

INCONEL® alloy 751 (UNS N07751) is a precipitation hardenable nickel-chromium alloy, used mainly for the exhaust valves of internal combustion engines. Its limiting chemical composition is shown in Table 1. The alloy has essentially the same excellent physical, mechanical and corrosion-resistance properties as INCONEL alloy X-750. Some physical constants for INCONEL alloy 751 are shown in Table 2. Its thermal properties correspond closely to those published for INCONEL alloy X-750.

In the evaluation of materials for exhaust valve applications, nickel-chromium alloys have performed well in a 1675°F (913°C) lead oxide screening test. INCONEL alloy 751 repeatedly offered good results, with corrosion rates averaging 4.31 g/dm²/h. Like other nickel-chromium alloys, INCONEL alloy 751 also resists attack by other exhaust stream impurities such as sulfur, bromine and chlorine.

Table 1 - Limiting Chemical Composition, %

| | |
|----------------------------|-----------|
| Nickel (+ Cobalt) | 70.0 min. |
| Chromium..... | 14.0-17.0 |
| Iron | 5.0-9.0 |
| Titanium..... | 2.0-2.6 |
| Aluminum | 0.9-1.5 |
| Niobium (+ Tantalum) | 0.7-1.2 |
| Manganese | 1.0 max. |
| Silicon | 0.5 max. |
| Sulfur | 0.01 max. |
| Copper..... | 0.5 max. |
| Carbon..... | 0.10 max. |

Physical Constants and Thermal Properties

Table 2 - Physical Constants & Thermal Properties

| | |
|---|------------|
| Density, lb/in ³ | 0.297 |
| g/cm ³ | 8.22 |
| Melting Range, °F | 2540-2600 |
| °C..... | 1390-1430 |
| Specific Heat, Btu/lb °F..... | 0.103 |
| J/kg °C | 431 |
| Curie Temperature, °F | -193 |
| °C | -125 |
| Permeability at 200 oersted (15.9 kA/m) | 1.0035 |
| Coefficient of Expansion, 10 ⁻⁶ in/in °F (µm/m °C) | |
| 70-200°F (21-93°C) | 7.0 (12.6) |
| Thermal Conductivity, Btu in/ft ² h °F..... | 83 |
| W/m °C | 12.0 |
| Electrical Resistivity, ohm•circ•mil/ft | 731 |
| µΩ ohm•m | 1.22 |
| Young's Modulus, 10 ³ ksi | 31 |
| GPa..... | 214 |
| Modulus of Rigidity, 10 ³ ksi..... | 11 |
| GPa..... | 76 |

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INCONEL® alloy 751



Mechanical Properties

Tensile properties for INCONEL alloy 751 are presented in Table 3 and Figure 1. These are average properties derived from production material. High-temperature stress-rupture properties are listed in Table 4. Fatigue strengths, at room and elevated temperatures, are shown in Table 5.

INCONEL alloy 751 has excellent hot hardness. As a result, hard facing of valve seat areas for good wear-resistance is unnecessary in most applications. Table 3 lists the results of hot hardness tests at typical valve operating conditions.

Table 3 - Tensile Properties

| Temperature | | Yield Strength (0.2% Offset) | | Tensile Strength | | Elongation | Reduction of Area | Hardness |
|-------------|------|------------------------------|-----|------------------|------|------------|-------------------|----------|
| °F | °C | ksi | MPa | ksi | MPa | % | % | BHN |
| Room | Room | 141.5 | 976 | 190.0 | 1310 | 22.5 | 38.2 | 352 |
| 1200 | 649 | 128.9 | 889 | 159.6 | 1100 | 22.5 | 32.1 | 291 |
| 1350 | 732 | 113.5 | 783 | 124.8 | 860 | 18.5 | 25.7 | 235 |
| 1500 | 816 | 76.3 | 526 | 80.3 | 554 | 26.0 | 35.9 | 173 |

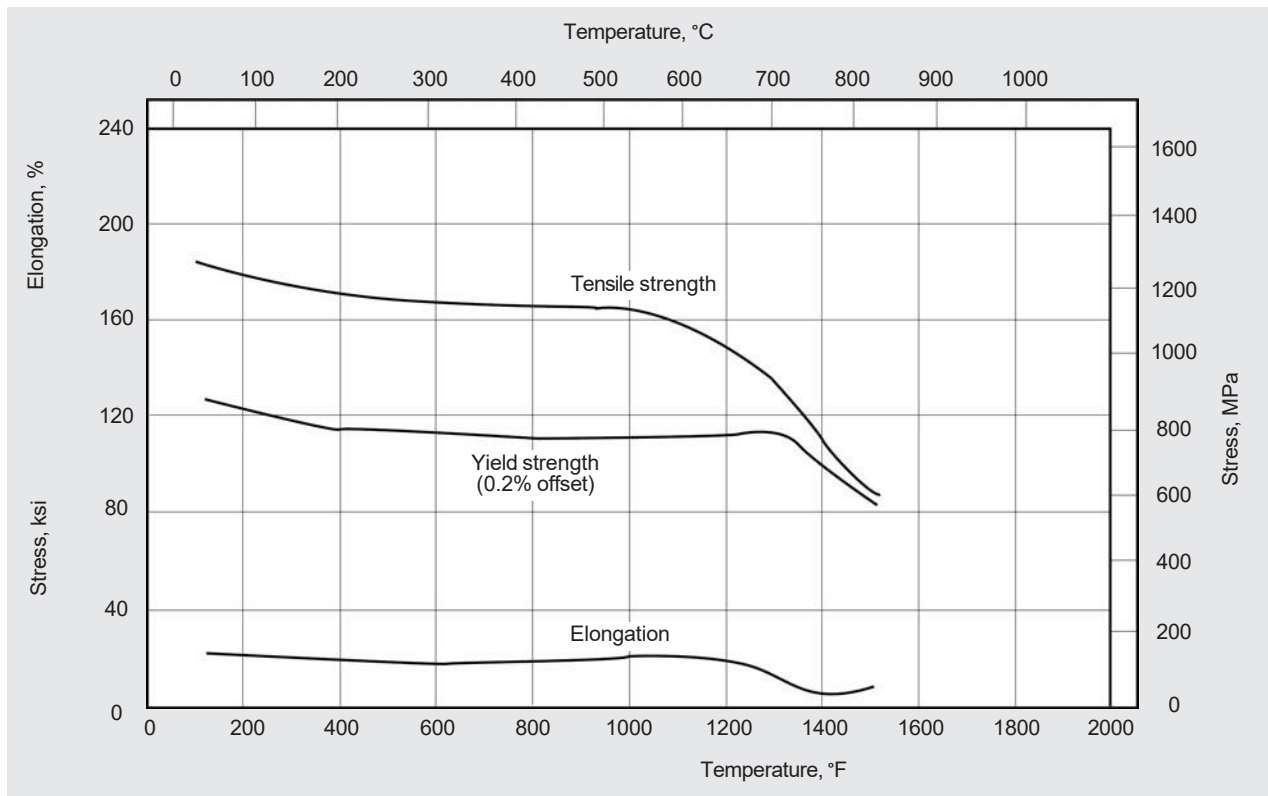


Figure 1 - High temperature tensile properties of precipitation hardened INCONEL alloy 751.

Table 4. Stress Rupture Properties

| Temperature | | Stress to Produce Rupture in 100 h | | Stress to Produce Rupture in 1000 h* | |
|-------------|-----|------------------------------------|-----|--------------------------------------|------|
| °F | °C | ksi | MPa | ksi | MPa |
| 1200 | 649 | 69 | 476 | 40 | 276 |
| 1350 | 732 | 51 | 352 | 35 | 241 |
| 1500 | 816 | 28 | 193 | 14 | 96.5 |

* Extrapolated

Table 5. Fatigue Strength

| Temperature | | 10 ⁶ Cycles | | 10 ⁷ Cycles | | 10 ⁸ Cycles | |
|-------------|-----|------------------------|-----|------------------------|-----|------------------------|-----|
| °F | °C | ksi | MPa | ksi | MPa | ksi | MPa |
| 80 | 27 | 99.5 | 686 | 92.5 | 638 | 90.0 | 621 |
| 1350 | 732 | 73.5 | 507 | 62.0 | 427 | 40.0 | 276 |
| 1500 | 816 | 47.0 | 324 | 39.5 | 272 | 20.0 | 138 |

Fabrication

Hot Working

The hot working range for INCONEL alloy 751 is 1800-2200°F (980-1205°C). The alloy should be reheated to 2200°F (1205°C) whenever its temperature falls below 1800°F (980°C).

Machining

INCONEL alloy 751 is readily machined in the as-hot finished condition. The best procedure is to machine to slightly oversize, precipitation heat treat, then finish to size. A slight permanent contraction (about 0.0003 in/in) takes place during precipitation. Precipitation treated material can be finish machined to fine finishes and close tolerances, and will have good dimensional stability.

Available Products and Specifications

INCONEL alloy 751 is designated as UNS N07751 and is produced as round bar.

Joining

INCONEL alloy 751 can be joined by the flash butt welding procedures commonly used in valve manufacture. The alloy can also be inertia welded.

Heat Treatment

All properties listed in this publication were derived from material direct aged for two hours at 1350°F (732°C). This short-time heat treatment has been found to produce material with the optimum combination of properties consistent with economy. Longer, more complex, aging treatments may be used to improve specific properties required for particular applications. Please consult Special Metals Corporation for further information.