Ualloy-4J36 (Expansion alloy)

Common Name: Invar, FeNi36, Invar Standard, Vacodil36

Ualloy-4J36 (Invar) , also known generically as FeNi36 (64FeNi in the US), is a nickel–iron alloy notable for its uniquely low coefficient of thermal expansion (CTE or α).

The name Invar comes from the word invariable, referring to its relative lack of expansion or contraction with temperature changes.

It was invented in 1896 by Swiss physicist Charles Édouard Guillaume. He received the Nobel Prize in Physics in 1920 for this discovery, which enabled improvements in scientific instruments.
Ualloy-4J36 (Invar) is used where high dimensional stability is required, such as precision instruments, clocks, seismic creep gauges, television shadow-mask frames, valves in motors, and antimagnetic watches. In land surveying, when first-order (high-precision) elevation leveling is to be performed, the Level staff (leveling rod) used is made of Invar, instead of wood, fiberglass, or other metals. Invar struts were used in some pistons to limit their thermal expansion inside their cylinders.

Normal composition%

Ni	35~37.0	Fe	Bal.	Co	-	Si	≤0.3
Mo	-	Cu	-	Cr	-	Mn	0.2~0.6
C	≤0.05	P	≤0.02	S	≤0.02		

Typical Physical properties

Density (g/cm^3)	8.1
Electrical resistivity at 20℃(Ωmm^2/m)	0.78
Coefficient of linear expansion（20℃~200℃） X10^{-6}/℃	3.7~3.9
Thermal conductivity, λ/ W/(m*℃)	11
Curie point T_c/ ℃	230
Elastic Modulus, E/ Gpa	144

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Coefficient of expansion

θ/℃	$\alpha_1/10^{-6}℃^{-1}$	θ/℃	$\alpha_1/10^{-6}℃^{-1}$
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

Typical Mechanical properties

Tensile Strength	Elongation
Mpa	%
641	14
689	9
731	8

Temperature factor of resistivity

Temperature range, ℃	20~50	20~100	20~200	20~300	20~400
$a_R/ 10^3 *℃$	1.8	1.7	1.4	1.2	1.0

The heat treatment process	
Annealing for stress relief	Heated to 530~550℃ and hold 1~2 h. Cold down
Annealing	In order to eliminate hardening, which be bring out in cold-rolled, cold drawing process. Annealing needs heated to 830~880℃ in vacuum,hold 30 min.
The stabilization process	1. In protective media and heated to 830 ℃, hold 20min. ~ 1h, quench 2. Due to the stress generated by quenching, heated to 315℃,hold 1~4h.
Precautions	1. Can not be hardened by heat treatment 2. Surface treatment can be sandblasting, polishing or pickling. 3. Alloy can be used 25% hydrochloric acid pickling solution at 70 ℃ to clear oxidized surface

Style of supply

Alloys Name	Type	Dimension	
Ualloy-4J36	Wire	D= 0.1~8mm	
Ualloy-4J36	Strip	W= 5~250mm	T= 0.1mm
Ualloy-4J36	Foil	W= 10~100mm	T= 0.01~0.1
Ualloy-4J36	Bar	Dia= 8~100mm	L= 50~1000

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