

Invar 36

Invar 36 is a low expansion alloy contains 36% nickel. The Curie point of Invar 36 is about 230 °C. Below this temperature, the alloy is ferromagnetic and has a very low expansion coefficient. Above this temperature, the alloy is non-magnetic and the coefficient of expansion increases. Invar 36 is mainly used to manufacture components with approximately constant dimensions over temperature variations and is widely used in the radio industry, precision instruments and other industries.

Common Trade Names

32H, Nilo 36, FeNi36, W.NR 1.3912

Chemical Composition

Grade	C%	P%	S%	Mn%	Si%
Invar 36	Max 0.05	Max 0.02	Max 0.02	0.2-0.6	Max 0.30
	Cr%	Mo%	Co%	Ni%	Fe%
	Max 0.50	Max 0.50	Max 1.00	35.0-37.0	Bal.

Heat Treatment

Semi-finished parts: 840 °C ± 10 °C for 1 hour, water cooling

After finished: 315 °C ± 10 °C, for 1h, air cool

Physical Properties

Properties	Invar 36
Resistivity at 20°C (micro ohm · meter)	0.78
Density (gram/cm ³)	8.10
Specific heat (J/kg · °C)	515
Thermal conductivity (W/m · °C)	11
Melting temperature (°C)	1430

Temperature Coefficient of Resistance

Temperature Range °C	20-50	20-100	20-200	20-300	20-400	20-500
$\alpha R/103^{\circ}\text{C}^{-1}$	1.8	1.7	1.4	1.2	1.0	0.9

Average Coefficient Of Linear Expansion

Temperature °C	10-6°C -1	Temperature °C	10-6°C -1
20-60	1.8	20-250	3.6
20-40	1.8	20-300	5.2
20-20	1.6	20-350	6.5
20-0	1.6	20-400	7.8
20-50	1.1	20-450	8.9
20-100	1.4	20-500	9.7
20-150	1.9	20-550	10.4
20-200	2.5	20-600	11.0

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Typical Mechanical Property

σ_b /MPa	$\sigma_{P0.2}$ /MPa	δ /%
450	272	35

Heat Treatment of Finished Parts

- 1, Stress-relief annealing: In order to eliminate the residual stress of parts after machining, 530-550°C, for 1-2h, cool in furnace
- 2, Intermediate annealing: In order to eliminate the hardening caused by cold rolling, cold drawing and cold stamping, 830-880°C in dry hydrogen or vacuum, for 30min, air or water cool
- 3, Stabilization treatment: to achieve low expansion coefficient and can stabilize workpiece's performance. Three-stage processing is generally used.
 - a) Homogenization: During heating, the impurities in the alloy are sufficiently solid-solved and the alloying elements tend to be uniform. The workpiece is heated to 830 ° C in a protective atmosphere, kept for 20 min to 1 h, and quenched.
 - b) Tempering: The stress generated by quenching can be partially eliminated during the tempering process. The workpiece is heated to 315 ° C, kept for 1 to 4 hours, cooling in furnace.
 - c) Stabilization aging: Stabilize the size of the alloy. The workpiece is heated to 95 ° C for 48 h. For high-precision parts after cold working or machining, when high temperature treatment is not suitable, the following stress relieving stabilization treatment can be used: the workpiece is heated to 315 to 370 ° C for 1 to 4 hours.

Descaling Treatment

Sandblasting, polishing or pickling can be used. The alloy can be pickled with a 25% hydrochloric acid solution at 70 ° C to remove scale.

Machining

High-speed steel or carbide tools are used for machining, low-speed machining, and coolant can be used for cutting. Good grinding performance

Available Forms

- 1, Sheet/Plate
Condition: Hot rolled, cold rolled, annealed, pickled
- 2, Disc/Ring
Condition: Hot rolled, forged, pickled, machined
- 3, Wire
Condition: Bright annealed, 1/4Hard-Hard Drawn, dia. 0.01-15mm, in coil or cut lengths
- 4, Bar
Condition: Hot rolled, forged, annealed, pickled, ground
- 5, Strip/Ribbon
Condition: Cold rolled, thickness 0.01-5mm
- 6, Tube/Capillary Tube
Condition: OD 0.2-15mm, Wall 0.015-3mm