

Cincinnati Tool Steel Company

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AISI D2

High Carbon/High Chrome Tool Steel

As the result of its special annealed structure, developed and tested over a period of several years, AISI Type D2 is the ideal grade for maximum production runs. Its machinability is superior to any of the similar types of tool steel. It also has excellent wear-resistance and deep hardening properties, and high compressive strength. Use D2 for applications requiring long runs and close tolerances. Use it for tools and dies for blanking, punching, forming, cold-extruding, and other operations requiring high compressive strength and excellent wear resistance.

Machinability - D2 has a machinability rating of 65, as compared with a rating of 100 for a 1 pct 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 900F. Tempering at approximately 925F usually eliminates this contraction and brings the part virtually back to its original size. D2 has the minimum distortion in heat-treatment as compared with other tool steels.

Typical Analysis

| | |
|----------------|------------------|
| Carbon 1.55 | Molybdenum 0.080 |
| Chromium 12.00 | Vanadium 0.090 |

Annealing

Use a controlled-atmospheric furnace or pack in some inert material in a sealed container to prevent decarburization. To anneal, heat slowly to approximately 1600°F to 1650°F and hold at temperature for 1-1/2 hours for each inch of greatest thickness. Cool slowly at a rate of 20 degrees per hour to 900°F, after which the steel may be allowed to cool down with the furnace. Resulting hardness will be Brinell 217 max.

Hardening

When heating for hardening, protect the steel by packing or wrapping in some inert material. When available, the use of a well-regulated salt bath, a controlled-atmospheric furnace, or a vacuum furnace is preferred. 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.

The fracture grain size and Rockwell C hardness of 1-in.-square specimens quenched in air after holding for one hour at various temperatures are indicated in the following chart.

| Still Air-Cooled | | |
|-------------------------|-------------------|-----------------|
| Quenching | Fracture | Rockwell |
| temperature - °F | grain size | C |
| 1700 | 8-3/4 | 62 |
| 1750 | 9-1/4 | 64 |
| 1800 | 9-1/4 | 65 |
| 1850 | 9-1/2 | 65 |
| 1900 | 9-1/4 | 63 |

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°F 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 to 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°F to 50°F below the previous temper.

Various size specimens from several heats of steel were air quenched from 1850°F and tempered for a minimum of 2 hours per inch of cross section with the following results:

| | 1850°F |
|-------------------------|-------------------|
| Tempering | Air-Quenched |
| <u>Temperature - °F</u> | <u>Rockwell C</u> |
| None | 64 |
| 400 | 60 |
| 500 | 58 |
| 600 | 58 |
| 700 | 58 |
| 800 | 57 |
| 900* | |
| 960 | 58/60 |
| 1000 | 56 |
| 1100 | 48 |
| 1200 | 40 |

These results 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.

Data shown are typical, and should not be construed as maximum or minimum values for specification or for final design.
Data on any particular piece of material may vary from those herein.