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(54) AUSTENITIC STAINLESS STEEL

(57) This austenitic stainless steel contains, in terms of % by mass: C: 0.100% or less, Si: 3.00% or less, Mn: 0.01% or more and 5.00% or less, P: 0.100% or less, S: 0.0050% or less, Ni: 7.00% or more and 38.00% or less, Cr: 17.00% or more and 28.00% or less, Mo: 10.00% or less, and N: more than 0.100% and 0.400% or less, with a remainder being Fe and impurities, and a brightness difference ΔL of a surface of a stainless steel is 5 or less.

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Description

TECHNICAL FIELD

[0001] The present invention relates to an austenitic stainless steel.

[0002] The present application claims priority on Japanese Patent Application No. 2020-060919 filed on March 30, 2020, the content of which is incorporated herein by reference.

BACKGROUND ART

[0003] Although stainless steel has been used for various applications as a representative corrosion resistant material, steel types with high atmospheric corrosion resistance have been developed in recent years, and applications thereof as construction materials for roofs, exteriors, and the like have been increased. For these purposes of exterior construction materials, not only prevention of rusting and pitting due to corrosion but also aesthetic appearance after construction are required.

[0004] As a stainless steel that has improved design, Patent Document 1, for example, discloses a stainless steel sheet with both a glare-proof property and corrosion resistance, and the stainless steel sheet contains, in terms of by % by weight, C: 0.10% or less, Si: 1.0% or less, Mn: 1.0% or less, P: 0.09% or less, S: 0.01% or less, Cr: 20% or more and 40% or less, Mo: 0.5% or more and 6.0% or less, Cr + Mo: 24.5% or more, N: 0.1 % or less, Nb: 0.01% or more and 0.8% or less, Ti: 0.01% or more and 0.8% or less, Al: 0.008% or more and 1.0% or less, and one or more selected from the group consisting of Ni: 0.1% or more and 25% or less, and Cu: 0.01 % or more and 3% or less, with a remainder being Fe and impurities, in which as surface roughness (Ra), arithmetic average roughness is 1.0 μm or more.

[0005] Also, Patent Document 2 discloses an pickling liquid for stainless steel, and the pickling liquid contains, as main components: 10 to 200 g/L of sulfuric acid or 5 to 150 g/L of hydrochloric acid, 1 to 40 g/L of one or two or more selected from a hydrofluoric acid, a fluorosilicic acid, sodium fluoride; and 5 to 40 g/L of Fe^{3+} ions, in which a thickener is added to an aqueous solution that does not contain a nitric acid to obtain the aqueous solution in a paste form. Moreover, Patent Document 2 further discloses an pickling liquid containing, in terms of concentration converted into 35%, either one or both of 5 to 15 g/L of hydrogen peroxide and 5 to 10 g/L of sodium peroxide in addition to the aforementioned components.

[0006] The stainless steel disclosed in Patent Document 1 has relatively high corrosion resistance. However, there is a probability that rusting may occur in a humid environment including chlorides such as seawater and aesthetic appearance is degraded, and there is still room for improvement.

[0007] On the other hand, so-called super austenitic stainless steel that contains relatively large amounts of Cr, Mo, and N among austenitic stainless steels have more excellent corrosion resistance as compared with other austenitic stainless steels. However, variations may occur in elution of the surface of the steel sheet due to segregation of components in conventional acid pickling performed for finishing in manufacturing of the super austenitic stainless steel. Specifically, since parts eluted through acid pickling is whitened, and parts that are not eluted has glossiness, there may be cases in which appearance unevenness of the super austenitic stainless steel are observed. Even with the technique described in Patent Document 2, it is difficult to elute the entire surface of the super austenitic stainless steel, and there may be cases in which appearance unevenness are observed. In cases of applications to exterior construction materials requiring aesthetic appearance, there is room for improvement in super austenitic stainless steel.

PRIOR ART DOCUMENTS

Patent Document

[0008]

Patent Document 1: Japanese Unexamined Patent Application, First Publication No. H9-228002
Patent Document 2: Japanese Unexamined Patent Application, First Publication No. 2005-29828

DISCLOSURE OF INVENTION

Problems to be Solved by the Invention

[0009] The present invention was made in view of the aforementioned problem, and an object of the present invention is to provide an austenitic stainless steel with aesthetic appearance.

Solutions for Solving the Problems

[0010] The present inventors achieved, as a result of various studies in regard to acid pickling conditions under which appearance unevenness did not occur, a knowledge that it was possible to suppress appearance unevenness caused by segregation of components of super austenitic stainless steel with segregation of components as long as washing is performed using a predetermined acidic solution with an oxidizing power.

[0011] Summary of the present invention completed on the basis of the above knowledge is as follows.

[1] An austenitic stainless steel containing, in terms of % by mass:

C: 0.100% or less;
Si: 3.00% or less;
Mn: 0.01% or more and 5.00% or less;
P: 0.100% or less;
S: 0.0050% or less;
Ni: 7.00% or more and 38.00% or less;
Cr: 17.00% or more and 28.00% or less;
Mo: 10.00% or less; and
N: more than 0.100% and 0.400% or less,
with a remainder being Fe and impurities,
in which a brightness difference ΔL of a surface of a steel sheet is 5 or less.

[2] The austenitic stainless steel according to [1], further containing, instead of a part of Fe, in terms of % by mass, one or more selected from a group consisting of:

Cu: 3.00% or less;
W: 2.00% or less; and
V: 1.00% or less.

[3] The austenitic stainless steel according to [1], further containing, instead of a part of Fe, in terms of % by mass, one or more selected from a group consisting of:

Al: 0.001% or more and 0.3% or less;
Ca: 0.001 % or more and 0.3% or less;
B: 0.0001% or more and 0.1% or less;
Ti: 0.001% or more and 0.40% or less;
Nb: 0.001 % or more and 0.40% or less;
Sn: 0.001% or more and 0.5% or less;
Zr: 0.001% or more and 0.5% or less;
Co: 0.001 % or more and 0.5% or less;
Mg: 0.001% or more and 0.5% or less;
Hf: 0.001% or more and 0.5% or less;
REM: 0.001% or more and 0.5% or less;
Ta: 0.001 % or more and 0.5% or less;
Ga: 0.001% or more and 0.5% or less; and
Sb: 0.001% or more and 0.5% or less.

Effects of Invention

[0012] According to an aspect of the present invention, it is possible to provide an austenitic stainless steel with aesthetic appearance.

EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0013] Hereinafter, preferred embodiments of the present invention will be described in detail. Note that the description will be given in the following order.

<Austenitic stainless steel>

<Method for manufacturing austenitic stainless steel>

<Austenitic stainless steel>

[0014] An austenitic stainless steel according to the present embodiment contains, in terms of % by mass, C: 0.100% or less, Si: 3.00% or less, Mn: 0.01% or more and 5.00% or less, P: 0.100% or less, S: 0.0050% or less, Ni: 7.00% or more and 38.00% or less, Cr: 17.00% or more and 28.00% or less, Mo: 10.00% or less, and N: more than 0.100% and 0.400% or less, with a remainder being Fe and impurities, in which a brightness difference ΔL of a surface of a steel sheet is 5 or less.

[0015] Hereinafter, the austenitic stainless steel according to the present embodiment will be described in detail. Note that % indicating the component means % by mass.

C: 0.100% or less

[0016] C is an element inevitably contained in a stainless steel and is an element that contributes to stabilization of the austenite phase and improvement in high-temperature strength. Excessive content of C may lead to degradation of welding solidification crack resistance and degradation of corrosion resistance due to precipitation of Cr-based carbides. Therefore, the content of C is set to 0.100% or less. The content of C is preferably 0.06% or less and is more preferably 0.04% or less. On the other hand, although a lower limit of the content of C is not particularly limited, the lower limit is preferably 0.005% or more.

Si: 3.00% or less

[0017] Si is an element effective for stabilizing the austenite phase. However, excessive content of Si may promote precipitation of a σ phase. Therefore, the content of Si is set to 3.00% or less. The content of Si is preferably 1.00% or less and is more preferably 0.80% or less. On the other hand, although a lower limit is not particularly limited, the content of Si is preferably 0.01% or more in order to obtain the effect of stabilizing the austenite phase due to Si. The content of Si is more preferably 0.10% or more.

Mn: 0.01% or more and 5.00% or less

[0018] Mn is an element effective for stabilizing the austenite phase. In order to obtain the above effect of Mn, the content of Mn is set to 0.01% or more. The content of Mn is preferably 0.20% or more and is more preferably 0.4% or more. On the other hand, excessive content of Mn may degrade corrosion resistance. Therefore, the content of Mn is set to 5.00% or less. The content of Mn is preferably 2.00% or less and is more preferably 1.50% or less.

P: 0.100% or less

[0019] P is contained as an impurity in a stainless steel. Since P is an element that degrades hot workability, it is preferable to reduce the content as much as possible. Therefore, the content of P is set to 0.100% or less. The content of P is preferably 0.080% or less and is more preferably 0.050% or less. Although a lower limit is not particularly limited, the content of P is preferably 0.005% or more from the viewpoint of cost.

S: 0.0050% or less

[0020] S is an element that segregates at austenite grain boundaries during hot working and induces cracking during hot working by weakening a binding force at the grain boundaries. Therefore, it is preferable to reduce the content of S as much as possible.. Therefore, the content of S is set to 0.0050% or less. The content of S is preferably 0.0020% or less and is more preferably 0.0010% or less. On the other hand, although a lower limit is not particularly provided, excessive decrease in content of S may lead to an increase in a steel manufacturing cost. Therefore, the content of S is preferably 0.0001 % or more. The content of S is more preferably 0.0002% or more.

Ni: 7.00% or more and 38.00% or less

[0021] Ni is an important element for stabilizing the austenite phase. In order to obtain the above-described effect due to Ni, the content of Ni is set to 7.00% or more. The content of Ni is preferably 16.00% or more and is more preferably

18.00% or more. On the other hand, excessive content of Ni may lead to an increase in material cost and degrade economic efficiency. Therefore, the content of Ni is set to 38.00% or less. The content of Ni is preferably 30.00% or less and is more preferably 25.00% or less.

Cr: 17.00% or more and 28.00% or less

[0022] Cr is an extremely important element for improving corrosion resistance of the austenitic stainless steel. In addition, Cr is an element that also contributes to an increase in strength of the austenitic stainless steel. Therefore, the content of Cr is set to 17.00% or more. The content of Cr is preferably 18.00% or more and is more preferably 19.00% or more. On the other hand, in the case where an excessive content of Cr is contained, it may cause the σ phase to easily precipitate. Therefore, the content of Cr is set to 28.00% or less. The content of Cr is preferably 25.00% or less and is more preferably 22.00% or less.

Mo: 10.00% or less

[0023] Mo is an extremely important element for improving corrosion resistance of the austenitic stainless steel. Also, Mo is an element that contributes to an increase in strength. However, in the case where an excessive content of Mo is contained, it causes the σ phase to easily precipitate. Therefore, the content of Mo is set to 10.00% or less. The content of Mo is preferably 8.00% or less and is more preferably 7.00% or less. On the other hand, although a lower limit is not particularly limited, the content of Mo is preferably 3.00% or more in order to stably obtain the effects of improving corrosion resistance and increasing strength due to Mo. The content of Mo is preferably 5.00% or more, is more preferably more than 5.00%, and is most preferably 6.00% or more.

N: More than 0.100% and less than 0.400%

[0024] N is an extremely important element for improving corrosion resistance of the austenitic stainless steel. In addition, N has an effect as an austenite stabilizing element. In order to obtain the above-described effect, the content of N is set to more than 0.100%. The content of N is preferably 0.120% or more and is more preferably 0.150% or more. On the other hand, in the case where an excessive content of N is contained, it may lead to degradation of intergranular corrosion resistance and workability. Therefore, the content of N is set to 0.400% or less. The content of N is preferably 0.300% or less and is more preferably 0.250% or less.

[0025] In the austenitic stainless steel according to the present embodiment, the remainder other than the aforementioned elements is Fe and impurities. However, it is also possible to contain elements other than the aforementioned each element within a scope in which the effects of the present embodiment do not deteriorate. Note that the impurities described here mean components that are included due to various factors including ingredient materials such as ore and scrap and manufacturing processes when the austenitic stainless steel according to the present embodiment is industrially manufactured and that are accepted within a range in which they do not adversely affect the present embodiment.

[0026] The austenitic stainless steel according to the present embodiment preferably contains one or more selected from a group consisting of Cu: 3.00% or less, W: 2.00% or less, and V: 1.00% or less instead of a part of Fe. Note that since these elements may not be contained, lower limits of content of these elements are 0%.

Cu: 3.00% or less

[0027] Cu is an element effective for stabilizing the austenite phase. However, in the case where an excessive content of Cu is contained, it may lead to degradation of strength of the austenite phase and degradation of hot workability. Therefore, the content of Cu is preferably set to 3.00% or less. The content of Cu is more preferably 2.00% or less. On the other hand, although a lower limit is not particularly limited, the content of Cu is preferably 0.10% or more in order to stably obtain the effect of stabilizing the austenite phase due to Cu. The content of Cu is more preferably 0.50% or more.

[0028]

W: 2.00% or less
W forms carbonitrides and has an effect of improving corrosion resistance.

However, even in the case where a large amount of W is contained, it may lead to saturation of the effect of corrosion resistance. Therefore, the content of W is preferably 2.00% or less. The content of W is more preferably 1.00% or less. On the other hand, the content of W is preferably 0.01% or more in order to stably obtain the above-described effect of W. The content of W is more preferably 0.05% or more.

V: 1.00% or less

[0029] V forms carbonitrides and has an effect of improving corrosion resistance. However, even in the case where a large amount of V is contained, it may lead to saturation of the effect of corrosion resistance. Therefore, the content of W is preferably 1.00% or less. The content of V is more preferably 0.50% or less. On the other hand, in order to stably obtain the above-described effect of V, the content of V is preferably 0.05% or more. The content of V is more preferably 0.10% or more.

[0030] Further, the austenitic stainless steel according to the present embodiment preferably contains, in terms of % by mass: one or more selected from a group consisting of Al: 0.001% or more and 0.3% or less, Ca: 0.001% or more and 0.3% or less, B: 0.0001 % or more and 0.1 % or less, Ti: 0.001 % or more and 0.40% or less, Nb: 0.001 % or more and 0.40% or less, Sn: 0.001% or more and 0.5% or less, Zr: 0.001% or more and 0.5% or less, Co: 0.001% or more and 0.5% or less, Mg: 0.001% or more and 0.5% or less, Hf: 0.001 % or more and 0.5% or less, REM: 0.001 % or more and 0.5% or less, Ta: 0.001% or more and 0.5% or less, Ga: 0.001% or more and 0.5% or less, and Sb: 0.001% or more and 0.5% or less, instead of a part of Fe. Note that since these elements may not be contained, lower limits of content of these elements are 0%.

Al: 0.001% or more and 0.3% or less

[0031] Al is an element having a deoxidizing effect. In order to stably obtain the deoxidizing effect of Al, the content of Al is preferably 0.001% or more. The content of Al is more preferably 0.01% or more. On the other hand, in the case where a large amount of Al is contained, it may lead to generation of a large amount of non-metallic inclusions and degradation of workability and toughness. Therefore, the content of Al is preferably 0.3% or less. The content of Al is further preferably 0.30% or less and is more preferably 0.10% or less.

Ca: 0.001% or more and 0.3% or less

[0032] Ca is an element effective for deoxidizing and improving hot workability. In order to stably obtain the above-described effect of Ca, the content of Ca is preferably 0.001% or more. The content of Ca is more preferably 0.002% or more. On the other hand, in the case where an excessive content of Ca exists, it may rather lead to degradation of hot workability. Therefore, the content of Ca is preferably 0.3% or less. The content of content of Ca is further preferably 0.30% or less and is more preferably 0.01% or less.

B: 0.0001 % or more and 0.1 % or less

[0033] B is an element that improves hot workability. In order to stably obtain the effect of improving hot workability due to B, the content of B is preferably 0.0001% or more. The content of B is more preferably 0.0002% or more. On the other hand, in the case where an excessive content of B exists, it may rather lead to degradation of hot workability. Therefore, the content of B is preferably 0.1% or less. The content of B is further preferably 0.10% or less and is more preferably 0.001 % or less.

Ti: 0.001% or more and 0.40% or less

[0034] Ti is an element that forms carbonitrides and improves corrosion resistance. Therefore, the content of Ti is preferably 0.001% or more. The content of Ti is more preferably 0.005% or more. On the other hand, in the case where an excessive content of Ti is contained, it may also lead to saturation of the effect. Therefore, the content of Ti is preferably 0.40% or less. The content of Ti is more preferably 0.10% or less.

Nb: 0.001 % or more and 0.40% or less

[0035] Nb is an element that forms carbonitrides and improves corrosion resistance. Therefore, the content of Nb is preferably 0.001% or more. The content of Nb is more preferably 0.002% or more. On the other hand, in the case where an excessive content of Nb is contained, it may lead to saturation of the effect. Therefore, the content of Nb is preferably 0.40% or less. The content of Ti is more preferably 0.10% or less.

Sn: 0.001 % or more and 0.5% or less

[0036] Sn is an element effective for improving oxidation resistance. In order to stably obtain the effect of improving the oxidation resistance due to Sn, the content of Sn is preferably 0.001 % or more. The content of Sn is more preferably

0.01 % or more. On the other hand, in the case where an excessive content of Sn is contained, it may lead to degradation of hot workability. Therefore, the content of Sn is preferably 0.5% or less. The content of Sn is further preferably 0.50% or less and is more preferably 0.10% or less.

Zr: 0.001% or more and 0.5% or less

[0037] Zr is an element that improves strength. In order to stably obtain the effect of improving strength due to Zr, the content of Zr is preferably 0.001% or more. The content of Zr is more preferably 0.01% or more. On the other hand, in the case where an excessive content of Zr exists, it may lead to degradation of toughness. Therefore, the content of Zr is preferably 0.5% or less. The content of Zr is further preferably 0.50% or less and is more preferably 0.10% or less.

Co: 0.001% or more and 0.5% or less

[0038] Co is an element effective for improving corrosion resistance. In order to stably obtain the above-described effect of Co, the content of Co is preferably 0.001 % or more. The content of Co is more preferably 0.01% or more. On the other hand, in the case where an excessive content of Co exists, it may lead to hardening, and the content of Co is thus preferably 0.5% or less. The content of Co is further preferably 0.50% or less and is more preferably 0.10% or less.

Mg: 0.001% or more and 0.5% or less

[0039] Mg is an element effective for deoxidizing and improving hot workability. In order to stably obtain the above-described effect of Mg, the content of Mg is preferably 0.001% or more. The content of Mg is more preferably 0.01% or more. On the other hand, in the case where an excessive content of Mg is contained, it may lead to a significant increase in manufacturing cost. Therefore, the content of Mg is preferably 0.5% or less. The content of Mg is further preferably 0.50% or less and is more preferably 0.10% or less.

Hf: 0.001% or more and 0.5% or less

[0040] Hf is an element that improves corrosion resistance. In order to stably obtain the above-described effect of Hf, the content of Hf is preferably 0.001% or more. The content of Hf is more preferably 0.01% or more. On the other hand, in the case where an excessive content of Hf is contained, it may lead to degradation of workability. Therefore, the content of Hf is preferably 0.5% or less. The content of Hf is further preferably 0.50% or less and is more preferably 0.10% or less.

REM: 0.001% or more and 0.5% or less

[0041] REM (rare earth element) is an element effective for deoxidizing and improving hot workability and corrosion resistance. In order to stably obtain the above-described effect of REM, the content of REM is preferably 0.001% or more. The content of REM is more preferably 0.01% or more. On the other hand, in the case where an excessive content of REM is contained, it may lead to a significant increase in manufacturing cost. Therefore, the content of REM is preferably 0.5% or less. The content of REM is further preferably 0.50% or less and is more preferably 0.10% or less.

[0042] Note that REM is two elements namely Sc and Y and fifteen elements (lanthanoids) from La to Lu, and REM is one or more selected from the above-described elements. In the case where two or more elements are contained as REM, the content of REM refers to a total amount of the contained elements.

Ta: 0.001% or more and 0.5% or less

[0043] Ta forms carbonitrides and improves corrosion resistance. In order to stably obtain the above-described effect of Ta, the content of Ta is preferably 0.001 % or more. The content of Ta is more preferably 0.01% or more. On the other hand, in the case where an excessive content of Ta is contained, it may lead to saturation of the above-described effect. Therefore, the content of Ta is preferably 0.5% or less. The content of Ta is further preferably 0.50% or less and is more preferably 0.10% or less.

Ga: 0.001 % or more and 0.5% or less

[0044] Ga is an element that contributes to an improvement in corrosion resistance and workability. In order to stably obtain the above-described effect of Ga, the content of Ga is preferably 0.001 % or more. The content of Ga is more preferably 0.01 % or more. On the other hand, if the content of Ga is more than 0.5%, then the above-described effect is saturated, and this only leads to an increase in cost. Therefore, the content of Ga is preferably 0.5% or less. The content of Ga is further preferably 0.50% or less and is more preferably 0.10% or less.

Sb: 0.001 % or more and 0.5% or less

[0045] Sb is an element effective for improving oxidation resistance. In order to stably obtain the effect of improving the oxidation resistance of Sb, the content of Sb is preferably 0.001 % or more. The content of Sb is more preferably 0.01% or more. On the other hand, in the case where an excessive content of Sb is contained, it may lead to degradation of hot workability. Therefore, the content of Sb is preferably 0.5% or less. The content of Sb is further preferably 0.50% or less and is more preferably 0.10% or less.

[Surface nature]

[0046] The austenitic stainless steel according to the present embodiment has a brightness difference ΔL of 5 or less.

[0047] The brightness difference ΔL refers to a difference between a maximum value and a minimum value of brightness L obtained in accordance with JIS Z 8730: 2009. In the case where the shape of the austenitic stainless steel is a sheet shape, for example, the brightness difference ΔL is a difference between a maximum value and a minimum value of measured brightness (L value) when the brightness L is continuously measured over a sheet width direction that perpendicularly intersects a rolling direction. In the case where a part of the sheet width is removed by a slit or the like to obtain a targeted construction material, a region where the brightness L is measured is defined as a part other than the removed part.

[0048] For the brightness difference ΔL, the length in the rolling direction is equally split into ten parts, a brightness difference ΔL' in the sheet width direction at a center position of each of the ten sections in the rolling direction is calculated, and the largest numerical value among them is defined as a brightness difference ΔL.

[0049] In the case where the shape of the austenitic stainless steel is a bar shape or a tubular shape, the length in an axial direction is equally split into ten parts, and brightness L is continuously measured along a circumference at the center positions of the ten sections in the axial direction, thereby calculating the brightness differences ΔL'. Then, the largest numerical value among the calculated brightness differences ΔL' is defined as a brightness difference ΔL.

[0050] If the brightness difference ΔL is 5 or less, occurrence of appearance unevenness is not observed in the exterior construction material using it or very slight variations are observed, which is not problematic. On the other hand, in the case where the brightness difference ΔL is more than 5, it is extremely difficult to stably prevent occurrence of appearance unevenness even if various kinds of processing such as temper rolling, dull rolling, embossing rolling, and polishing is performed.

[0051] The austenitic stainless steel according to the present embodiment may have various shapes such as a thin sheet, a thick plate, a wire, and a bar material.

[0052] The austenitic stainless steel according to the present embodiment has been described hitherto. Although a method for manufacturing the austenitic stainless steel sheet according to the present embodiment is not particularly limited, for example, it is possible to manufacture the austenitic stainless steel sheet by the following method. Hereinafter, an example of the method for manufacturing the austenitic stainless steel according to the present embodiment will be described.

<Method for manufacturing austenitic stainless steel>

[0053] The manufacturing method of the austenitic stainless steel according to the present embodiment includes: a steel manufacturing step; a hot rolling step; an annealing step after the hot rolling; a hot rolled sheet acid pickling step; a cold rolling step; an annealing step after the cold rolling; and an finishing acid pickling step. Manufacturing conditions for the steps other than the finishing acid pickling step are not particularly limited, and known methods can be applied.

[Finishing acid pickling step]

[0054] In the finishing acid pickling step, a stainless material is immersed in an acid pickling solution for 10 seconds or more. The acid pickling solution contains: either one or both of a sulfuric acid with a concentration of 10 to 200 g/L and a hydrochloric acid with a concentration of 5 to 150 g/L; one or two or more selected from a hydrofluoric acid with a concentration of 40 g/L or less, a fluorosilicic acid with a concentration of 40 g/L or less, and sodium fluoride with a concentration of 40 g/L or less, the total of which being 1 g/L or more in terms of F converted amount; and ozone with a dissolved ozone concentration of 0.5 to 2.0 mg/L, with a remainder being water.

[0055] The acid pickling solution contains either one or both of a sulfuric acid with a concentration of 10 to 200 g/L and a hydrochloric acid with a concentration of 5 to 150 g/L.

[0056] In the case where the acid pickling solution contains a sulfuric acid and the concentration of the sulfuric acid is less than 10 g/L, it takes a long time to remove scale from the surface of the stainless material. Therefore, in the case where the acid pickling solution contains a sulfuric acid, the concentration of the sulfuric acid is 10 g/L or more. The concentration of the sulfuric acid is preferably 20 g/L or more and is more preferably 50 g/L or more. On the other hand, if the concentration of the sulfuric acid is more than 200 g/L, then erosion due to the acid is severe, and the surface nature of the stainless steel after the acid pickling deteriorates. Therefore, in the case where the acid pickling solution contains a sulfuric acid, the concentration of the sulfuric acid is 200 g/L or less. The concentration of the sulfuric acid is preferably 150 g/L or less and is more preferably 100 g/L or less.

[0057] In the case where the acid pickling solution contains a hydrochloric acid, and the concentration of the hydrochloric acid is less than 5 g/L, it takes a long time to remove scale from the surface of the stainless steel. Therefore, in the case where the acid pickling solution contains a hydrochloric acid, the concentration of the hydrochloric acid is 5 g/L or more. The concentration of the hydrochloric acid is preferably 10 g/L or more and is more preferably 50 g/L or more. On the other hand, when the hydrochloric acid concentration is more than 150 g/L, erosion due to the acid is severe, and the surface nature of the stainless steel after acid pickling deteriorates. Therefore, in the case where the acid pickling solution contains a hydrochloric acid, the concentration of the hydrochloric acid is 150 g/L or less. The concentration of the hydrochloric acid is preferably 120 g/L or less and is more preferably 100 g/L or less.

[0058] For the acid pickling solution, one or two or more selected from a hydrofluoric acid with a concentration of 40 g/L or less, a fluorosilicic acid with a concentration of 40 g/L or less, and sodium fluoride with a concentration of 40 g/L or less are contained such that the total F converted amount thereof is 1 g/L or more.

[0059] If the concentration of the hydrofluoric acid, the fluorosilicic acid, or the sodium fluoride contained in the acid pickling solution is less than 1 g/L in terms of the total F converted amount, it takes a long time to remove scale from the surface of the stainless material. Therefore, in the case where one or two or more selected from the hydrofluoric acid, the fluorosilicic acid, and the sodium fluoride are contained, the concentration of the contained compounds is 1 g/L or more in terms of the total F converted amount. The concentration thereof is preferably 5 g/L or more and is more preferably 10 g/L or more in terms of the total F converted amount.

[0060] On the other hand, if each concentration of the hydrofluoric acid, the fluorosilicic acid, and the sodium fluoride contained in the acid pickling solution is more than 40 g/L, the effect of removing scale is saturated, which leads to an increase in manufacturing cost. Therefore, each concentration of the hydrofluoric acid, the fluorosilicic acid, and the sodium fluoride contained in the acid pickling solution is 40 g/L or less. The concentration is preferably 30 g/L or less and is more preferably 20 g/L or less.

[0061] The acid pickling solution contains ozone with a dissolved ozone concentration of 0.5 to 2.0 mg. Ozone is an oxidizing agent and uniformly whitens the surface of the austenitic stainless steel after the acid pickling. If the concentration of dissolved ozone is less than 0.5 mg/L, the surface of the austenitic stainless steel after the acid pickling is not uniformly whitened. Therefore, the concentration of dissolved ozone is 0.5 mg/L or more. The concentration of dissolved ozone is preferably 0.8 mg/L or more and is more preferably 1.0 mg/L or more. On the other hand, if the concentration of dissolved ozone is more than 2.0 mg/L, the whitening effect is saturated. Therefore, the concentration of dissolved ozone is 2.0 mg/L or less. The concentration of dissolved ozone is preferably 1.8 mg/L or less and is more preferably 1.5 mg/L or less.

[0062] The method for adjusting the concentration of dissolved ozone in the acid pickling solution is not particularly limited, and it is only necessary to adjust the concentration of dissolved ozone by causing ozone gas to pass through the acid pickling solution from the lower side. Note that a commercially available dissolved ozone meter, for example, may be used to measure the concentration of dissolved ozone.

[0063] The time for immersion in the acid pickling solution is 10 seconds or more. If the acid pickling time is less than 10 seconds, the surface of the austenitic stainless steel after the acid pickling is not uniformly whitened. In the case where the acid pickling time is excessively long, dissolution of the steel material component leads to degradation of the acid pickling solution, and the acid pickling time is thus preferably 60 seconds or less and is more preferably 20 seconds or less.

[0064] Note that although it is possible to use a nitric acid as an oxidizing agent for the acid pickling solution, a nitrogen oxide may be generated in the case where the acid pickling is performed using the nitric acid. In order to process a nitrogen oxide, special equipment and processing are required. Therefore, the acid pickling solution preferably does not contain a nitric acid solution.

[0065] The austenitic stainless steel obtained through the finishing acid pickling step has a brightness difference ΔL of 5 or less and is aesthetic with no appearance unevenness observed therefrom. Moreover, the austenitic stainless steel obtained through the finishing acid pickling step has the aforementioned chemical components and thus has high corrosion resistance.

[0066] An example of the manufacturing method of the austenitic stainless steel according to the present embodiment has been described hitherto.

EXAMPLES

[0067] Hereinafter, embodiments of the present invention will be specifically described by describing examples. Note that the examples shown below are just examples of the present invention and the present invention is not limited to the following examples.

[0068] First, materials of stainless steel having chemical components shown in Tables 1A to 1C were melted in a vacuum induction melting furnace and were then casted, thereby obtaining cast slabs. Thereafter, each cast slab was uniformly heated to 1200°C and was then subjected to hot forging and hot rolling; and thereby, a hot rolled sheet having a thickness of 6 mm was obtained. The hot rolled sheet was subjected to annealing and acid pickling, and then was cold-rolled; and thereby, a cold rolled sheet with a length of 1 m in the rolling direction, 200 mm in the sheet width direction, and 1 mm in the sheet thickness direction was obtained. Finishing acid pickling step under conditions shown in Tables 1D to 1F was performed on the cold rolled sheet; and thereby, a stainless steel sheet was obtained.

[0069] The brightness difference ΔL was calculated by the following method. The length of the manufactured stainless steel sheet in the rolling direction was equally split into ten parts, a brightness difference $\Delta L'$ in the sheet width direction was calculated at the center position of each of the ten sections in the rolling direction, and a maximum value among the calculated brightness differences $\Delta L'$ was defined as the brightness difference ΔL. Brightness L necessary to calculate the brightness difference ΔL was measured by a method in accordance with JIS Z 8730: 2009. Also, a measurement interval for the brightness L was set to 10 mm.

[0070] Also, evaluation was made by the following methods as appearance evaluation. The surface of the stainless steel sheet was masked such that a 50 mm square was exposed, and whether streaky appearance unevenness were observed in the 50 mm square was visually observed. Cases in which variations were observed were evaluated with a point 1, and cases in which no variations were observed were evaluated with a point 0. The aforementioned evaluation was performed at ten locations on the surface of the stainless steel sheet, and evaluation was performed using the total points (0 to 10). If the total point was 3 or less, the appearance was evaluated to be aesthetic enough for practical use.

[0071] Manufacturing conditions and evaluation results are shown in Tables 1D to 1F.

Table 1A

No.	Chemical components (% by mass); the remainder is Fe and impurities.											
	C	Si	Mn	P	S	Ni	Cr	Mo	N	Cu	W	Others
Example 1	0.009	1.01	0.55	0.030	0.0008	12.89	24.99	0.91	0.351	0.00	0.00	-
Example 2	0.010	0.35	0.35	0.019	0.0008	25.01	23.08	5.50	0.253	1.03	0.10	-
Example 3	0.010	0.31	0.56	0.019	0.0005	24.37	20.90	6.33	0.191	0.73	0.10	-
Example 4	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.10	-
Example 5	0.005	0.11	0.21	0.018	0.0005	24.74	23.15	5.44	0.193	0.00	0.10	-
Example 6	0.008	0.12	0.16	0.021	0.0006	35.11	22.99	7.35	0.189	0.00	0.10	-
Example 7	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.00	0.10	-
Example 8	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 9	0.010	0.50	0.45	0.023	0.0008	18.01	20.18	6.10	0.183	0.70	0.00	-
Example 10	0.010	0.50	0.45	0.023	0.0008	24.90	20.18	6.10	0.183	0.70	0.00	-
Example 11	0.010	0.50	0.45	0.023	0.0008	18.93	20.05	6.10	0.183	0.70	0.00	-
Example 12	0.010	0.50	0.45	0.023	0.0008	18.93	24.95	6.10	0.183	0.70	0.00	-
Example 13	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	5.03	0.183	0.70	0.00	-
Example 14	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.91	0.183	0.70	0.00	-
Example 15	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.106	0.70	0.00	-
Example 16	0.010	0.50	3.27	0.023	0.0008	18.93	20.18	6.10	0.397	0.70	0.00	-
Example 17	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.00	0.00	-
Example 18	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	0.00	0.183	0.00	1.95	-
Example 19	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-

(continued)

No.	Chemical components (% by mass); the remainder is Fe and impurities.											
	C	Si	Mn	P	S	Ni	Cr	Mo	N	Cu	W	Others
Example 20	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.00	0.10	-
Example 21	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	0.00	0.183	0.70	0.10	-
Example 22	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.10	-
Example 23	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.10	Ti: 0.10 Nb: 0.10

Table 1B

No.	Chemical components (% by mass); the remainder is Fe and impurities.											
	C	Si	Mn	P	S	Ni	Cr	Mo	N	Cu	W	Others
Example 24	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.10	Nb: 0.10 V: 0.10
Example 25	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.10	Ti: 0.10 V: 0.10
Example 26	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.10	Ti: 0.10 Nb: 0.10 V: 0.10
Example 27	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Ti: 0.10
Example 28	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Nb: 0.10
Example 29	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Al: 0.10
Example 30	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Ca: 0.0010
Example 31	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	B: 0.0010
Example 32	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Sn: 0.10
Example 33	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	V: 0.10
Example 34	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Zr: 0.10
Example 35	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Co: 0.10
Example 36	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Mg: 0.0010
Example 37	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Hf: 0.10
Example 38	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	REM: 0.05
Example 39	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Ta: 0.02
Example 40	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Ga: 0.10
Example 41	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	Sb: 0.10
Example 42	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 43	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 1	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-

Table 1C

No.	Chemical components (% by mass); the remainder is Fe and impurities.											
	C	Si	Mn	P	S	Ni	Cr	Mo	N	Cu	W	Others
Example 44	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 45	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 2	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 46	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 47	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 48	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 49	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 50	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 51	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 3	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 4	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 5	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 6	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 7	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 8	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 9	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 52	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 53	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 10	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 54	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Example 55	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-
Comparative Example 11	0.010	0.50	0.45	0.023	0.0008	18.93	20.18	6.10	0.183	0.70	0.00	-

Table 1D

No.	Finishing acid pickling conditions							Evaluation result	
	Concentration of sulfuric acid (g/L)	Concentration of hydrochloric acid (g/L)	Type of fluoride	Concentration of fluoride (g/L)	Type of oxidizing agent	Concentration of oxidizing agent (mg/L)	Time (second)	ΔL	Appearance unevenness
Example 1	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.09	0
Example 2	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.69	0
Example 3	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.42	0
Example 4	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.03	0
Example 5	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.28	0
Example 6	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.98	0
Example 7	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.97	0
Example 8	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.09	0
Example 9	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.55	0
Example 10	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.55	0
Example 11	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.66	0
Example 12	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.56	0
Example 13	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.98	0

(continued)

No.	Finishing acid pickling conditions							Evaluation result	
	Concentration of sulfuric acid (g/L)	Concentration of hydrochloric acid (g/L)	Type of fluoride	Concentration of fluoride (g/L)	Type of oxidizing agent	Concentration of oxidizing agent (mg/L)	Time (second)	ΔL	Appearance unevenness
Example 14	100	50	Hydrofluoric acid	20	Ozone	1.0	20	4.56	0
Example 15	100	50	Hydrofluoric acid	20	Ozone	1.0	20	1.98	0
Example 16	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.44	0
Example 17	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.96	0
Example 18	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.99	0
Example 19	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.05	0
Example 20	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.33	0
Example 21	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.21	0
Example 22	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.56	0
Example 23	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.96	0

Table 1E

No.	Finishing acid pickling conditions							Evaluation result	
	Concentration of sulfuric acid (g/L)	Concentration of hydrochloric acid (g/L)	Type of fluoride	Concentration of fluoride (g/L)	Type of oxidizing agent	Concentration of oxidizing agent (mg/L)	Time (second)	ΔL	Appearance unevenness
Example 24	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.96	0
Example 25	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.96	0
Example 26	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.96	0
Example 27	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.97	0
Example 28	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.95	0
Example 29	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.96	0
Example 30	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.56	0
Example 31	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.78	0
Example 32	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.99	0
Example 33	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.40	0
Example 34	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.79	0
Example 35	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.99	0
Example 36	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.70	0

(continued)

No.	Finishing acid pickling conditions							Evaluation result	
	Concentration of sulfuric acid (g/L)	Concentration of hydrochloric acid (g/L)	Type of fluoride	Concentration of fluoride (g/L)	Type of oxidizing agent	Concentration of oxidizing agent (mg/L)	Time (second)	ΔL	Appearance unevenness
Example 37	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.12	0
Example 38	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.71	0
Example 39	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.68	0
Example 40	100	50	Hydrofluoric acid	20	Ozone	1.0	20	3.02	0
Example 41	100	50	Hydrofluoric acid	20	Ozone	1.0	20	2.70	0
Example 42	200	50	Hydrofluoric acid	20	Ozone	1.0	20	2.51	0
Example 43	15	50	Hydrofluoric acid	20	Ozone	1.0	20	4.59	3
Comparative Example 1	5	50	Hydrofluoric acid	20	Ozone	1.0	20	5.22	4

Table 1F

No.	Finishing acid pickling conditions							Evaluation result	
	Concentration of sulfuric acid (g/L)	Concentration of hydrochloric acid (g/L)	Type of fluoride	Concentration of fluoride (g/L)	Type of oxidizing agent	Concentration of oxidizing agent (mg/L)	Time (second)	ΔL	Appearance unevenness
Example 44	100	150	Hydrofluoric acid	20	Ozone	1.0	20	2.29	0
Example 45	100	8	Hydrofluoric acid	20	Ozone	1.0	20	4.22	2
Comparative Example 2	100	2	Hydrofluoric acid	20	Ozone	1.0	20	5.39	7
Example 46	100	50	Fluorosilicic acid	20	Ozone	1.0	20	3.09	0
Example 47	100	50	Sodium fluoride	20	Ozone	1.0	20	3.12	0
Example 48	100	50	Hydrofluoric acid + fluorosilicic acid	20	Ozone	1.0	20	2.99	0
Example 49	100	50	Hydrofluoric acid + sodium fluoride	20	Ozone	1.0	20	3.01	0
Example 50	100	50	Hydrofluoric acid	40	Ozone	1.0	20	2.01	0
Example 51	100	50	Hydrofluoric acid	1	Ozone	1.0	20	4.99	3
Comparative Example 3	100	50	Hydrofluoric acid	0	Ozone	1.0	20	5.81	10
Comparative Example 4	100	50	Hydrofluoric acid	20	Fe^{3+}	20000.0	20	6.99	10
Comparative Example 5	100	50	Hydrofluoric acid	20	Fe^{3+}	50000.0	20	6.77	10
Comparative Example 6	100	50	Hydrofluoric acid	20	Hydrogen peroxide	15000.0	20	6.45	10
Comparative Example 7	100	50	Hydrofluoric acid	20	Hydrogen peroxide	30000.0	20	6.21	10
Comparative Example 8	100	50	Hydrofluoric acid	20	Sodium persulfate	10000.0	20	6.67	10
Comparative Example 9	100	50	Hydrofluoric acid	20	Sodium persulfate	20000.0	20	6.45	10

(continued)

No.	Finishing acid pickling conditions							Evaluation result	
	Concentration of sulfuric acid (g/L)	Concentration of hydrochloric acid (g/L)	Type of fluoride	Concentration of fluoride (g/L)	Type of oxidizing agent	Concentration of oxidizing agent (mg/L)	Time (second)	ΔL	Appearance unevenness
Example 52	100	50	Hydrofluoric acid	20	Ozone	0.8	20	3.21	1
Example 53	100	50	Hydrofluoric acid	20	Ozone	0.5	20	4.51	2
Comparative Example 10	100	50	Hydrofluoric acid	20	Ozone	0.1	20	5.12	4
Example 54	100	50	Hydrofluoric acid	20	Ozone	1.0	100	2.99	0
Example 55	100	50	Hydrofluoric acid	20	Ozone	1.0	10	4.54	2
Comparative Example 11	100	50	Hydrofluoric acid	20	Ozone	1.0	5	5.24	6

[0072] The chemical composition of each obtained steel sheet was substantially the same as the chemical composition of the material of each stainless steel. Also, the stainless steel sheets (invention examples) according to the present embodiments had aesthetic appearance as shown in Tables 1D to 1F.

[0073] Although preferred embodiments of the present invention have been described above in detail, the present invention is not limited to such examples. It is obvious that those ordinarily skilled in the technical field to which the present invention belongs can achieve various modification examples or amended examples within the scope of the technical features described in the claims, and it should be understood that these also belong to the technical scope of the present invention as a matter of course.

Industrial Applicability

[0074] The austenitic stainless steel according to the present embodiment is suitably applied to construction materials for roofs, exteriors, and the like that require aesthetic appearance.

Claims

1. An austenitic stainless steel comprising, in terms of % by mass:

C: 0.100% or less;
Si: 3.00% or less;
Mn: 0.01% or more and 5.00% or less;
P: 0.100% or less;
S: 0.0050% or less;
Ni: 7.00% or more and 38.00% or less;
Cr: 17.00% or more and 28.00% or less;
Mo: 10.00% or less; and
N: more than 0.100% and 0.400% or less,
with a remainder being Fe and impurities,
wherein a brightness difference ΔL of a surface of a steel sheet is 5 or less.

2. The austenitic stainless steel according to Claim 1, further comprising, instead of a part of Fe, in terms of % by mass, one or more selected from a group consisting of:

Cu: 3.00% or less;
W: 2.00% or less; and
V: 1.00% or less.

3. The austenitic stainless steel according to Claim 1 or 2, further comprising, instead of a part of Fe, in terms of % by mass, one or more selected from a group consisting of:

Al: 0.001 % or more and 0.3% or less;
Ca: 0.001% or more and 0.3% or less;
B: 0.0001 % or more and 0.1% or less;
Ti: 0.001 % or more and 0.40% or less;
Nb: 0.001 % or more and 0.40% or less;
Sn: 0.001% or more and 0.5% or less;
Zr: 0.001 % or more and 0.5% or less;
Co: 0.001% or more and 0.5% or less;
Mg: 0.001% or more and 0.5% or less;
Hf: 0.001 % or more and 0.5% or less;
REM: 0.001% or more and 0.5% or less;
Ta: 0.001% or more and 0.5% or less;
Ga: 0.001 % or more and 0.5% or less; and
Sb: 0.001% or more and 0.5% or less.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/010547

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. C22C38/00(2006.01)i, C22C38/58(2006.01)i, C22C38/60(2006.01)i, C21D9/46(2006.01)n, C23G1/08(2006.01)n
FI: C22C38/00 302Z, C22C38/58, C22C38/60, C21D9/46 Q, C23G1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. C22C38/00-38/60, C21D9/46, C23C1/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	一般財団法人 日本規格協会編. JIS ハンドブック 1 鉄鋼 I. First Edition. Japanese Standards Association, 31 January 2020, pp. 1820-1823, table 3, non-official translation (JAPANESE STANDARDS ASSOCIATION ed. JIS Handbook 1 - Steel I.)	1-3
Y	JP 09-228000 A (KAWASAKI STEEL CORP.) 02 September 1997, claims, paragraphs [0002], [0007], [0022]-[0030]	1-3
A	JP 11-279781 A (KAWASAKI STEEL CORP.) 12 October 1999	1-3
A	JP 2000-328142 A (NISSHIN STEEL CO., LTD.) 28 November 2000	1-3

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 20.05.2021	Date of mailing of the international search report 01.06.2021
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT	International application No. PCT/JP2021/010547

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 106835159 A (BAOSTEEL STAINLESS STEEL CO., LTD.) 13 June 2017	1-3
A	JP 60-243289 A (KOBE STEEL, LTD.) 03 December 1985	1-3

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/010547

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 09-228000 A	02.09.1997	(Family: none)	
JP 11-279781 A	12.10.1999	US 6149744 A EP 915185 A1 BR 9804257 A CN 1220321 A KR 10-1999-0037420 A	
JP 2000-328142 A	28.11.2000	(Family: none)	
CN 106835159 A	13.06.2017	(Family: none)	
JP 60-243289 A	03.12.1985	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2020060919 A **[0002]**
- JP H9228002 A **[0008]**
- JP 2005029828 A **[0008]**