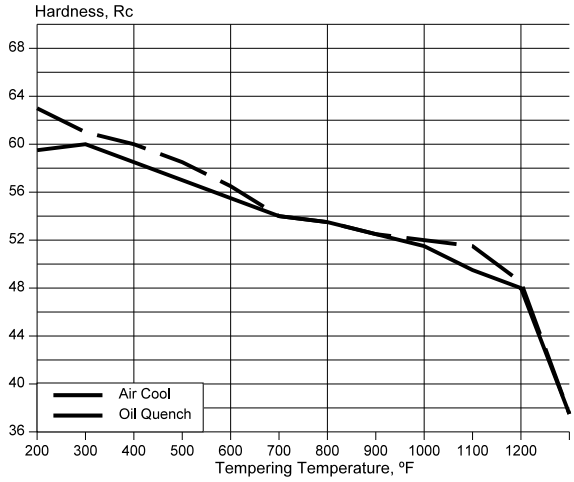
Heating (Ac) 100º/hr - begins 1440ºF; ends 1508ºF

Cooling (Ar) 50º/hr - begins 1346ºF; ends 1270ºF

### 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 1725ºF and tempered at the indicated temperaures. Resulting hardness is shown above.

### Sub-Zero Treatment

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

### Mean Thermal Coefficient of Expansion

| Range ºF | Coefficient, in./in./ºF | | Range, ºF | Coefficient, in./in./ºF |
|---|---|---|---|---|
| 70–200 | 5.77 x $10^{-6}$ | | 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 | **7.41** |

### IZOD Impact Properties

- Test samples prepared from 1/2 inch square annealed bars.
- Samples were tempered for 20 minutes at 1850ºF 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 1300ºF
- Air-quenched from 1725ºF
- Tempered at increasing rates (see table)

| Tempering Temperature, ºF | 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. |