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(19) **United States**(12) **Patent Application Publication**
Kim et al.(10) **Pub. No.: US 2008/0112840 A1**(43) **Pub. Date: May 15, 2008**(54) **DUPLEX STAINLESS STEEL HAVING
EXCELLENT CORROSION RESISTANCE
WITH LOW NICKEL**(76) Inventors: **Kwang-tae Kim**, Pohang (KR);
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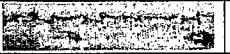

























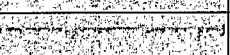











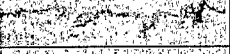






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(57) **ABSTRACT**

Disclosed is duplex stainless steel that contains relatively low content of Ni, and limits constituents of Cr—Mo—Mn—N to make volume fraction of α and γ have about 50:50, thereby minimizing incidence of a edge crack to enhance a production yield and decrease a processing load, in which the alloy constituents includes Cr of 19.5~22.5%, Mo of 0.5-2.5%, Ni of 1.0-3.0%, Mn of 1.5-4.5%, N of 0.15-0.25%, Fe and unavoidable elements, and a constitution range of the alloy constituents are adjusted to make a C_{Pt} higher than 20° C. depending on the constitution range of the alloy constituents. Thus, the contents of Cr, Mo and Ni is decreased and the content of Mn is increased a little, so that a production cost thereof is reduced; the corrosion resistance is secured to be better than the STS 304 steel and the 316L steel; the incidence of the edge crack is decreased while being hot-rolled, thereby decreasing a load on the following process; and the surface defective is decreased, thereby improving a production yield.

[Fig. 1]

Steel No.		Alloy constituents					20mmt Side View	3mmt Top View	Test result
		Cr	Mo	Mn	N	Ni			
inventive	1	20.0	1.0	2.5	0.16	2.5			△
	2	21.0	1.0	2.5	0.16	2.5			△
	3	20.0	2.0	2.5	0.16	2.5			○
	4	20.0	2.0	4.5	0.16	2.5			○
	5	21.0	2.0	4.5	0.16	2.5			○
	6	21.0	1.0	2.5	0.18	2.5			△
	7	20.0	2.0	2.5	0.18	2.5			△
	8	21.0	2.0	2.5	0.18	2.5			△
	9	20.0	2.0	4.5	0.18	2.5			△
	10	21.0	2.0	4.5	0.18	2.5			△
	11	19.5	1.5	3.5	0.17	2.5			○
	12	21.5	1.5	3.5	0.17	2.5			○
	13	20.5	1.5	1.5	0.17	2.5			△
	14	20.5	1.5	3.5	0.15	2.5			○
	15	20.5	1.5	3.5	0.17	2.5			○
comparative	16	23.0	2.0	2.5	0.16	2.5			△
	17	19.0	1.0	4.5	0.16	2.5			×
	18	20.0	1.0	5.5	0.18	2.5			×
	19	21.0	1.0	5.5	0.18	2.5			×
	20	20.5	0.0	3.5	0.17	2.5			×
	21	20.5	3.0	3.5	0.17	2.5			×
	22	20.5	1.5	5.5	0.17	2.5			×
	23	20.5	1.5	3.5	0.25	2.5			×

TEST CRITERION: DEFECTIVE(X), GOOD(△), EXCELLENT(O)

[Fig. 2]

Steel No.		Alloy constituents									α Volume fraction	Test result
		C	P	S	Si	Cr	Mo	Mn	N	Ni		
inventive	1	0.027	0.02	0.001	0.5	20.0	1.0	2.5	0.16	2.5	44.90	○
	2	0.027	0.02	0.001	0.5	21.0	1.0	2.5	0.16	2.5	52.01	△
	3	0.027	0.02	0.001	0.5	20.0	2.0	2.5	0.16	2.5	50.56	○
	4	0.027	0.02	0.001	0.5	20.0	2.0	4.5	0.16	2.5	48.36	○
	5	0.027	0.02	0.001	0.5	21.0	2.0	4.5	0.16	2.5	53.05	△
	6	0.027	0.02	0.001	0.5	21.0	1.0	2.5	0.18	2.5	50.25	○
	7	0.027	0.02	0.001	0.5	20.0	2.0	2.5	0.18	2.5	48.80	○
	8	0.027	0.02	0.001	0.5	21.0	2.0	2.5	0.18	2.5	53.49	△
	9	0.027	0.02	0.001	0.5	20.0	2.0	4.5	0.18	2.5	46.60	○
	10	0.027	0.02	0.001	0.5	21.0	2.0	4.5	0.18	2.5	51.29	△
	11	0.027	0.02	0.001	0.5	19.5	1.5	3.5	0.17	2.5	42.80	△
	12	0.027	0.02	0.001	0.5	21.5	1.5	3.5	0.17	2.5	54.60	△
	13	0.027	0.02	0.001	0.5	20.5	1.5	1.5	0.17	2.5	50.90	○
	14	0.027	0.02	0.001	0.5	20.5	1.5	3.5	0.15	2.5	50.46	○
	15	0.027	0.02	0.001	0.5	20.5	1.5	3.5	0.17	2.5	48.70	○
comparative	16	0.027	0.02	0.001	0.5	23.0	2.0	2.5	0.16	2.5	64.63	×
	17	0.027	0.02	0.001	0.5	19.0	1.0	4.5	0.16	2.5	35.59	×
	18	0.027	0.02	0.001	0.5	20.0	1.0	5.5	0.18	2.5	39.84	×
	19	0.027	0.02	0.001	0.5	21.0	1.0	5.5	0.18	2.5	46.95	○
	20	0.027	0.02	0.001	0.5	20.5	0.0	3.5	0.17	2.5	42.02	△
	21	0.027	0.02	0.001	0.5	20.5	3.0	3.5	0.17	2.5	55.37	△
	22	0.027	0.02	0.001	0.5	20.5	1.5	5.5	0.17	2.5	46.50	○
	23	0.027	0.02	0.001	0.5	20.5	1.5	3.5	0.25	2.5	41.67	△

TEST CRITERION: DEFECTIVE(X), GOOD(△), EXCELLENT(O)

[Fig. 3]

Steel No.		Alloy constituents					CPT (°C)	Test result
		Cr	Mo	Mn	N	Ni		
inventive	1	20.0	1.0	2.5	0.16	2.5	22.5	△
	2	21.0	1.0	2.5	0.16	2.5	25.0	○
	3	20.0	2.0	2.5	0.16	2.5	32.5	○
	4	20.0	2.0	4.5	0.16	2.5	32.0	○
	5	21.0	2.0	4.5	0.16	2.5	32.5	○
	6	21.0	1.0	2.5	0.18	2.5	25.0	○
	7	20.0	2.0	2.5	0.18	2.5	35.0	○
	8	21.0	2.0	2.5	0.18	2.5	37.5	○
	9	20.0	2.0	4.5	0.18	2.5	30.0	○
	10	21.0	2.0	4.5	0.18	2.5	35.0	○
	11	19.5	1.5	3.5	0.17	2.5	25.0	○
	12	21.5	1.5	3.5	0.17	2.5	30.0	○
	13	20.5	1.5	1.5	0.17	2.5	30.0	○
	14	20.5	1.5	3.5	0.15	2.5	27.5	○
	15	20.5	1.5	3.5	0.17	2.5	27.5	○
comparative	16	23.0	2.0	2.5	0.16	2.5	42.5	○
	17	19.0	1.0	4.5	0.16	2.5	15.0	×
	18	20.0	1.0	5.5	0.18	2.5	17.5	×
	19	21.0	1.0	5.5	0.18	2.5	22.5	△
	20	20.5	0.0	3.5	0.17	2.5	10.0	×
	21	20.5	3.0	3.5	0.17	2.5	45.0	○
	22	20.5	1.5	5.5	0.17	2.5	22.5	△
	23	20.5	1.5	3.5	0.25	2.5	30.0	○

TEST CRITERION: DEFECTIVE(X), GOOD(△), EXCELLENT(O)

[Fig. 4]

Steel No.	Alloy constituents					Corrosion resistance	Hot formability	Total test result
		Cr	Mo	Mn	N	Ni		
inventive	1	20.0	1.0	2.5	0.16	2.5	△	△
	2	21.0	1.0	2.5	0.16	2.5	○	△
	3	20.0	2.0	2.5	0.16	2.5	○	○
	4	20.0	2.0	4.5	0.16	2.5	○	○
	5	21.0	2.0	4.5	0.16	2.5	○	△
	6	21.0	1.0	2.5	0.18	2.5	○	△
	7	20.0	2.0	2.5	0.18	2.5	○	△
	8	21.0	2.0	2.5	0.18	2.5	○	△
	9	20.0	2.0	4.5	0.18	2.5	○	△
	10	21.0	2.0	4.5	0.18	2.5	○	△
	11	19.5	1.5	3.5	0.17	2.5	○	△
	12	21.5	1.5	3.5	0.17	2.5	○	△
	13	20.5	1.5	1.5	0.17	2.5	○	△
	14	20.5	1.5	3.5	0.15	2.5	○	○
	15	20.5	1.5	3.5	0.17	2.5	○	○
comparative	16	23.0	2.0	2.5	0.16	2.5	○	△
	17	19.0	1.0	4.5	0.16	2.5	×	×
	18	20.0	1.0	5.5	0.18	2.5	×	×
	19	21.0	1.0	5.5	0.18	2.5	△	×
	20	20.5	0.0	3.5	0.17	2.5	×	×
	21	20.5	3.0	3.5	0.17	2.5	○	×
	22	20.5	1.5	5.5	0.17	2.5	△	×
	23	20.5	1.5	3.5	0.25	2.5	○	×

TEST CRITERION: DEFECTIVE(X), GOOD(△), EXCELLENT(O)

[Fig. 5]

Steel		Alloy constituents					Oxidation increment according to S contents (mg/cm ²)*
		Cr	Mo	Mn	N	Ni	
conventional steel	304	18.3	0.11	1.09	0.041	8.14	56.5
	316L	17.7	2.21	0.71	0.020	12.22	22.1
	2205	22.5	3.06	1.47	0.159	5.87	1.56
inventive	1	20.0	1.0	2.5	0.16	2.5	8.32
	2	21.0	1.0	2.5	0.16	2.5	7.44
	3	20.0	2.0	2.5	0.16	2.5	9.06
	4	20.0	2.0	4.5	0.16	2.5	7.10
	5	21.0	2.0	4.5	0.16	2.5	6.53
	6	21.0	1.0	2.5	0.18	2.5	6.78
	7	20.0	2.0	2.5	0.18	2.5	7.26
	8	21.0	2.0	2.5	0.18	2.5	5.87
	9	20.0	2.0	4.5	0.18	2.5	9.28
	10	21.0	2.0	4.5	0.18	2.5	4.27
	11	19.5	1.5	3.5	0.17	2.5	7.24
	12	21.5	1.5	3.5	0.17	2.5	6.05
	13	20.5	1.5	1.5	0.17	2.5	7.22
	14	20.5	1.5	3.5	0.15	2.5	7.26
	15	20.5	1.5	3.5	0.17	2.5	7.04

* : 1250°C heating(120minutes), 200minutes reference,
gas stmosphere with S content of 200ppm

DUPLEX STAINLESS STEEL HAVING EXCELLENT CORROSION RESISTANCE WITH LOW NICKEL

BACKGROUND ART

[0001] 1. Field of the Invention

[0002] The present invention relates to duplex stainless steel containing Mn of high content and Cr, Mo, N and Ni of low contents as compared with S32205 duplex stainless steel, and more particularly, to duplex stainless steel that includes low contents of Cr, Mo, N and Ni to thereby decrease a production cost thereof, has excellent corrosion resistance better than STS 304 steel and 316L steel, and has a low incidence of an edge crack when it is hot-rolled.

[0003] 2. Description of Related Art

[0004] In general, austenite stainless steel excellent in formability and corrosion resistance uses Fe as base metal and mainly contains Cr and Ni. Further, the austenite stainless steel has been variously developed by adding other elements such as Mo, Cu, etc. for various purposes.

[0005] Among the austenite stainless steel, 316L steel is excellent in corrosion resistance, pitting resistance and high temperature strength. However, the 316L steel is low carbon steel and contains Ni more than 10wt% and Mo more than 2wt%, so that a cost price thereof heavily fluctuates according to the price of Ni and Mo, thereby decreasing competitive power.

[0006] To increase the competitive power, iron and steel business tries to develop new steel by lowering contents of Ni and Mo and securing corrosion resistance better than that of the 316L steel.

[0007] As an example of duplex stainless steel that has mixed formation of an austenite phase and a ferrite phase, S32205 duplex stainless steel (hereinafter, referred to as "2205 steel" contains high percentage of Cr, Mo and N to secure excellent corrosion resistance, and contains Ni more than 5wt% to secure a volume fraction.

[0008] Such duplex stainless steel contains a relatively low percentage of Ni as compared with STS 316L steel containing 10% Ni, so that its production cost is low and thus its price is competitive, thereby increasing added value. However, the 2205 steel has poor hot-formability and thus has a very low production yield of 80%. Further, the 2205 steel has high contents of Cr and Mo, so that a sigma-phase deposition rate is high, thereby deteriorating the property of steel and having a high load on winding and cooling processes. Thus, it is hard to replace the 316L steel by the 2205 steel.

SUMMARY OF THE INVENTION

[0009] Accordingly, it is an object of the present invention to provide duplex stainless steel that has low contents of Cr, Mo, N and Ni as compared with 2205 steel to thereby decrease a production cost thereof, increases production yield by lowering an incidence of an edge crack when it is hot-rolled, and has excellent corrosion resistance better than STS 304 steel and 316L steel.

[0010] The present inventor develops duplex stainless steel that contains relatively low content of Ni, and limits constituents of Cr-Mo-Mn-N to make volume fraction of α and γ have about 50:50, so that a production cost is reduced; a CPT is secured to be higher than 20°C. of that of the STS 304 steel

and the 316L steel; and the incidence of a edge crack is minimized to enhance a production yield and decrease a processing load.

[0011] In an exemplary embodiment of the present invention, duplex stainless steel includes Cr of 19.5-22.5%, Mo of 0.5-2.5%, Ni of 1.0-3.0%, Mn of 1.5-4.5%, N of 0.15%-0.25%, C of 0.03% and less, P of 0.03% and less, Si of 2% and less, Fe and un-avoidable elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] These and/or other objects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

[0013] FIG. 1 are photographs showing an edge crack of a hot-rolled sample according to alloy constituents;

[0014] FIG. 2 is a table showing alloy constituents and a volume fraction of steel samples according to the present invention and comparative steel samples;

[0015] FIG. 3 is a table showing critical pitting temperatures (CPT) of the samples of FIG. 2;

[0016] FIG. 4 is a table showing total test results of the samples of FIG. 2 with regard to corrosion resistance and hot formability; and

[0017] FIG. 5 is a table showing oxidation increment of the steel according to the present invention and the conventional steel.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Hereinafter, embodiments of the present invention will be described with reference to accompanying drawings. Below, essential constituents are limited as follows.

[0019] Carbon (C): C is effective for strengthening a material by solid solution strengthening. However, when the content of C is excessive, C is easily combined with a carbide-forming element such as Cr, which is effective for corrosion resistance in a boundary between ferrite-austenite phases. Thus, C lowers the content of Cr around a grain boundary, so that the corrosion resistance is deteriorated. To maximize the corrosion resistance, the content of C is lowered into 0.03% and below.

[0020] Nitrogen (N): N, together with Ni, is one of elements that contribute stabilization of an austenite phase. As the content of N increases, the corrosion resistance and high strengthening are achieved. However, when the content of N is too high, the hot formability of steel is deteriorated, thereby lowering the production yield thereof. On the other hand, when the content of N is too low, the contents of Cr and Mo should be lowered to secure the volume fraction of steel, and it is difficult to secure the strength of a welding part and phase stability. Therefore, the content of N preferably ranges between 0.15% and 0.25%.

[0021] Manganese (Mn): Mn generally has a content of about 1.5% to adjust a metal flow rate. In the meanwhile, Mn can be additionally contained instead of Ni. In this case, the hot formability can be secondarily improved. However, when the content of Mn is excessive, Mn is combined with S of the steel and forms MnS, thereby deteriorating the corrosion resistance and the hot formability. Thus, the upper limit content of Mn is limited to 4.5%. Preferably, the content of Mn ranges between 1.5% and 4.5%.

[0022] Chrome (Cr): Cr, together with Mo, is used as an element to stabilize the ferrite phase. Here, Cr is essential to not only primarily securing the ferrite phase of duplex stainless steel but also securing excellent corrosion resistance. When the content of Cr increases, the corrosion resistance increases, but the content of expensive Ni should be also increased to maintain the volume fraction. In results, the content of Cr is preferably limited between 19.5% and 22.5% so as to maintain the volume fraction of the duplex stainless steel and the corrosion resistance better than that of STS 304 and 316L steel.

[0023] Molybdenum (Mo): like Cr, Mo is used for not only stabilizing the ferrite phase but also largely enhancing the corrosion resistance. However, if the content of Mo is excessive, Mo is likely to form the sigma phase when it is annealed, thereby deteriorating the corrosion resistance and impact resistance. In the present embodiment, Mo just assists Cr in securing the ferrite volume fraction and secures the proper corrosion resistance, so that the content of Mo is preferably limited between 0.5% and 2.5%.

[0024] Nickel (Ni): Ni, together with Mn and N, is an element to stabilize the austenite phase, and mainly used in securing the austenite phase of the duplex stainless steel. To reduce a production cost, if the content of expensive Ni is lowered, the decrement of Ni can be replaced by increasing the content of Mn and N that form the austenite phase. However, if the content of Ni is excessively lowered, Mn and N should be excessively needed so that the corrosion resistance and the hot formability are deteriorated, or the contents of Cr and Mo are lowered so that it is difficult to secure the corrosion resistance better than the 316L steel. Thus, the content of Ni preferably ranges between 1.0% and 3.0%.

[0025] Phosphorous (P): P is seeded in the grain boundary or an interface, and is likely to deteriorate the corrosion resistance and toughness. Therefore, the content of P is lowered as low as possible. Preferably, the upper limit content of P is limited to 0.03% in consideration of the efficiency of a refining process.

[0026] Sulfur (S): S deteriorates the hot formability, or forms MnS together with Mn, thereby deteriorating the corrosion resistance. Therefore, the content of S is lowered as low as possible. Preferably, the content of S is lower than 0.03%.

[0027] Silicon (Si): Si is added for deoxidization, but it can act as an element for stabilizing the ferrite phase. If the content of Si is excessive, Si deteriorates the mechanical property such as impact toughness of steel. Therefore, the content of Si is preferably limited to 2% and below.

[0028] Meanwhile, samples of duplex stainless steel having constituents according to an embodiment of the present invention are prepared and they are tested about the volume fraction, the corrosive resistance and the hot formability. FIG. 2 shows alloy constituents of the samples and a-volume fractions after they are annealed at a temperature of 1050° C. In these alloys, the a-volume fractions thereof range from about 40 to about 60%. Regarding welding, phase stability, and the like, it is determined that the duplex stainless steel has an a-volume fraction ranging from 44 to 51% is excellent (0); the duplex stainless steel has an a-volume fraction lower than 44% or higher than 54% is defective (X); and the duplex stainless steel has an a-volume fraction ranging from 51 to 54% is good (A).

[0029] In the samples of FIG. 2, the alloy constituents except Cr, Mo, Mn and N are unified to satisfy general content

ranges of the duplex stainless steel, but the content range of Ni is limited to 2.5 wt% for experimental convenience.

[0030] FIG. 3 is a table showing critical pitting temperatures (CPT) of the samples of FIG. 2, in which the CPT means the corrosion resistance. Here, it is determined that the steel having a CPT of 20° C. and below is defective (X); the steel having a CPT ranging from 20° C. to 25° C. and below is good (?); and the steel having a CPT of 20° C and higher is excellent (0).

[0031] The foregoing CPTs result from annealing the hot-rolled samples having a size of 50 mm(L)×25 mm(W)×3 mm(T) at a temperature of 1050° C. on the basis of an American society for testing and materials (ASTM) G48 method, and then depositing it in acidified ferric chloride solution for 24 hours.

[0032] According to the ASTM G48 method, a CPT measuring starting temperature is obtained by the following equation:

$$\text{CPT}(^{\circ}\text{C}) = (2.5 \times \% \text{Cr}) + (7.6 \times \% \text{Mo}) + (31.9 \times \% \text{N}) - 41.0.$$

[0033] The ASTM G48 method suggests calculating the CPTs and selecting the closest value at intervals of 5° C.

[0034] However, the CPT measuring starting temperature estimated by the ASTM G48 has a large deviation. Why the deviation is large is because the corrosion resistance deteriorated by Mn is not considered. That is, because the duplex stainless steel having lowered contents of Ni has relatively high content of Mn, the deviation arises in the estimated CPT obtained by the foregoing ASTM G48 method.

[0035] To compensate the deviation, the present inventor calculates the CPT by considering Mn as follows.

$$\text{CPT}(^{\circ}\text{C}) = -150.47 + 2.65\text{Cr} + 11.71\text{Mo} - 1.3\text{Mn} + 64.58\text{N}.$$

[0036] According to the present invention, the estimated CPT is approximately equal to the measured CPT.

[0037] Meanwhile, in the case of the steel having the low contents of Cr and Mo or having the high content of Mn, the measured CPT is relatively lower than the estimated CPT.

[0038] Therefore, it is undesirable that the content of Mn is excessively increased or the contents of Cr and Mo is excessively decreased in order to secure the volume fraction of duplex stainless steel with reduced Ni.

[0039] While producing the duplex stainless steel with reduced Ni, the production yield should be increased to decrease the incidence of an edge crack, and the hot formability should be secured to minimize an invariable load. The steel with constituents of FIG. 2 is produced as an ingot of 50 kg and pressed to have 20 mm(T) and 30 mm(T), and then the incidence of their edge crack is observed, thereby getting test results as shown in FIG. 1 by selecting the steel remarkably improved in the incidence of the edge crack as compared with the 2205 steel.

[0040] Here, it is determined that the steel having the edge crack like the 2205 steel is defective (X); the steel having a local edge crack is good (A); and the steel having little edge crack is excellent (0).

[0041] FIG. 4 shows total test results of the samples of FIG. 2 with regard to the volume fraction, the corrosion resistance, and the hot formability. Four steels (steel Nos. 3, 4, 14, 15) satisfy the formation properties of the duplex stainless steel, has the corrosion resistance better than that of the 316L steel, and is excellent in the hot formability.

[0042] Further, other steels (steel Nos. 1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 20, 21, and 22) can be selected as preferred steel, but they are inferior to the foregoing steels. Thus, the hot formability and the corrosion resistance are deteriorated as the content of Mn becomes higher. Further, the hot formability is deteriorated as the content of N becomes higher. Also, the steels having the high content of Mn needs relatively higher content of Mo.

[0043] FIG. 5 shows difference in high temperature oxidation between the excellent and good steels according to the embodiment of the present invention and comparative steels such as STS304, STS316L and 2205 when they are reheated as slabs for hot-rolling. The high temperature oxidation measurement is performed by measuring oxidation increment under the condition that the hot-rolled sample having a size of 10 mm(L)×10 mm(W)×3 mm(T) is heated at a temperature of 1250° C. and remained in a heating furnace for 180 minutes.

[0044] At this time, under gas atmosphere of the heating furnace, the content of S is adjusted into 200 ppm. In results, the oxidation increment of the steel according to the present invention is 4 through 6 times lower than the convention 2205 steel, and about 1/3 through 1/2 times higher than the 316L steel. As compared with the conventional 2205 steel, the surface quality of the steel according to the present invention is enhanced as a surface defective is decreased by the surface lubrication effect due to an oxidation layer formed on a surface of a reheating slab while being hot-rolled.

[0045] In the duplex stainless steel according to the present invention as compared with the 2205 duplex stainless steel, the contents of Cr, Mo and Ni is decreased and the content of Mn is increased a little, so that a production cost thereof is reduced; the corrosion resistance is secured to be better than the STS 304 steel and the 316L steel; the incidence of the edge crack is decreased while being hot-rolled, thereby decreasing a load on the following process; and the surface defective is decreased, thereby improving a production yield.

[0046] Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes might be made in this embodiment without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

1. (canceled)

2. (canceled)

3. A duplex stainless steel having excellent corrosion resistance with low Ni, having alloy constituents comprising Cr ranging from 19.5 wt% to 22.5 wt%, Mo ranging from 0.5 wt% to 2.5 wt%, Ni ranging from 1.0wt% to 3.0 wt%, Mn ranging from 1.5 wt% to 4.5 wt%, N ranging from 0.15 wt% to 0.25 wt%, Fe and unavoidable elements, wherein a critical pitting temperature of the duplex stainless steel is calculated as a function of constitution ranges of Cr, Mo, Mn, and N in the alloy constituents, and the constitution ranges of the alloy constituents are adjusted to have the critical pitting temperature of 20° C. or more.

4. The duplex stainless steel according to claim 3, further including C of 0.03 wt% or less P of 0.03 wt% or less, and Si of 2 wt% or less.

5. The duplex stainless steel according to claim 3, wherein the critical pitting temperature of the duplex stainless steel is calculated by:

$$\text{CPT} = \text{CONST} + 2.65\text{Cr} + 11.71\text{Mo} - 1.3\text{Mn} + 64.58\text{N},$$

and

wherein CPT is the critical pitting temperature in ° C and CONST is a constant for calculating the critical pitting temperature in C.

6. The duplex stainless steel according to claim 5, wherein the constant, CONST, is a negative constant.

7. The duplex stainless steel according to claim 6, wherein the negative constant is -50.47.

8. The duplex stainless steel according to claim 7, wherein the constitution ranges of the alloy constituents are adjusted to have the critical pitting temperature of 25° C. or more.

9. The duplex stainless steel according to claim 3, wherein the constitution ranges of the alloy constituents are adjusted to have the critical pitting temperature of 25° C. or more.

10. A method for forming duplex stainless steel having excellent corrosion resistance with low Ni, having alloy constituents including Cr ranging from 19.5 wt% to 22.5wt%, Mo ranging from 0.5 wt% to 2.5 wt%, Ni ranging from 1.0wt% to 3.0 wt%, Mn ranging from 1.5 wt% to 4.5 wt%, N ranging from 0.15 wt% to 0.25 wt%, Fe and unavoidable elements, the method comprising:

calculating a critical pitting temperature of the duplex stainless steel as a function of constitution ranges of Cr, Mo, Mn, and N in the alloy constituents, and adjusting the constitution ranges of the alloy constituents to have the critical pitting temperature of 20 C or more.

11. The method according to claim 10, further comprising: adding C of 0.03 wt% or less, P of 0.03 wt% or less, and Si of 2 wt% or less to form the duplex stainless steel.

12. The method according to claim 10, wherein the calculating the critical pitting temperature of the duplex stainless steel comprises calculating the critical pitting temperature of the duplex stainless steel using:

$$\text{CPT} = \text{CONST} + 2.65\text{Cr} + 11.71\text{Mo} - 1.3\text{Mn} + 64.58\text{N},$$

and

wherein CPT is the critical pitting temperature in ° C and CONST is a constant for calculating the critical pitting temperature in ° C.

13. The method according to claim 12, wherein the constant, CONST, is a negative constant.

14. The method according to claim 13, wherein the constant, CONST, is -50.47.

15. The method according to claim 14, wherein the adjusting the constitution ranges of the alloy constituents comprises adjusting the constitution ranges of the alloy constituents to have the critical pitting temperature of 25 C or more.

16. The method according to claim 10, wherein the constitution ranges of the alloy constituents are adjusted to have the critical pitting temperature of 25 C or more.

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