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JFE Steel's Ferritic Stainless Steel Thick Hot Bands

1. Introduction

The flanges used for the high temperature exhaust pipe near automobile engines have always been made from carbon steel plates, but in recent years, the exhaust gas temperature has tended to be higher and the EGR (Exhaust Gas Recirculation) cooler has been adopted for high temperature exhaust pipes to meet the needs of environmental load reduction and fuel efficiency improvement. As a result, these flanges are now required to have high temperature durability and light weight. In this situation, the flanges used in this high temperature application are now made from ferritic stainless steel plates, which have higher high temperature strength than carbon steel. However, low productivity is a problem because the plates are produced one by one by the plate hot mill and must also be annealed and pickled individually.

To overcome this problem, in 2014 JFE Steel developed a hot rolling[1)] and coiling technology for ferritic stainless steel which is used in high temperature flanges and has a thickness of over 6 mm. This process, in which the product is produced as strips (coils), enables continuous annealing and pickling, and has made it possible to produce and supply ferritic stainless steel over 6 mm thick by using the hot strip mill, which has high productivity as hot band in coil compared with ferritic stainless steel plates. **Photo 1** shows the appearance of an exhaust pipe flange made from JFE Steel's thick hot band of ferritic stainless steel JFE436LT.

The following introduces the ferritic stainless steel thick hot bands with thickness over 6 mm produced by JFE Steel.

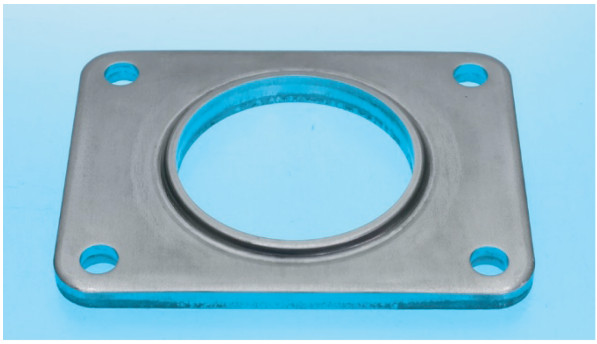

Photo 1 Exhaust pipe flange made of JFE Steel's ferritic stainless steel thick hot band

Table 1 Grades of ferritic stainless steel thick hot bands

JFE Steel's Grade	JIS Grade	Main chemical composition (mass%)				
		Classification	Cr	Mo	Cu	Others
JFE409L	SUH409L	Spec.	10.50-11.75	—	—	Ti
		Typical	11.02	—	—	0.23
JFE439L	SUS430LX	Spec.	16.00-19.00	—	—	Ti
		Typical	17.43	—	—	0.30
JFE436LT	SUS436L	Spec.	16.00-19.00	0.75-1.50	—	Ti
		Typical	17.87	1.20	—	0.29
JFE430CUN	SUS430J1L	Spec.	16.00-20.00	—	0.30-0.80	Nb
		Typical	19.20	—	0.52	0.43

2. Ferritic Stainless Steel Hot Band

2.1 Available Grades and Mechanical Properties

Table 1 shows the thick hot band grades of ferritic stainless steel which are currently produced by JFE Steel. JFE Steel now produces four grades of thick hot bands, and three of them are Ti-added corrosion resistant ferritic stainless steels for mufflers.

Table 2 shows the mechanical properties of the thick hot bands of ferritic stainless steel now produced at JFE Steel. According to Table 2, these thick hot bands have sufficient tensile strength as specified in the standard.

2.2 Available Thicknesses

Table 3 shows the available thicknesses of the thick hot band of ferritic stainless steel now produced at JFE Steel. Basically, thick hot bands up to 8 mm thick are annealed and pickled white hot bands, and thick hot bands exceeding 8 mm are annealed black hot bands with scale.

2.3 High Temperature Strength

Figure 1 shows the high temperature strength of the thick hot bands of ferritic stainless steel at each temperature. According to Fig. 2, the four thick hot band grades possess excellent high temperature strength, and

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Table 2 Mechanical properties of ferritic stainless steel thick hot bands

JFE Steel's Grade (Thickness)	JIS Grade	Mechanical property				
		Classification	0.2% Proof Stress (MPa)	Tensile Strength (MPa)	Elongation (%)	Hardness HRB
JFE409L (8 mm)	SUH409L	Spec.	175≦	360≦	25≦	≦80
		Typical	276	383	42	74
JFE439L (8 mm)	SUS430LX	Spec.	175≦	360≦	22≦	≦88
		Typical	289	396	44	79
JFE436LT (8 mm)	SUS436L	Spec.	245≦	410≦	20≦	≦96
		Typical	306	435	42	83
JFE430CUN (6.5 mm)	SUS430J1L	Spec.	205≦	390≦	22≦	≦90
		Typical	324	444	40	83

Table 3 Thickness of ferritic stainless steel thick hot bands

Thickness (mm)	: Manufacturing / : Not manufacturing; : White band / : Black band			
13.0	13.0 mm			
12.0				
11.0				
10.0				
9.0				
8.0		8.0 mm	8.0 mm	
7.0				
6.0				6.5 mm
Grade	JFE 409L	JFE 439L	JFE 436LT	JFE 430CUN

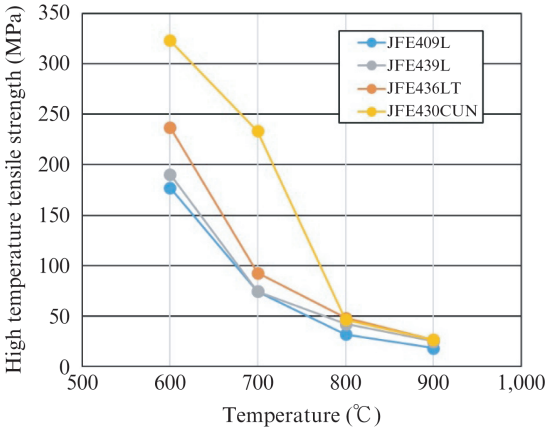

Fig. 1 High temperature tensile strength of JFE409L, JFE439L, JFE436LT, JFE430CUN

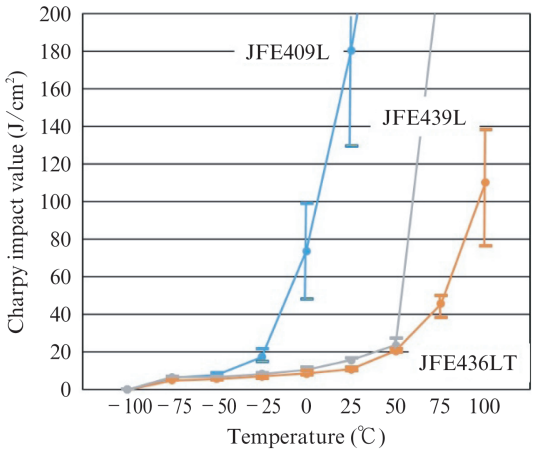

Fig. 2 Charpy impact value of JFE409L, JFE439L, JFE436LT (Thickness: 8 mm)

thus are suitable for flanges used at high temperatures.

3. Notes on Processing of Thick Hot Bands of Ferritic Stainless Steel

Because thick hot bands of ferritic stainless steel such as Ti-added JFE439L and JFE436LT display low temperature brittleness, as indicated in **Fig. 2**, these materials may sometimes crack during slitting, shearing, blanking, pressing and hole drilling in winter. The precautions when using thick hot bands of ferritic stainless steel by slitting, shearing, blanking, pressing drilling, etc. are as follows[2, 3]:

(1) When slitting, shearing or blanking thick hot bands of ferritic stainless steel, the clearance of the cutter and mold are always to be adjusted appropriately.
(2) When blanking parts, fine blanking should be adopted.
(3) In winter, thick hot band of ferritic stainless steel should be warmed before slitting, shearing, blanking, pressing, drilling, etc.

Because these products are hot rolled strips, the surface of the thick hot bands of ferritic stainless steel includes some pits or rough surface areas with a depth of 50 to 100 μm. When thick hot bands are used in flanges which require good air tightness, we recommend that the surface be polished more than 150 μm.

4. Summary

JFE Steel's thick hot bands of ferritic stainless steel and notes on slitting, shearing, blanking, pressing and drilling were introduced.

Because these thick hot bands of ferritic stainless steel are produced in coils, parts such as flanges which have been produced individually from plates so far, can now be produced continuously by using coils. As a result, a remarkable increase in the productivity of part manufacturing is expected.

References

1) Yamashita, H.; Ujiro, T.; Yaginuma, H. Outline of Stainless Steel Business in JFE Steel. JFE Giho. 2008, no. 20, p. 1–9.

2) Hamada, J.; Urashima, H.; Hayashi, T.; Hirade, N.; Fudanoki, F. Development of Ferritic Stainless Hot-Rolled Steel Sheets for Exhaust Pipe Flange. JSAE 2018 Annual Congress (Spring). Program no. 080.
3) Koseki, N.; Aoki, I. Series: Practical Press Forming Learning from the Basics − Press Punching. Nikkan Kogyo Shinbun. 199p. (p. 124–133.)

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https://www.jfe-steel.co.jp/en/products/stainless/thin_steelsheet.php