**AISI D3**

**High Carbon High Chromium Die Steel**

**Typical Analysis**

Carbon 2.20; Chromium 12.00; Nickel 0.50

**Advantages**

Excellent abrasion resistance

High hardening response

Very high compressive strength

**Applications**

Use AISI D3 for exceptionally long runs in blanking and forming where emphasis is not on toughness. This grade has the highest as-quenched hardness of all cold work die steels, providing the opportunity for a relatively high working hardness, frequently Rc 63-64. AISI D3 holds dimension during hardening quite well for an oil hardening steel, and its reduced depth of hardening tends to restore toughness in this high carbon die steel. Typical applications include blanking and forming dies and punches, forming rolls, slitters, drawing and bending dies, and cold trimmer dies.

**Thermal Treatment Summary**

**Critical Points**

 Heating (Ac) - 100⁰F/Hr. – begins 1445⁰F, ends 1510⁰F

 Cooling (Ar) - 50⁰F/Hr. – begins 1410⁰F, ends 1370⁰F

**Forging** – Heat slowly to 1900/2000⁰F, stop at 1700⁰F and cool slowly

**Annealing** – 1600-1650⁰F, furnace cool, BHN 248 max

**Preheating** – 1200-1300⁰F prior to hardening

**Hardening** – 1750-1800⁰F, oil quench to 150⁰F

**Tempering** – 350 to 500⁰F Rc 60-64

 850 to 950⁰F Rc 57-58

**FABRICATION**

**Forging**

AISI D3 is a highly alloyed steel and its heat penetration is slow. Therefore, it is desirable to preheat the forging stock to 1200-1300⁰F. When uniformly soaked at this temperature, raise the furnace temperature to 1900-2000⁰F. The forging range is rather narrow and it is well to discontinue hot working below 1650-1700⁰F. Reheat if necessary. After forging, the parts should be placed out of contact of air currents or moisture, preferably buried in either an insulating pack medium such as lime or vermiculite or placed in a furnace held at 1200/1400⁰F, equalized and then slowly cooled to room temperature.

**Annealing**

In order to maintain surface neutrality, it is advisable to use atmosphere or vacuum furnaces or pack procedure in annealing AISI D3. Heat slowly to 1600-1650⁰F and allow charge to equalize at temperature. Then furnace cool at a rate not to exceed 25⁰F/hour to about 1000⁰F, pull charge and air cool.

Machinability

AISI D3 is readily machinable in the fully annealed condition. Its machinability rating is about 35% when compared to 1% carbon tool steel rated at 100%.

**HEAT TREATMENT**

**Hardening**

Controlled atmosphere, vacuum or salt bath furnaces are recommended for hardening AISI D3 in order to minimize decarburization or carburization. If such facilities are unavailable, pack hardening in a sealed container with neutral compound can be used. Preheat slowly to 1200-1400⁰F, equalize, and then slowly raise temperature to 1750-1800⁰F, allowing work to soak thoroughly at high heat. Quench in warm oil (120-150⁰F) with a well agitated bath.

**Tempering**

The usual tempering temperature range for AISI D3 when full hardness is sought is 350-500⁰F, designed for tool working on medium to light gage material. When more toughness is needed, a tempering range of 850-950⁰F is suggested. This will result in some hardness decrease. Double tempering is recommended when tempering within this higher range.

**Hardening and Tempering Series**

Ground annealed bars 1 inch round by 2 inches long were preheated at 1200⁰F. The samples were transferred to an electric furnace with an atmosphere of about 10% CO, held for 30 minutes at 1750 and 1800⁰F and quenched in oil. Samples were tempered cumulatively for 1 hour at the indicated temperature. Hardness results are shown on the tempering chart.

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| **Tempering Temperature ⁰F** | **Oil Quenched** |
| **1750⁰F** | **1800⁰F** |
| None | 63.0 Rc | 65.5 |
| 300 | 62.5 | 65.0 |
| 400 | 61.0 | 63.5 |
| 500 | 58.5 | 61.5 |
| 600 | 57.0 | 59.5 |
| 700 | 56.5 | 59.0 |
| 800 | 55.5 | 58.5 |
| 900 | 54.5 | 57.5 |
| 1000 | 52.5 | 56.0 |
| 1100 | 48.5 | 51.0 |
| 1200 | 41.0 | 43.0 |