INCOLOY® alloy 890

INCOLOY® alloy 890 (UNS N08890) is the latest addition to the INCOLOY alloy family of heat resistant alloys. Alloy 890 joins the existing INCOLOY products in offering high strength along with excellent resistance to oxidation, carburization, and sulfidation at temperatures up to 2200°F (1200°C).

The chemical composition of alloy 890 is found in Table 1. Alloy 890 offers the high chromium content of alloy 803 along with enhanced properties from additions of silicon, molybdenum, and niobium. Alloy 890 is protected by United States Patent Number 5,873,950 dated February 23, 1999.

Physical and Thermal Properties

Physical constants for alloy 890 are given in Table 2. Values for Young's Modulus, Shear Modulus, and Poisson's Ratio as a function of temperature are given in Table 3. Thermal expansion data are reported in Table4.

Table 2 - Physical Constants

Density, lb/in³	0.287
g/cm³	7.94
Melting Range, °C	1309-1383
°F	2388-2522

Table 3 - Modulus at Elevated Temperatures

Temperature °F	Modulus of Elasticity Tension, 10^3 ksi	Shear Modulus Tension, 10^3 ksi	Poisson's Ratio
72	28.3	10.7	0.322
200	27.9	10.5	0.329
400	26.9	10.1	0.332
600	26.0	9.8	0.327
800	25.0	9.6	0.302
1000	23.8	9.1	0.308
1200	22.5	8.6	0.308
1400	21.4	8.2	0.305
1600	20.4	7.5	0.360
°C	GPa	GPa	
22	195.1	73.8	0.322
100	191.0	72.4	0.319
200	186.2	70.3	0.324
300	180.0	68.3	0.318
400	173.8	66.2	0.313
500	166.9	64.1	0.301
600	159.3	61.4	0.298
700	151.7	57.9	0.310
800	144.1	54.5	0.323
900*	138.6	50.3	0.377

*- Extrapolated Value.

Table 1-Chemical Composition, %

Nickel	42.5
Chromium	25
Iron	Bal.
Aluminum	0.1
Niobium	0.4
Titanium	1 max.
Carbon	0.1
Manganese	1 max.
Silicon	1.8
Phosphorus	0.03 max.
Sulfur	0.015 max.
Copper	0.75 max.
Molybdenum	1.5
Tantalum	0.2

Table 4 - Coefficient of Expansion[a]

Temperature °F	Coefficient of Expansion, 10^{-6} in/in/°F
200	8.02
400	8.20
600	8.43
800	8.67
1000	8.94
1200	9.26
1400	9.52
°C	µm/m/°C
100	14.47
200	14.76
300	15.11
400	15.51
500	15.94
600	16.40
700	16.88
800[b]	17.35

[a]Mean coefficient of linear expansion between 78°F (26°C) and temperature shown.

[b]Extrapolated Data.

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Mechanical Properties

INCOLOY alloy 890 is supplied in the annealed condition. The tensile and yield strength values of alloy 890 at ambient and elevated temperatures are approximately the same as those of alloy 803 and slightly higher than values for alloy 800HT®. Like alloy 803 it is strengthened by its content of chromium and carbon. However, alloy 890 is further strengthened, especially at very high temperatures, by molybdenum and niobium. Tensile properties of some alloy 890 products are presented in Table 5.

Table 5 - Tensile Properties of INCOLOY alloy 890 plate and tubing.

Product	Temper	Temperature °F (°C)	0.2% Yield Strength, ksi (MPa)	Ultimate Tensile Strength, ksi (MPa)	Elongation	Reduction of Area, %
Hot-Rolled Plate	Solution-Annealed	72 (22)	39.4 (272)	94.5 (652)	46.6	62.7
Cold-Drawn Tubing	Solution-Annealed	72 (22)	48.4 (334)	94.2 (652)	46.5	60.1
Hot-Rolled Plate	Solution-Annealed	1600 (870)	16.0 (110)	23.5 (132)	84.8	71.0
Hot-Rolled Plate	Solution-Annealed	1800 (980)	9.6 (66)	13.4 (92)	98.0	87.5
Hot-Rolled Plate	Solution-Annealed	2000 (1100)	6.4 (44)	9.0 (62)	83.6	91.8

Creep and Rupture Properties

INCOLOY alloy 890 offers excellent resistance to creep and stress rupture at elevated temperatures. Its properties are similar to those of alloy 803 and slightly higher than those for alloy 800HT. The alloy's contents of molybdenum and niobium enhance its resistance to creep and stress rupture at temperatures above 1800°F (980°C). Stress rupture data is shown in Figure 1. A Larson-Miller presentation of creep rupture data for the three alloys is shown in Figure 2.

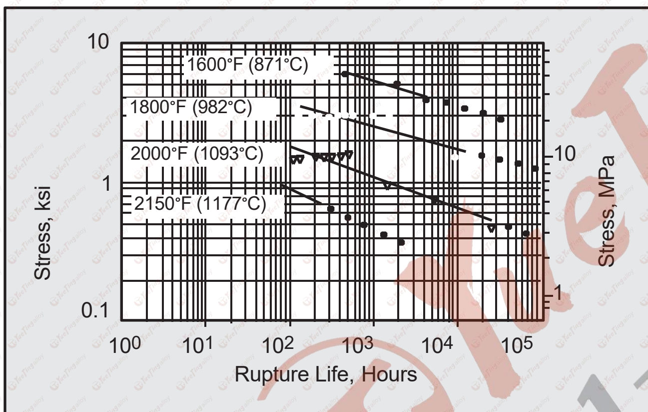

Figure 1. Stress Rupture Data for INCOLOY alloy 890 (Cold-Pilgered and Solution Annealed Tubing; Hot-Rolled and Solution Annealed Plate).

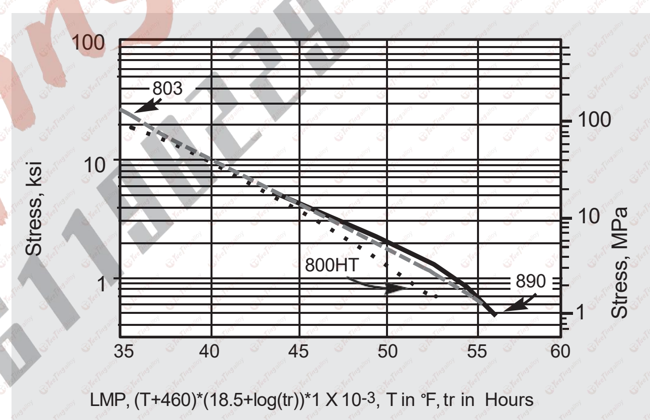

Figure 2. Larson-Miller plot showing relative creep rupture properties of as-produced INCOLOY alloys 803, 890 and 800H/HT.

Resistance to Corrosion at Elevated Temperatures

By virtue of its chromium and silicon contents, alloy 890 offers the greatest resistance to attack at elevated temperatures of any of the INCOLOY family of alloys. The resistance of alloys 890, 803, and 800HT® to carburization is shown in Figures 3, 4, 5, and 6. It is seen that alloy 890 outperforms even alloy 803, which is well known for its resistance to attack in carburizing environments. The resistance of the same alloys to oxidation is seen in Figures 7 and 8. Again, alloy 890 offers significantly superior performance.

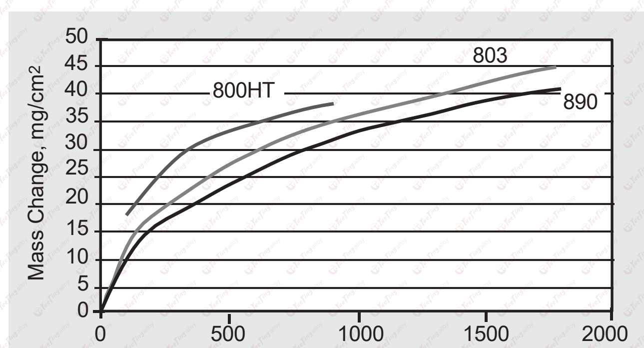

Figure 3. Mass change results after exposure in a carburizing atmosphere comprised of H_2 - 1% CH_4 at 1000°C.

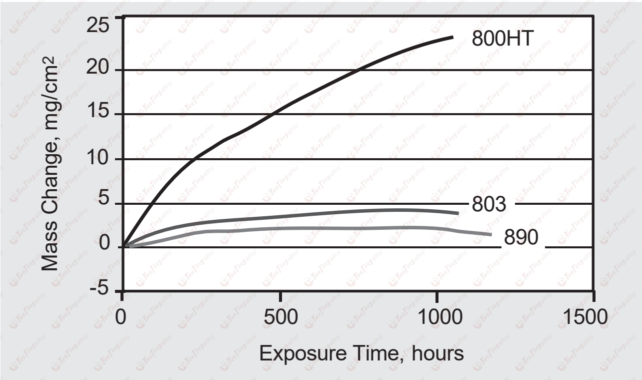

Figure 4. Mass change results after exposure in an oxidizing-carburizing atmosphere comprised of H_2 - 5.5% CH_4 - 4.5% CO_2 at 1000°C.

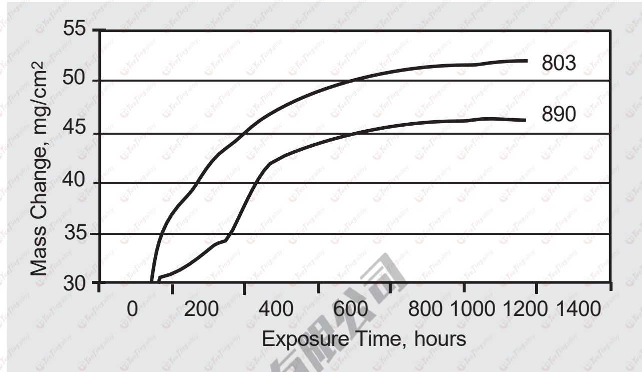

Figure 5. Mass change results after exposure in a carburizing atmosphere comprised of H_2 - 1% CH_4 at 1100°C.

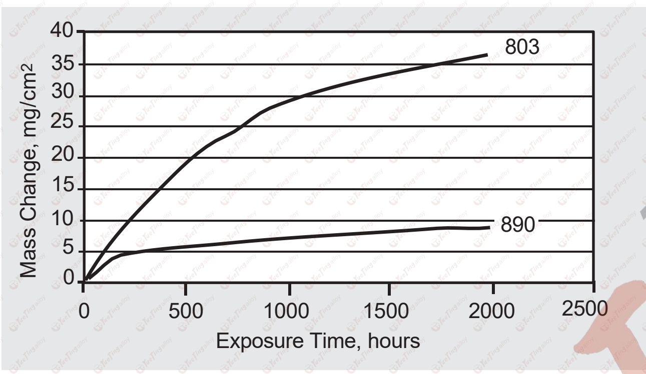

Figure 6. Mass change results after exposure in an oxidizing-carburizing atmosphere comprised of H_2 - 5.5% CH_4 - 4.5% CO_2 at 1100°C.

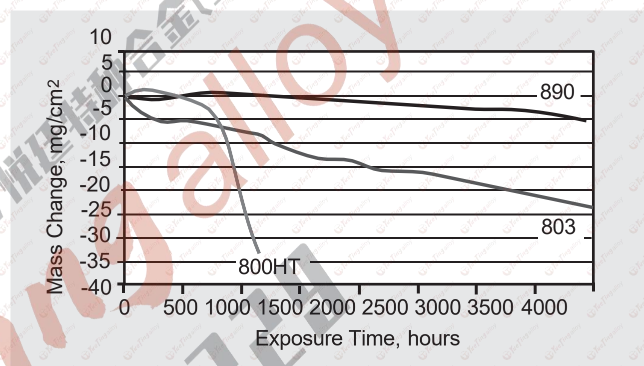

Figure 7. Mass change results after exposure in an air + 5% H_2O at 1000°C.

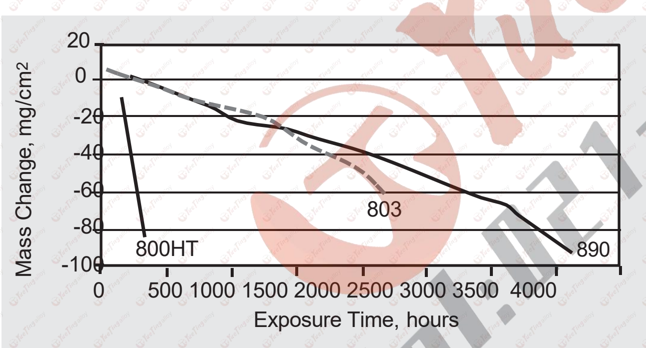

Figure 8. Mass change results after exposure in an air + 5% H_2O at 1100°C.

Machining

Information on machining is available in the Special Metals publication 'Machining' on the website, www.specialmetals.com.

Fabrication

INCOLOY alloy 890 is readily fabricated by conventional techniques. Forming requirements and procedures are essentially identical to those for alloys 800HT and 803. Work hardening of alloy 890 during cold deformation is similar to that of other INCOLOY alloys. It is compared with alloy 803 in Figure 9.

Heat Treatment

INCOLOY alloy 890 is a solid-solution, single phase alloy. It is normally supplied in the annealed condition. Annealing alloy 890 is accomplished by heating to a temperature between 2050 and 2200°F (1121 and 1204°C), holding for a time commensurate with section thickness, followed by rapid cooling in air or water quenching.

Alloy 890 can be sensitized by carbide precipitation when exposed to intermediate temperatures for extended periods of time. A time-temperature-sensitization (TTS) plot for alloy 890 is presented as Figure 10. However, sensitization of materials such as alloy 890 which are primarily used at elevated temperatures is not generally considered a significant problem since conditions to cause aqueous corrosion are not often encountered. Further information on fabricating is available in the Special Metals publication ' Fabricating' or on our website, www.yttzhj.com.

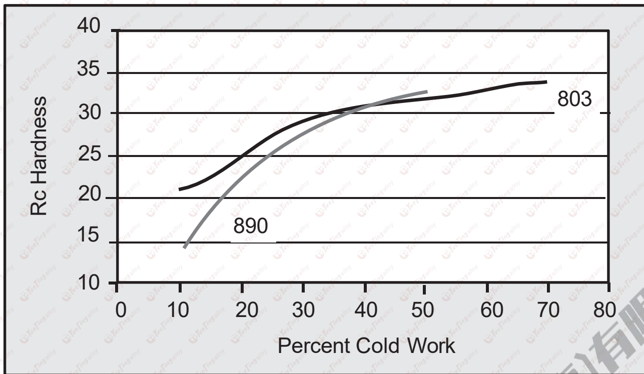

Figure 9. Typical hardness versus cold work for INCOLOY alloys 803 and 890 plate in the solution-annealed condition.

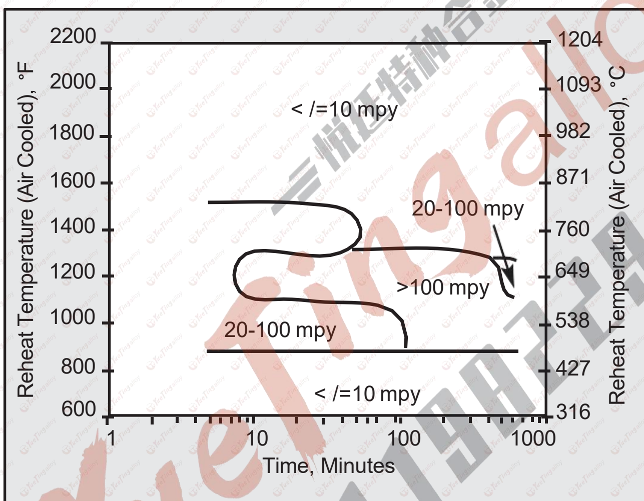

Figure 10. Time temperature sensitization of INCOLOY alloy 890 hot-rolled plate. ASTM A262, Practice C (Huey) test results. Specimens were solution annealed at 2175°F (1190°C) and water-quenched prior to subsequent exposure.

Joining

Alloy 890 components may be joined by most conventional welding processes including GMAW, GTAW, and SMAW. For applications requiring high strength and resistance to creep and stress rupture, INCONEL® Filler Metal 617 and INCONEL Welding Electrode 117 are used. When resistance to high temperature corrosion is critical, INCONEL Filler Metal 52 and INCONEL Welding Electrode 152 should be used. For dissimilar welding of alloy 890 to structural or stainless steels for service at moderate temperatures, INCONEL Filler Metal 82 and INCO-WELD® A Welding Electrode may also be considered.

More information on joining is available in the Special Metals publication ‘Joining’ on the website, www.specialmetals.com.

Available Products and Specifications

INCOLOY alloy 890 is designated UNS N08890 and is available in a variety of product forms. Specifications include:

Pipe and Tube - ASTM B 407
Rod and Bar - ASTM B 408
Plate, Sheet and Strip - ASTM B 409, ASTM B 906