

JFE443 Family of Ni-free Stainless Steels with High Corrosion Resistance

1. Introduction

Stainless steels contain a large amount of additive elements such as Cr and Ni in order to obtain excellent corrosion resistance. In recent years, demand for consideration of the environment is increasing, and resource saving is also required in stainless steel. In 2005, JFE Steel developed JFE443CT containing almost no Ni, which is a scarce and expensive element¹⁾, and has widely popularized it. Recently, a lineup of Ni-free stainless steels named the JFE443 family was newly developed to enable use of Ni-free stainless steels in a wider range of applications. This paper introduces the features and examples of the application of the JFE443 family.

2. Features of JFE443 Family

2.1 Component Design

JFE443CT, JFE443MT, and JFE445NT, which are members of the JFE443 family, do not contain Ni, a

Table 1 Typical chemical composition of JFE 443 family (mass%)

Steel grade	C	Cr	Ni	Mo	Cu	N	Other
JFE443CT	0.01	21	—	—	0.4	0.01	Ti
JFE443MT	0.01	21	—	0.5	—	0.01	Ti, Nb
JFE445NT	0.01	22.5	—	1.0	—	0.01	Ti, Nb
SUS304	0.06	18	8	—	—	0.03	—
SUS316L	0.03	18	12	2.0	—	0.03	—

rare metal, as shown in **Table 1**. On the other hand, in order to obtain appropriate corrosion resistance in atmospheric environments, the Cr content in the chemical composition is increased to more than 20% and small amounts of Cu and Mo are added.

Reduction of corrosion resistance by precipitation of Cr carbonitride is suppressed by reducing C and N to around 0.01 mass% and adding Ti and Nb as stabilizing elements. As a result, the JFE443 family shows good corrosion resistance in welds without using welding wire.

2.2 Physical and Mechanical Properties

Since the steels in the JFE443 family are ferritic stainless steels, their properties are different in some respects from those of SUS304 and SUS316L, which are austenitic stainless steels.

Table 2 shows typical examples of the physical and mechanical properties of the JFE443 family. Because the JFE443 family has a lower density and smaller thermal expansion coefficient than SUS304, it is more suitable than SUS304 for applications in which thermal expansion becomes a problem, for example, in chimney inner walls. The JFE443 family is also characterized by high thermal conductivity, low electrical resistivity, and magnetism.

As shown in **Table 2**, the tensile strength of the JFE443 family is lower than that of SUS304, and elongation is about 30%, or half that of SUS304. On the other hand, since the *r* value, which is an index of deep drawing formability, is high and deep drawing formability is good, forming may be easier than SUS304,

Table 2 Typical physical property and mechanical property of JFE443 family

Steel grade	Thickness	Physical property			Mechanical property (Rolling direction)			
		Density	Young's modulus	Thermal expansion coefficient (0~650°C)	0.2% yield strength	Tensile strength	Elongation	<i>r</i> -value
		mm	g/cm ³	GPa	×10 ⁻⁶ /°C	MPa	MPa	%
JFE443CT	0.8	7.74	204	11.5	305	483	31	1.3
JFE443MT	0.6	7.69	210	11.1	321	484	30	1.5
JFE445NT	0.6	7.67	212	11.6	366	513	30	1.5
SUS304	0.8	7.93	193	18.4	279	652	57	1.0
SUS316L	0.8	7.98	193	18.5	268	588	55	0.9

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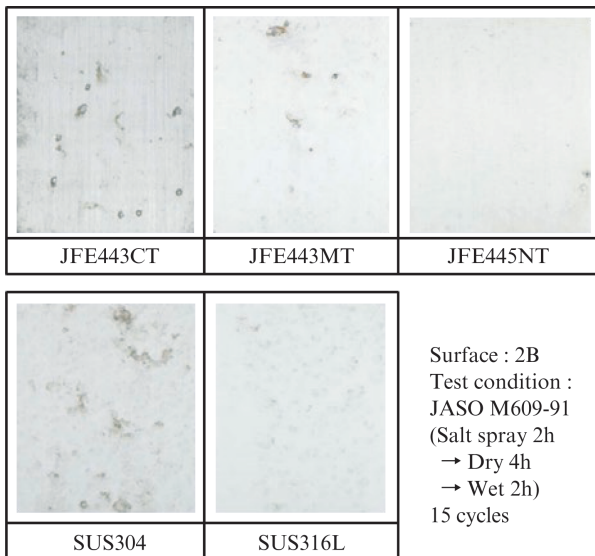


Fig. 1 Appearance of JFE443 family after cyclic corrosion test

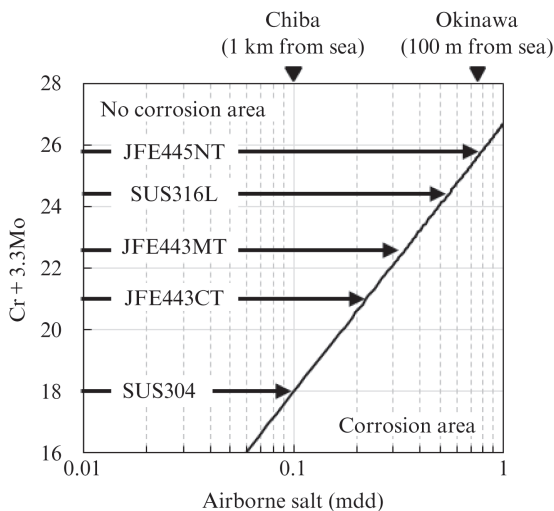


Fig. 2 Suitable environment of JFE443 family

depending on the forming method.

2.3 Corrosion Resistance in Atmospheric Environments

Figure 1 shows photographs of samples of the JFE443 family steels after a cyclic corrosion test. Corrosion of JFE443CT in a 15 cycle corrosion test was equivalent to that of SUS304. SUS316L showed slight corrosion, but JFE445NT showed good corrosion resistance in the cyclic corrosion test.

Corrosion of stainless steel in atmospheric environments can be arranged by the amount of airborne salt, and the amount of airborne salt at the limit where corrosion does not occur is decided in proportion to the pitting index $Cr + 3.3 Mo$. Figure 2 shows the suitable environment of the JFE443 family. In the environment about 1 km from the coast, corrosion may occur in

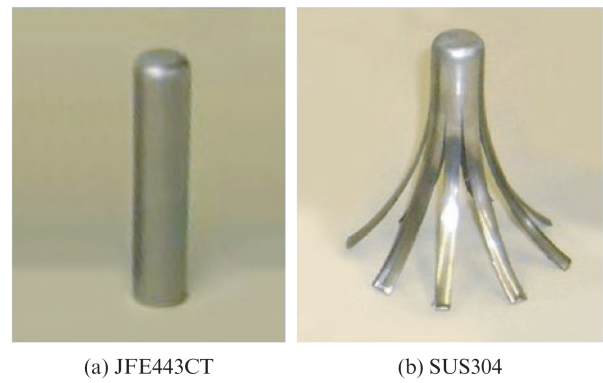


Fig. 3 Comparison of delayed failure between JFE443CT and SUS304 by multistage deep drawing

SUS304, but does not occur in JFE443CT and JFE443MT. JFE445NT is expected to show good corrosion resistance even in the environment about 100 m from the coast in Okinawa.

In this way, the optimum steel in the JFE443 family can be selected according to the corrosion environment.

2.4 Other Features of Workability and Corrosion Resistance

The JFE 443 family is characterized by its resistance to season cracking (delayed failure), which is often a problem in austenitic stainless steels. Figure 3 shows photographs of JFE443CT and SUS304 after the samples were formed in multiple stages and left for one day. JFE443CT kept the shape formed by deep drawing, while cracking occurred along the direction of deep drawing in SUS304.

The JFE443 family also has the feature of excellent resistance to stress corrosion cracking. In the 42% magnesium chloride stress corrosion cracking test prescribed in JIS G 0576, cracking occurs in about 4 h in SUS304 and SUS316L, while no cracking occurs in the JFE443 family even after 100 h.

3. Application Examples

JFE443CT has been applied to various applications such as building hardware, ducts, exterior materials of entrances and elevators, housings of electrical equipment and control panels, drums, kitchen equipment, and tableware since sales began in 2005. JFE443MT and JFE445NT are applied to applications requiring higher corrosion resistance, such as the drums and piping of electric water heaters.

4. Conclusion

The JFE 443 family is a group of ferritic stainless

steels capable of general handling, having not only excellent corrosion resistance which can substitute for SUS304 and SUS316L in atmospheric corrosion environments, but also other excellent features such as a low thermal expansion coefficient and no stress corrosion cracking. We hope that customers will consider the JFE 443 family as excellent corrosion resistance materials.

References

- 1) Ishii, K.; Ishii, T.; Ota, H. Ni- and Mo-Free Ferritic Stainless Steel with High Corrosion Resistance, JFE443CT. JFE Technical Report. 2008, no. 12, p. 39–44.

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