United States Patent Office

3,276,864

Patented Oct. 4, 1966

1

3,276,864

AUSTENITIC STAINLESS STEEL RESISTANT TO STRESS-CORROSION CRACKING

Alexei W. Loginow and Edson H. Phelps, Monroeville Borough, Pa., assignors to United States Steel Corporation, a corporation of Delaware

No Drawing. Filed Dec. 3, 1962, Ser. No. 241,520
2 Claims. (Cl. 75—128)

This invention relates to an austenitic stainless steel which is resistant to stress-corrosion cracking. The steel of our invention is of the type consisting essentially of iron, carbon, chromium, nickel, nitrogen, and the usual steel-making residual elements.

Austenitic stainless steels have had widespread use as constructional materials in nuclear reactors and in the chemical industry, but service experience and laboratory tests have shown that under certain adverse conditions, such as chloride-type environments, stress-corrosion cracking of these steels can occur. Because of the hazards associated with failure of critical components in nuclear reactors and because of the expense involved in replacing components that have failed in the chemical industry, an austenitic stainless steel that is resistant to stress-corrosion cracking is needed. Although stress-relieving treatments, proper design, and process control can be used to minimize the problem of stress corrosion, these preventive measures are usually expensive and are not always reliable and practical.

Accordingly, it is a principal object of this invention to provide an austenitic stainless steel having a composition inherently resistant to stress-corrosion cracking, including resistance to failure from this phenomenon at elevated temperatures in chloride-type environments.

These and other objects will become apparent from the ensuing discussion of specific examples and tests.

The steel contains sufficient chromium (about 17 percent) for good resistance to corrosion and high-temperature oxidation. Nickel is added to the steel in sufficient amount to assure an austenitic structure, high ductility, and good cold-working properties. The carbon content is controlled closely at a relatively high level (about 0.08 percent) to provide austenite stabilization and resistance to stress-corrosion cracking. The nitrogen content of the steel is kept at a very low level in the interest of resistance to stress-corrosion cracking. The other elements contained in the new steel, such as manganese, sulfur, phosphorus, silicon, molybdenum, and aluminum are present in the amounts normally present in 18 percent chromium, 8 percent nickel (AISI Type 304) austenitic stainless steels.

The characteristic ranges of proportions of elements making up the steel of the invention are presented in Table I.

TABLE I.—COMPOSITION RANGE OF STEEL OF INVENTION

	Broad, percent	Preferred, percent
Carbon	0.075 to 1.0	0.075 to 0.09.
Manganese	1.0 to 2.0	1.4 to 1.6.
Phosphorus	0.04 max	0.02 to 0.03.
Sulfur	0.03 max	0.01 to 0.02.
Silicon	1.0 max	0.4 to 0.6.
Nickel	7.0 to 14.0	8.0 to 12.0.
Chromium	17.0 to 19.0	17.0 to 18.0.
Nitrogen	0.015 max	0.010 max.

Balance iron and residual amounts of other steelmaking elements.

2

The total austenitizing elements, such as carbon, nickel, and nitrogen, must be in sufficient proportions relative to the ferritizing elements, primarily chromium, to render the steel predominately austenitic.

Table II presents an example of a typical steel of the invention, namely a nominally 18 percent chromium and 8 percent nickel base composition, along with representative compositions of similar steels with critical elements falling outside of the composition range necessary to impart stress-corrosion resistance. The results of comparative tests of these steels are reported in Table III.

TABLE II.—COMPOSITION OF STEELS WHOSE CORROSION PROPERTIES ARE REPORTED IN TABLE III

	Steel of Invention, percent	Other Steels	
		AISI 304, percent	AISI 304L, percent
Carbon	0.075	0.05	0.029
Manganese	1.50	1.67	1.28
Phosphorus	0.028	0.024	0.019
Sulfur	0.012	0.013	0.015
Silicon	0.50	0.49	0.35
Nickel	8.0	9.73	9.52
Chromium	17.7	18.8	18.6
Nitrogen	0.006	0.029	0.040
Molybdenum	(*)	0.22	0.19

Balance iron and residual amojnts of other steelmaking elements.
* Not intentionally added—present in residual amounts.

TABLE III.—STRESS-CORROSION CRACKING OF AUSTENIC STAINLESS STEELS IN BOILING 42% $MgCl_2$

Steel:	Time to failure, hrs.
Steel of invention	4500 (no failure)
AISI 304	4
AISI 304L	5

Note. — Specimens were annealed at 1950° F., quenched in water, and stressed, throughout test, to 75% of the yield strength.

The above table is illustrative of the superior performance of the austenitic stainless steel of this invention as compared to those previously available for comparable applications.

While we have shown and described specific embodiments of our invention, it will be understood that these embodiments are merely for the purpose of illustration and description and that various other forms may be devised within the scope of our invention, as defined in the appended claims.

We claim:

1. A predominately austenitic stainless steel consisting essentially of:

	Percent
Carbon	0.075 to 0.1
Manganese	1.0 to 2.0
Phosphorus	0.04 maximum
Sulfur	0.03 maximum
Silicon	1.0 maximum
Nickel	7.0 to 14.0
Chromium	17 to 19
Nitrogen	0.015 maximum

with the balance essentially iron, said steel being characterized by inherent resistance to stress-corrosion cracking.

2. A predominately austenitic stainless steel consisting essentially of:

	Percent
Carbon	0.075 to 0.09
Manganese	1.4 to 1.6
Phosphorus	0.02 to 0.03
Sulfur	0.01 to 0.02
Silicon	0.4 to 0.6
Nickel	8.0 to 12.0
Chromium	17.0 to 18.0
Nitrogen	0.010 maximum

with the balance essentially iron said steel being characterized by inherent resistance to stress-corrosion cracking.

References Cited by the Examiner

UNITED STATES PATENTS

2,150,901 3/1939 Arness ---------- 75—128

OTHER REFERENCES

Metal Progress, vol. 80, December 1961, pages 99–102.

Transactions of the American Society for Metals, vol. 30, page 947. Published in 1942 by the A.S.M., Cleveland, Ohio.

DAVID L. RECK, *Primary Examiner.*

P. WEINSTEIN, *Examiner.*