Alloy X-750, 2.4669, UNS N07750, Inconel X-750

Alloy X-750: Properties and Applications

Properties:

- **High Strength**: Excellent mechanical properties at temperatures up to 1300°F (700°C).
- **Corrosion Resistance**: Good resistance to oxidation and corrosion.
- **Creep Resistance**: Maintains performance under prolonged stress at high temperatures.
- **Precipitation-Hardenable**: Strengthened by heat treatment (aging).

Applications:

- **Aerospace**: Jet engine components, gas turbine parts.
- **Nuclear Industry**: Reactor components, fuel assembly hardware.
- **Industrial**: Fasteners, springs, high-temperature tooling.
- **Chemical Processing**: Equipment exposed to corrosive environments.

A versatile nickel-chromium alloy, X-750 is ideal for high-stress, high-temperature applications.

Applications

Typical applications include gas turbine components (both aerospace and industrial turbines), high-temperature fasteners, springs, and rocket engines. With slightly modified heat treatments, Alloy X-750 is also used in nuclear reactor components, primarily in pressurized water reactors (PWRs) and boiling water reactors (BWRs). Additionally, it finds use in cryogenic applications.

Equivalent or Similar Grades - Chemical Composition

Alloy X-750, 2.4669, UNS N07750, Inconel® X-750 according to ASTM B637 and EN 10302

Standard	Grade	Ni:	Cr:	Fe:	Ti:	Al:	Nb:	Co:	Mn:	Cu:	Si:	C:	S:	P:	Comments:
ASTM	**Alloy X-750,N07750,Inconel X-750**	>70.0	14.0-17.0	5.0-9.0	2.25-2.75	0.4-1.0	0.7-1.2	<1.0	<1.0	<0.5	<0.5	<0.08	<0.01	-	Nb:Nb+Ta
EN	**2.4669 / NiCr15Fe7TiAl**	>70.0	14.0-17.0	5.0-9.0	2.25-2.75	0.4-1.0	0.7-1.2	<1.0	<1.0	<0.5	<0.5	<0.08	<0.015	<0.02	Nb:Nb+Ta
ISO	**NW7750**	>70.0	14.0-17.0	5.0-9.0	2.2-2.8	0.4-1.0	0.7-1.2	<1.5	<1.0	<0.5	<0.5	<0.08	<0.015	-	Nb:Nb+Ta; Ni:Ni+Co
GOST-R	**EP601 / NiCr15Fe7TiAl**	Balance	14.0-17.0	5.0-9.0	2.0-2.6	1.10-1.35	0.7-1.2	-	<0.5	-	<0.5	0.03-0.10	<0.015	<0.015	Nb:Nb+Ta
JIS	**NCF750**	>70.0	14.0-17.0	5.0-9.0	2.25-2.75	0.4-1.0	0.7-1.2	-	<1.0	<0.5	<0.5	<0.08	<0.015	<0.03	Nb:Nb+Ta; Ni:Ni+Co

Mechanical Properties

Mechanical properties of Inconel® X-750 bar at room temperature

- Tensile strength: 1200 MPa
- Yield strength: 815 MPa
- Elongation: 27%

High-temperature (540°C) mechanical properties of Inconel® X-750 bar

- Tensile strength: 1050 MPa
- Yield strength: 725 MPa
- Elongation: 26%

Rupture strength of Inconel X-750 bar at elevated temperatures

- 650°C: 470 MPa
- 870°C: 50 MPa

Corrosion Behavior

As a superalloy, X-750 exhibits high corrosion resistance in moderately aggressive environments. Below are the test results of its tolerance to some challenging conditions.

Molten carbonate – Corrosion data from 504-hour exposure to molten carbonate salt at 900°C demonstrate that Inconel® X-750 has sufficient tolerance to molten carbonates. The total corrosion depth measured was 0.27 mm.

High-temperature water – Inconel® X-750 is susceptible to stress corrosion cracking (SCC) in deaerated high-purity water at 300–350°C and to intergranular SCC in oxygenated high-temperature water applications. Non-optimized heat treatments further reduce the alloy's resistance to high-temperature water (see the "Heat Treatment" section for more details).

Halides – X-750 is not resistant to **hydrogen fluoride (HF)** and **hexafluorosilicic acid (H_2SiF_6)** at temperatures above 50°C. Exposure to these agents can cause SCC.

X-750 is not tolerant to **hydrogen fluoride (HF)**, which leads to stress corrosion cracking.

Physical Properties

- Density: 8.28 g/cm³
- Initial melting temperature: 1290 °C

- Precipitation temperature: 955 °C

Heat Treatment

Soft Annealing

- **Temperature:** 955–1155°C
- **Duration:** 30–60 min (continuous annealing) or 60–180 min (batch annealing)
- **Cooling method:** Air cooling

Solution Treatment Before Age Hardening
While nickel alloys typically do not require solution treatment before aging, Alloy X-750 benefits from it to enhance **creep resistance, stress relaxation resistance, and rupture strength above 600°C**—critical for high-temperature springs and turbine blades. For this purpose, Alloy X-750 can undergo solution treatment followed by air cooling before a dual (high- and low-temperature) aging cycle. Different temperatures are specified in **AMS 5668** and **AMS 5671**.

However, a two-stage solution treatment does not provide optimal corrosion resistance in very hot, deaerated water (typical of boiling water reactor environments). For such applications, literature recommends a **single-stage solution treatment** (note: this may reduce corrosion resistance in oxygenated water).

Processing Performance

Weldability

This alloy falls under Group 43 in ISO 15608.

Welding consumables for Inconel® X-750:

- **Filler metal:** ERNiFeCr-2

Best practices for welding Al- and Ti-containing alloys:

- Use proper joint design, welding techniques, and filler metals to minimize residual and thermally induced stresses.
- Keep heat input as low as possible during welding.
- For heavy-section welds, apply **multiple** stress-relief anneals between welding passes.

Heat Treatment, Forming, and Machining

Aluminum or copper particles on the surface of Inconel® X-750 can rapidly alloy at high temperatures, degrading corrosion resistance and mechanical properties. All contaminants must be removed before heat treatment.

Hot-forming pressures for Alloy X-750:

- 870°C: 335 MPa
- 1040°C: 299 MPa
- 1095°C: 265 MPa
- 1150°C: 230 MPa

Forging
Below 980°C, this alloy is hard and difficult to work; attempting to forge it may cause cracking. Heavy forging should be performed at around **1040°C**, and the metal should be reheated if cooled below this temperature. Some light reduction can be done between 980°C and 1040°C.

- **Forging range:** 980–1205°C
- **Heavy forging range:** 1040–1205°C
- **Cooling method:** Air cooling

Variable cross-sections are particularly prone to hot cracking during cooling. For very large cross-sections, furnace cooling may be necessary.

Machining
Alloy X-750 belongs to **Machinability Group D-2**, meaning it is extremely difficult to machine. Rough machining should be performed in the solution-annealed condition, followed by finish machining after aging. Aging causes dimensional shrinkage of up to **~0.07%**, which must be accounted for during rough machining.

For nickel-based alloys, **power spinning** is preferred over manual spinning. The practical limit for manual spinning of Alloy X-750 is a blank thickness of **0.94 mm**, with a maximum blank hardness of **94 HRB**.

Electropolishing

Electropolishing technique for Alloy X-750:

- **Electrolyte composition:** 25 mL H_3PO_4, 25 mL HNO_3, 50 mL H_2O
- **Cathode:** Platinum

- **Conditions:** 17.8 A/cm² for 5–10 seconds

Alternative Names, Equivalents, and Other Designations

- Alloy X-750
- Alloy x750
- N07750
- AISI 688
- 72Ni15.5Cr-0.95Cb
- 2-5Ti
- 0.70Al-7.0Fe
- AMS 5698
- ASTM B637 Grade 688
- Pyromet Alloy X-750
- NAS 750
- AMS 5747
- AMS 7246
- AMS 5542
- AMS 5583
- AMS 5667
- AMS 5671
- AMS 5779
- AMS 7246B
- AMS AS7245
- Inconel® X-750
- Unitemp® 750
- Nickelvac® X-750
- J467
- SAE J467
- 2.4669
- NW7750
- NiCr15Fe7TiAl
- NC750
- EP601
- Sanicro® 75XT
- Sanicro® 75X1T