JFE

2006 Nikkei
Superior Products and Services
Awards
Nikkei Business Daily Awards
for **Excellence**

2008
The Ichimura Prize
for Industry
Meritorious Achievement Prize

JFE443CT

Ni, Mo-Free Stainless steel with high corrosion resistance

21Cr Stainless Steel

JFE Steel Corporation

High corrosion resistant Ferritic Stainless steel, sparing rare alloy elements

- **Achieves high corrosion resistance equal or superior to Type304 without the addition of Nickel & Molybdenum**
- **Accredited steel grades under Japanese Industrial Standards as SUS443J1 and ASTM international as UNS No.S44330 in 2010**

1 Features of JFE443CT

1. Excellent corrosion resistance

1 With the increase of Cr content up to 21%, the corrosion resistance of JFE443CT is equal or superior to that of Type304.

2 In particular, JFE443CT has proved to be better than Type304 in long-term field exposure tests.

2. Price competitiveness and price stability

Since sources of Nickel (Ni) or Molybdenum (Mo) are very small, their prices are high and fluctuating. The price of JFE443CT is stable, even when the prices of Ni or Mo soar.

3. Good formability and weldability

1 Better formability and weldability

2 Less working load in pressing and shearing because of less work hardening than Type304.

4. Good physical properties

1 Smaller thermal expansion than Type304.

2 Possible magnetic separation and handling by magnet.

5. Wide variety of surface finishes

In addition to regular bright finishes such as 2B, BA, polished finishes such as HL & No.4, 2BW and tandem-mill finish (KB, KD) are available. 2BW has a white surface similar to the 2B finish of Type304.

6. Accredited steel grade listed on JIS and ASTM

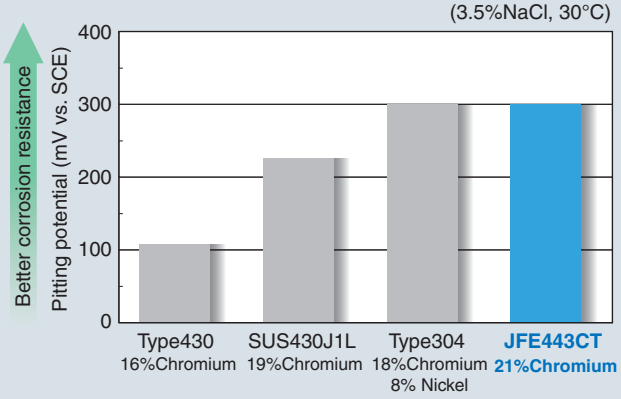
Both SUS443J1 of JISG4304/JISG4305 and UNS No.S44330 of ASTM A240/240M-10 which are equivalent to JFE443CT are available.

7. Wide range of size availability

Thickness under 4mm, width under 1524mm is available.

■Corrosion resistance of JFE443CT and other stainless grades

(3.5%NaCl, 30°C)



■The result of four-years field exposure test at a seashore on Okinawa

(Excerpt from p.5 6.3.2)

Type304	JFE 443CT
	

■Comparison of limiting drawing ratio between JFE443CT and Type304

(Excerpt from p.7 6.4)

Type304 Limiting drawing ratio = 2.21	JFE 443CT Limiting drawing ratio = 2.36
	

2 History of JFE443CT

Aug. 2005	Commercialized
Feb. 2007	Awarded Nikkei Superior Products and Services and Nikkei Business Daily Award for Excellence
Jul. 2007	Awarded Sankei Shinbun's 21st "Pioneer Technologies"
Apr. 2008	Awarded the Ichimura Prize for Industry Meritorious Achievement Prize
2009	Achieved accumulated product shipment of 100,000 tons
Aug. 2010	Accredited grade as SUS443J1 in JIS

3 Applications

JFE443CT is widely used in a variety of applications as the substitute for Type304.

Architecture/Building	Roofs, exterior/interior parts, elevators, escalators, ornament pipes, curtain rails, expansions for absorbing earthquake tremors
Industrial machinery	Ducts, manufacturing machines for semi-conductor & liquid crystal, cases for telecommunications equipment, meters, air conditioners, control panels, drum cans, thermostatic uses, etc.
Transportation	Refrigeration containers, automobile components, etc
Kitchenware/cookware	Cooking pans for induction heating (IH), kitchen sinks, ranges, B.B.Q. grills, bottles for seasonings
Household goods	Mailboxes, garbage containers, clothes poles and stands, shopping cart gates, etc
Electric appliances	Freezer cases, dishwashers, rice cookers, microwave ovens

■ Examples of application













● For further information, please contact our nearest office or send your inquires directly to:

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4 Chemical Composition

Nickel (Ni) and molybdenum (Mo)-free 21% chromium stainless steel with copper (Cu) and titanium (Ti) added to improve corrosion resistance.

Typical values. Mass%

Steel Grade		Cr (Chromium)	Ni (Nickel)	Cu (Copper)	Ti (Titanium)	Nb (Niobium)
JFE standard	JIS standard					
JFE443CT	**SUS443J1**	**21.0**	**–**	**0.4**	**0.3**	**–**
	SUS304 (Type304)	18.2	8.2	–	–	–
JFE430CuN	SUS430J1L	19.2	–	0.5	–	0.4
	SUS430 (Type430)	16.1	–	–	–	–

■Chemical Composition of SUS443J1 and JFE443CT

Chemical composition of JFE443CT is equivalent to those of SUS443J1

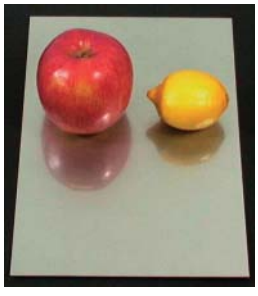
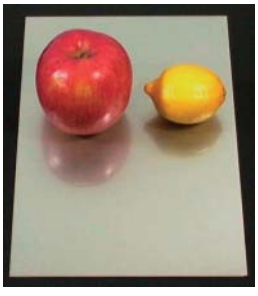
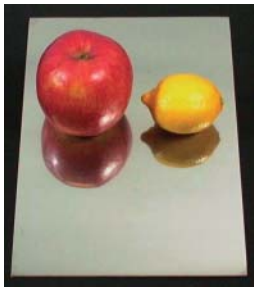
	C (Carbon)	Si (Silicon)	Mn (Manganese)	P (Phosphorous)	S (Sulfur)	Cr (Chromium)	Cu (Copper)	N (Nitrogen)	Others
SUS443J1 (JIS standard)	≦0.025	≦1.00	≦1.00	≦0.040	≦0.030	20.00 ~ 23.00	0.30 ~ 0.80	≦0.025	Ti (Titanium), Nb (Niobium), Zr (Zirconium) or combination of these 8 × (C% + N%) ~ 0.80
JFE443CT (JFE standard)	≦0.025	≦1.00	≦1.00	≦0.040	≦0.030	20.00 ~ 23.00	0.30 ~ 0.80	≦0.025	Ti (Titanium) 8 × (C% + N%) ~ 0.80
typical values	0.01	0.1	0.2	0.03	0.002	21.0	0.4	0.01	Ti / 0.30

5 Surface finishing

White surface (2BW), bright finishes (2B,BA), polish finishes and tandem finishes (KB, KD) are available.

■Feature of 2BW surface

- White surface similar to Type304*2B
- Anti-glare properties
- Resists showing scratches

Type304 *2B	**JFE443CT** *2BW	**JFE443CT** *2B
		

6 Properties

6.1 Mechanical properties

Compare with Type304, JFE443CT has a higher mean r-value, resulting in superior drawing formability and lesser work hardening.

Typical values. Specimen thickness : 0.8mm

Steel Grade		0.2% proof stress (N/mm^2)	Tensile stress (N/mm^2)	Elongation (%)	Hardness (Hv)	Mean r-value	Bendability (Bending angle 180°)
JFE standard	JIS standard						
JFE443CT	**SUS443J1**	**305**	**483**	**31**	**153**	**1.3**	**Excellent (r=0t)**
	SUS304 (Type304)	260	645	60	176	1.0	Excellent (r=0t)
JFE430CuN	SUS430J1L	356	496	29	158	1.3	Excellent (r=0t)
	SUS430 (Type430)	320	490	29	164	1.0	Excellent (r=1t)

r=0t bending

■Mechanical properties of JFE443CT and SUS443J1

Mechanical properties of JFE443CT are equivalent to those of SUS443J1

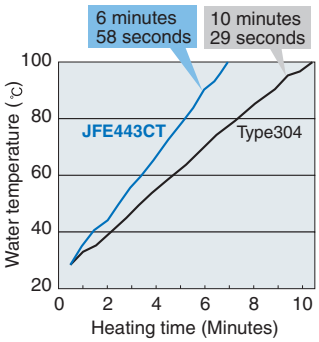
	Proof stress (N/mm^2)	Tensile stress (N/mm^2)	Elongation (%)	Hardness (Hv)	Bendability
SUS443J1 (JIS standard)	205≦	390≦	22≦	≦200	r=1t, Bending angle 180°
JFE443CT (JFE standard)	205≦	390≦	22≦	≦200	r=1t, Bending angle 180°

6.2 Physical properties

Compared with Type304, JFE443CT exhibits the following features:

- About 40% higher thermal conductivity
- About 40% lower thermal expansion.
  Good thermal conductivity and lower thermal expansion results in less transformation during welding.
- Lower density; weight saving of about 2.5%
- Magnetic separation and handling by magnet is applicable. Especially, suitable for cooking pans for induction heating (IH).

■Example of heating time for two liters of water from room temperature.



With IH heating, the pan of JFE 443CT takes less heating time than that of Type304.

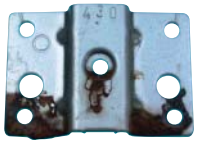
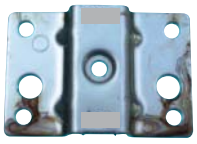
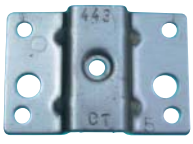
Typical values

Steel Grade		Density (g/cm^3)	Electric resistivity ($10^{-6}\Omega$·cm)	Magnetism	Specific heat 25°C (J/kg·°C)	Thermal conductivity 100°C (W/m·°C)	Thermal expansion coefficient 20～100°C (10^{-6}/°C)	Young's modulus (GPa)
JFE standard	JIS standard							
JFE443CT	**SUS443J1**	**7.74**	**58**	**Magnetic**	**440**	**22.5**	**10.5**	**204**
	SUS304 (Type304)	7.93	70	Non-magnetic	500	16.2	17.3	193
JFE430CuN	SUS430J1L	7.73	61	Magnetic	460	24.0	10.5	203
	SUS430 (Type430)	7.70	60	Magnetic	460	26.1	10.4	200

6.3 Corrosion resistance

JFE443CT exhibits excellent corrosion resistance equivalent to or better than Type304

6.3.1 Salt spray tests

	Type430	JFE430CuN (SUS430J1L)	Type304	**JFE443CT (SUS443J1)**
Cyclic corrosion test (CCT JASO M609 91) After 30 cycles #600 finish				
Neutral salt spray test (NSS JIS Z2371) 5%NaCl, 35°C After 3000hrs				

[Cyclic corrosion test condition (JASO M609 91,JIS H8502)]
1 cycle: Salt spray (5%NaCl,35°C,2hrs)➡ Dry (60°C, relative humidity 20~30%,4hrs)➡ Wet (50°C,relative humidity≧95%,2hrs)

6.3.2 Field exposure test

JFE443CT exhibits excellent corrosion resistance superior to Type304 after a four-year field exposure test at a seashore on Okinawa

	Type430	JFE430CuN (SUS430J1L)	Type304	**JFE443CT (SUS443J1)**
After 6 months				
After 14 months				
After 24 months				
After 48 months				

[Test condition] Sample size: 75mm x 150mm, surface:#800polished, Distance from beach:20m, Deposited sea salt:0.8 mg.dm.$^{-2}$ day^{-1}

6.3.3. Corrosion resistance to various chemicals, organic solvents, and foods

Equal to Type304, JFE443CT exhibits good corrosion resistance to the following various solutions.

Note) when in actual use, it might be happen that corrosion will be accelerated due to the shapes of stainless steel or contamination by other solutions.

■ Results of corrosion resistance to various chemicals at 50°C

Solution	Concentration (%)	Type 430	Type 304	JFE 443CT
Hydrochloric acid	0.1	×	○	○
	1.0	×	×	×
Sulfuric acid	10	×	×	○
Sulfurous acid	10	×	○	○
	50	×	○	○
Nitric acid	10	△	○	○
	60	○	○	○
Phosphoric acid	10	○	○	○
	80	○	○	○
Formic acid	10	×	○	○
	50	×	○	○
Acetic acid	10	○	○	○
	50	○	○	○
Oxalic acid	10	×	○	○
	50	×	○	○
Citric acid	10	○	○	○
	50	○	○	○
Lactic acid	10	○	○	○
	50	○	○	○
Butyric acid	10	○	○	○
	50	○	○	○
Ammonium chloride	10	○	○	○
	50	○	○	○
Ammonium sulfate	10	○	○	○
	50	○	○	○
Sodium hydroxide	10	○	○	○
	50	○	○	○

■ Results of corrosion resistance to various organic solvents and foods

Solution	Concentration (%)	Type 430	Type 304	JFE 443CT
Methyl alcohol	100	○	○	○
Ethyl alcohol	100	○	○	○
Diethyl ether	100	○	○	○
Acetone	100	○	○	○
Toluene	100	○	○	○
Methyl acetate	100	○	○	○
Methyl ethyl ketone	100	○	○	○
Soy sauce	100	○	○	○
Vinegar	100	○	○	○
Worcester sauce	100	○	○	○
Ketchup	100	○	○	○
Milk	100	○	○	○
Japanese sake	100	○	○	○
Red wine	100	○	○	○
White wine	100	○	○	○
Orange juice	100	○	○	○
Ammonia	28	○	○	○
Hypochlorous acid	0.1	○	○	○
	12	○	○	○
Toilet cleaner (9.5% hydrochloric acid)	100	×	△	△

○ : GOOD - Corrosion rate under 0.005g/m²·hr
△ : INSUFFICIENT - Corrosion rate under 0.005～0.008g/m²·hr
× : POOR - Corrosion rate over 0.088g/m²·hr (0.1mm per annum)

[Test condition]
Method : Dipping half of specimen into solution
Time : 48hrs for Hydrochloric acid, Sulfuric acid, and Nitric acid
Six-months for foods listed from soy source to orange juice
96hrs for others

6.3.4 Stress corrosion cracking (42% $MgCl_2$ U-Bending: JIS G 0576)

Type304 is susceptible to stress corrosion cracking (SCC); JFE443CT is not.

	Type304	JFE443CT
Test Result	Crack appeared within 4hrs	No crack appeared after 250 hrs
Appearance after test		

42%$MgCl_2$, boiled at 143℃

5mm

6.4 Formability

JFE443CT has good formability.

Compared with Type304, JFE443CT has the following properties.

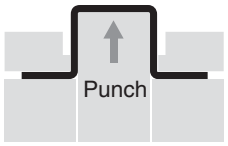
1. Better drawing, with less punch stretch forming
2. No season cracking after severe forming
3. Excellent bore expanding ratio
4. Less work hardening, which results in less load during press forming or shearing.
5. Burrs are apt to be large during slitting, shearing, or punching
6. Less spring back with general bending, but a large spring back is likely in the case of a large-radius shape
7. Low elongation may cause whitening of bent parts (not cracks but tiny wrinkles or rough skin)

Hints for forming when shifting material from Type304

1. Not punch stretch forming but drawing or bore expanding is effective for press forming
2. Narrowing clearance during shearing or punching
3. Adjusting angle prospect before bending
4. Optimizing forming conditions from initial design enables high formability

By taking above-mentioned measures, it is possible to shift materials from Type 304 to JFE443CT in most cases.

■Limiting drawing ratio



Type304 Limiting drawing ratio = 2.21	JFE 443CT Limiting drawing ratio = 2.36
	

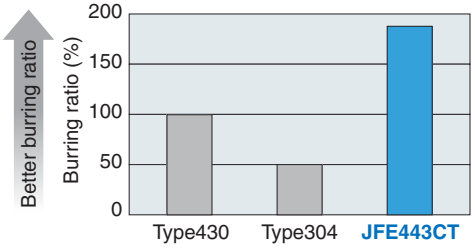
JFE443CT exhibits excellent drawing superior to Type304

$$\text{Limiting drawing ratio} = \frac{\text{Maximum blank diameter}}{\text{Punch Diameter}}$$

The bigger the figure, the better the drawing.

Thickness : 0.8mm
Punch Diameter : 33mmϕ

■Burring ratio



$$\text{Burring ratio (\%)} = \frac{\text{Diameter at breakage} - \text{Initial Diameter}}{\text{Initial Diameter}}$$

Punching a 10mm diameter hole, then widening with conic punch.
Thickness : 1.5mm
Japan Steel Association Standard JFS T1001-1996 punching test

■Multi-pass drawing (Diameter of blank: 84mm, Thickness 0.8mm)

Type304	JFE 443CT
 Season cracking	

6.5. Weldability

6.5.1 TIG Weld

TIG-welded area of JFE443CT exhibits good corrosion resistance and mechanical properties.

Notes for better welding

1. Y316L grade is recommended as filler metals (wire or rod). Y308 may decrease corrosion resistance.
2. Welding to Type304, Type430 or other ferrite stainless grades
   - When welding JFE443CT to Type304, the corrosion resistance may decrease without filler metals. Please overlay with plenty of ultra-low carbon austenitic filler wire or rod such as Y316L.
   - The combination of JFE443CT and JFE443CT exhibits excellent corrosion even without filler metals. Welded areas of JFE443CT with low carbon austenitic grades such as Type304L or Type316L also exhibit good corrosion resistances.
   - Please avoid welding JFE443CT with Type430 since either the combination of Type430 and Type430 or that of Type430 and Type304 decreases corrosion resistances.
   - Welding to SUS430LX, SUS430J1L, or other special ferrite stainless grades in which a very small amount of titanium or niobium is added gives good corrosion resistance.
3. The corrosion resistance of welded metal decreases when carbon or nitrogen penetrates it. Therefore, it is important to prepare and perform welding appropriately as in the case of Type304.
   - Before welding, clean the material surfaces to remove oils, fats, etc.
   - Provide a sufficient argon gas shield. Ar gas shield for the bottom side is effective to secure the corrosion resistance of the topside.
   - Remove the temper color after welding by pickling or grinding.

■Results of corrosion resistance for TIG welded area

Combination of materials	Type430/ Type430	Type304/ Type304	JFE443CT/JFE443CT			JFE443CT/Type304	
Methods for welding	Butt Welding					overlap fillet welding	
welding rod	None	None	None	Y308	Y316L	None	Y316L
Thickness	0.8mm	0.8mm	0.8mm	1.5mm	1.5mm	1.5mm	1.5mm
appearances after corrosion test							

Test condition : Shielding gas : argon (Top : 10ℓ/min, back :none),
Cyclic corrosion test (JASO-CCT 30 cycles)

chemical composition of welding wire (%)

	C (Carbon)	Cr (Chromium)	Ni (Nickel)	Mo (Molybdenum)
Y308	0.05	20	9.6	-
Y316L	0.01	19	12	2.2

■Results of tensile strength test for TIG welded area

Steel grade	welding rod	Test results		
		0.2% proof test (N/mm²)	Tensile stress (N/mm²)	elongation (%)
JFE443CT/JFE443CT	None	328	441	20
	Y316L	323	449	30
JFE443CT/Type304	Y316L	330	484	22
Type304/Type304	None	313	648	35
	Y308	329	677	36

Thickness : 1.5mm, Butt Welding

6.5.2.Other welding methods

1. MIG, MAG welding:
   By using Y308L as filler materials, it is possible to achieve good corrosion resistance and mechanical properties in the case of welding JFE443CT to JFE443CT or JFE443CT to Type304.

2. Spot welding:
   It is possible to achieve good corrosion resistance and mechanical properties in the case of welding JFE443CT to JFE443CT or JFE443CT to Type304.

1. PRODUCTS AND COMPANY IDENTIFICATION

Product information

Product name : Stainless steel sheets and Coils

Company information

Company name : JFE Steel Corporation

Address : 2-2-3 Uchisaiwai-cho, Chiyoda-ku, Tokyo, Japan

Contact information

Department in charge : Stainless Steel Sec., Products Design & Quality Control Dept. , East Japan Works (Chiba), JFE Steel Corporation

Address : 1 Kawasaki-cho, Chuo-ku, Chiba-shi, Chiba Prefecture, Japan

Telephone number : +81-43-262-2291 / 2587

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2. HAZARDS IDENTIFICATION

No serviceable information about hazardous properties on the product. However, the following cases need special care.
For further details, please refer to section 7 “HANDLING AND STORAGE”.

(1) With operations such as welding, sawing, brazing, grinding and machining that might cause fumes or dust, it is necessary to wear protective goods or use an exhaust fan.
(2) With operations handling acids or chemical goods, it is necessary to wear protective goods or use an exhaust fan.
(3) It is necessary to wear protective gloves in order to avoid injury by burrs at cut sections.

3. COMPOSITION/INFORMATION ON INGREDIENTS

(1) Classification as simple chemical substance or preparation: Preparation (alloy steel)
(2) Chemical nature of chemical substance, etc. (product): Chemically stable solid substance
(3) Constituents and concentration

Chemical or Generic name	Chemical formula	Concentration range (wt %) [1) 2)]	CAS No.
Iron	Fe	Balance	7439-89-6
Chrome	Cr	10～40	7440-47-3
Nickel	Ni	0～30	7440-02-0
Manganese	Mn	0～10	7439-96-5
Molybdenum	Mo	0～10	7439-98-7
Copper	Cu	0～10	7440-50-8

Notes:
1) Composition values will vary within the concentration ranges mentioned above depending on the steel types/standards.
2) Depending on the application, products may include traceable elements other than the ingredients mentioned above.

4. FIRST-AID MEASURES

Consulting a doctor is recommended, if necessary, after taking first-aid measures.
Examples of first-aid measures

(1) It is necessary to consult a doctor speedily when fumes or particulate dusts are inhaled and cause disorder to the respiratory system.
(2) It is necessary to consult a doctor speedily when fumes or particulate dusts enter the eyes, after flushing eyes with plenty of water.
(3) If necessary, it is recommended to consult a doctor when injured by burrs at cut sections, after sterilizing wounds properly.

5. FIRE-FIGHTING MEASURES

The product is a non-combustible and non-explosive under normal conditions of use.
But the powder form of the product may be flammable or explosive depending on circumstances.

6. ACCIDENTAL RELEASE MEASURES

Since the product is solid under normal circumstances, no leakage occurs.

7. HANDLING AND STORAGE

1) Precautions for handling

(1) If metals or metal compounds (dust, fume, etc.) are generated as a result of processing, heating, melting, or grinding this product, etc., the face, clothing, etc. shall be protected appropriately and ventilation shall be properly done in order not to exceed the exposure limits for the constituent elements. The hazardous properties of collected substances containing dust, fumes, etc., corresponding to the state thereof (oxides of constituent elements transformed to powder, etc.), shall be confirmed. For exposure limit values, the permissible exposure limit of “Japanese Society of Occupational Health”, of “ACGIH: American Conference of Industrial Hygienists” or “OSHA PEL: Occupational Safety and Health Administration” shall be used for reference purposes. The following are values of OSHA PEL.
Hexavalent chromium; 1mg/m^3, nickel; 1mg/m^3, manganese; 5mg/m^3, molybdenum; 15mg/m^3, copper fume; 0.1mg/m^3, copper dust; 1 mg/m^3)

(2) If metals are dissolved through pickling, descaling, etc., necessary measures shall be taken to prevent touching or inhaling of dissolved substances.
(3) It is necessary to wear protective gloves when handling the products in order not to hurt hands due to sharp cut sections.

2) Precautions for storage

(1) Keep the product away from water leakage, or acid /alkali liquid or materials that contain them and environments of high temperature and humidity

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Under normal circumstances, there is no need for exposure control or personal protection. Because the product is a solid with a fixed shape, there are no applicable items. However, in case of welding or grinding, etc., refer to clause 7 “HANDLING AND STORAGE” for further details.

9. PHYSICAL AND CHEMICAL PROPERTIES

(1) Physical properties
Shape : Solid in sheet form or band form
Color : Silver-white
Odor : Odorless
Melting point : 1400°C or higher
Density : 7~9 g/cm^3
(2) Chemical properties
- Not soluble in water.
- Dissolves to some extent in strong acids (hydrochloric acid, sulfuric acid, etc.) and high temperature alkalis. Oxidizing acids form a passive film.
- The dust generated by processing may be flammable or explosive.

10.CHEMICAL STABILITY AND REACTIVITY INFORMATION

Stability: Under normal circumstances, the product is chemically stable.
Hazardous decomposition products: Metal compounds and/or fumes are formed during heating, dissolving, melting, grinding, etc.

11. TOXICOLOGICAL INFORMATION

Under normal circumstances, the strip shaped product is stable. For the fumes generated during processing, refer to section 7 “HANDLING AND STORAGE” for further details. Certain types of steel grades may cause abnormalities on human skin when an allergic person contacts the products for long time.

12. ECOLOGICAL INFORMATION

Under normal circumstances, the product is not easy to be dissolved compared with carbon steel.

13. DISPOSAL CONSIDERATIONS

Can be recycled as stainless steel scrap.

14. TRANSPORT INFORMATION

No applicable information to this item.

15. REGULATORY INFORMATION

No applicable information to this item.

16. OTHER INFORMATION

Reference materials.
(1) Hazardous Substance Data Book (Tokyo Fire Department, Research Committee)
(2) Metallic Alloys and Harmonization of Classification Criteria (OECD)
(3) Safety Data Sheet for Chemical Products (ISO 11014-1)
(4) Recommended values of the Japan Industrial Hygiene Society, OSHA PEL, ACGIHTLV, etc.
(5) Industrial Safety and Health Law
(6) PRTR (Pollutant Release and Transfer Registers)

Cat.No.G1E-004-03

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