



## TECHNICAL BULLETIN

### AISI D2 Air Hardening Tool Steel Annealed

Typical Analysis:	Carbon	Chromium	Vanadium	Moly.	Mang.
	1.55	11.50	0.90	0.80	0.40

Color Code: White

#### HEAT TREATMENT

<b>FORGING</b>	1950 to 2050°F, stop at 1700°F, and cool slowly
<b>NORMALIZING</b>	Do not normalize
<b>ANNEALING</b>	1650°F, furnace-cool, max Brinell 229
<b>PREHEATING</b>	1200 to 1250°F, prior to hardening
<b>HARDENING</b>	1850°F, air-quench to 150°F
<b>TEMPERING</b>	900°F minimum (See Tempering under General Instructions.)

#### CHARACTERISTICS

**MACHINABILITY** — D2 has a machinability rating of 65, as compared with a rating of 100 for a 1% carbon tool steel.

**DIMENSIONAL STABILITY** — Tests on this grade normally show a slight amount of contraction after hardening with the part in the as-quenched condition or tempered below 900°F. Tempering at approximately 925°F usually eliminates this contraction and brings the part virtually back to its original size. D2 has the least distortion in heat treatment as compared with other tool steels.

**CRITICAL POINTS** — Critical point ranges obtained by dilatometer test when heating and cooling at a rate of 400 degrees per hour are as follows:

Heating — Ac range 1520 to 1600°F  
Cooling — Ar range 1390 to 1300°F

**GRINDING** — D2 is somewhat sensitive to grinding stresses resulting from improper practice. Oversize allowance for machining should be held to a minimum to avoid the necessity of excessive grinding for finishing. In general, the superior abrasion-resistance of this grade makes it necessary to use a soft wheel with the coarsest grit commensurate with the finish required. A generous amount of coolant should cover the work at all times. Light cuts must be made to avoid danger of cracking. For any specific grinding operations, it is advisable to consult your grinding wheel representative for aid in selecting the proper grain and grade of wheel.

**COMPRESSIVE STRENGTH** — Test specimens were machined oversize, heat treated and finished by grinding to 0.505 in. dia. x 0.750 in. long. Heat-treatment consisted of heating at 1850°F and tempering at 100-degree intervals, at temperatures ranging from 300 to 1300°F. The specimens were checked for hardness and were then compressed between hardened steel plates. The results obtained are shown in Figure 1.

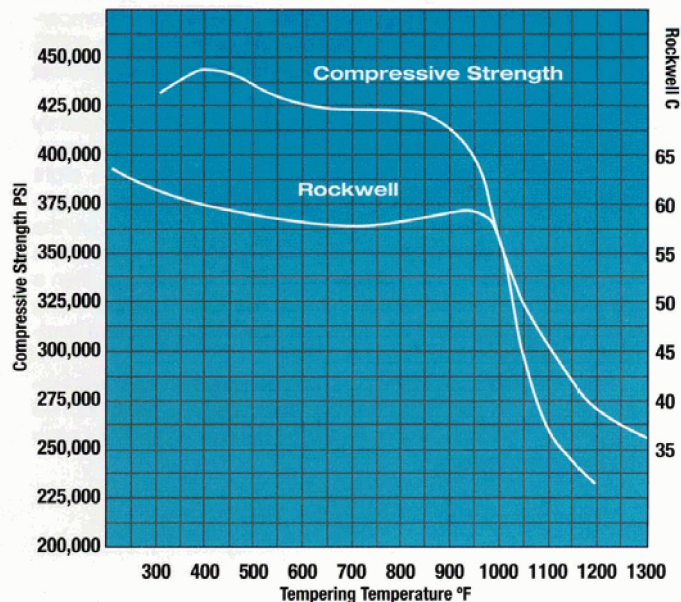


Figure 1

#### GENERAL INSTRUCTIONS

**HARDENING** — Preheat to 1200°F and hold at this temperature until thoroughly soaked. Heat to 1850°F and hold at this temperature 1 hour for each inch of greatest cross section. The pieces may then be removed and cooled in still air to a temperature of 150°F and tempered immediately. Oil quenching is required on sections 6 in. and larger.

(cont'd on back)





# LINDQUIST STEELS, INC.

## TOOL STEEL SPECIALISTS

### TECHNICAL BULLETIN (cont'd)

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Typical Analysis: Carbon 1.55 Chromium 11.50 Vanadium 0.90 Moly. 0.80 Mang. 0.40

Color Code: White

**TEMPERING** — Double tempering is always preferable with the second temper 50 degrees lower than the first. The type of tool and service requirements largely determine the tempering temperature. For most applications the tempering range is 900 to 960°F. A minimum holding time of two hours for each inch of greatest cross section should be used.

To minimize the possibilities of cracking, temper immediately after hardening and heat slowly to desired tempering temperature.

In the as-quenched condition, D2 normally shows a slight amount of contraction in size. Tempering at 900°F or slightly higher usually neutralizes the original shrinkage produced in the quench and brings the part virtually back to its original size. If the first temper does not completely neutralize the shrinkage, then a second, or even a third temper may be used, each temper being raised 10 degrees over the previous temper. This produces a hardness in the range of Rockwell C 58/60.

After the shrinkage of the part has been neutralized, it is advisable to give the part a final temper to temper any newly formed martensite. This final temper should be done at 25 to 50°F below the previous temper.

Tempering Temperature -°F	1750°F Oil-Quenched Rockwell C
None	64
400	60
500	58
600	58
700	58
800	57
900*	58/60
960	58/60
1000	56
1100	48
1200	40

The results in Figure 2 may be used as a guide in tempering tools to desired hardness, keeping in mind that tempering below 900°F is not recommended. However, tools of heavy section or mass may be several points lower in Rockwell hardness for a given treatment.

\* See Tempering

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