

## 2.25%Cr-1.6%W Ferritic Steel for Boiler Piping and Tubing Applications<sup>†</sup>

### 1. Introduction

In thermal power plants, relatively high temperature and/or pressure steam conditions are essential from the viewpoint of improving thermal efficiency. To meet this need, further improvement in the performance of boiler piping and tubing is also required. From an early date, JFE Steel focused its attention on the tensile properties at elevated temperature, steam oxidation resistance, weldability, and high economy of ferritic alloy steels, and developed and produced seamless pipes by the Mannesmann process, which offers excellent production efficiency.

The steel pipe introduced in this report is a 2.25%Cr-Nb-V steel added W. Tensile properties at elevated temperature were remarkably improved, achieving a level equivalent to those of 9%Cr-1%Mo-Nb-V steel, while maintaining excellent weldability equal to that of 2.25%Cr-1%Mo steel.

### 2. Features of W-Added 2.25%Cr Steel Pipe

JFE Steel obtained the chemical composition patent<sup>1)</sup> for this steel in the 1980s and has realized the following advantages, which are unique to JFE Steel, with the composition design (Table 1) of this steel pipe.

- (1) Low C and N contents result in good weldability (Fig. 1). Preheating and post weld heat treatment are unnecessary, and the crack resistance of the heat affected zone (HAZ) was improved.
- (2) The low Al content, which was reduced to the minimum possible limit, results in good creep properties (Fig. 2).

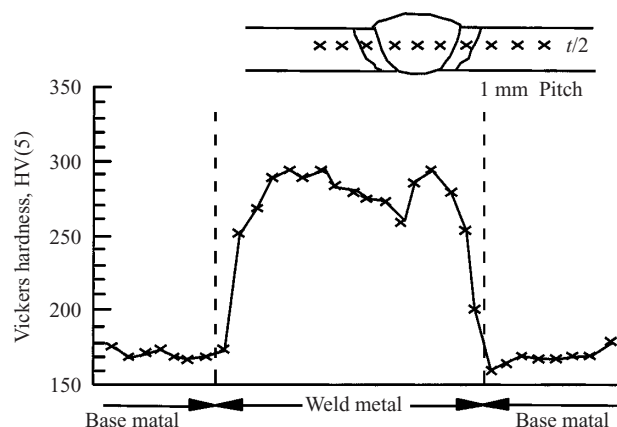


Fig. 1 Hardness distribution of welded joint (OD50.8 mm × 8.0 mm, Non preheating)

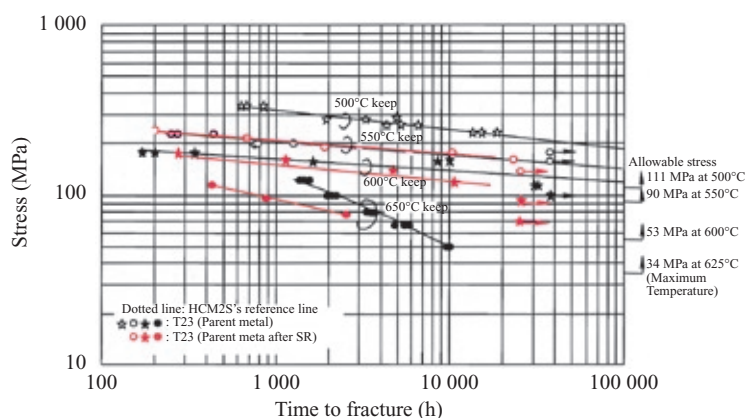


Fig. 2 Creep rupture strength of T23 compared the thermal and nuclear power (HCM2S)<sup>2)</sup>

Table 1 Chemical composition of T23

	(mass%)												
	C	Si	Mn	P	S	Cr	Mo	V	Nb	W	B	N	Al
ASME Specification	0.04–0.10	Max.: 0.50	0.10–0.60	Max.: 0.030	Max.: 0.010	1.90–2.60	0.05–0.30	0.20–0.30	0.02–0.08	1.45–1.74	5–60 ppm	Max.: 0.030	Max.: 0.030
JFE Steel Aim	0.055	0.20	0.43	Max.: 0.024	Max.: 0.010	2.25	0.10	0.25	0.06	1.65	30 ppm	Max.: 0.005	0.002

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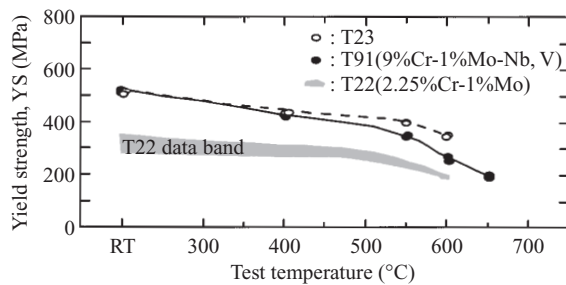


Fig.3 Yield strength of T23 at elevated temperature

- (3) The high W, high Nb and high V composition design results in tensile properties at elevated temperature approximately 1.8 times higher than those of the conventional 2.25%Cr-1%Mo steel (**Fig. 3**).

In addition to these features, this steel also offers the numerous other advantages long associated with JFE Steel's piping and tubing for boiler applications, including (1) guaranteed high dimensional accuracy by hot finishing, (2) availability of extra length (maximum: 22.3 m) products, and (3) a quality assurance system using triple NDE (MLFT-ET-UT).

### 3. Development from Tubes to Pipes

At present, the primary application of this steel is tubes. However, because the excellent performance and economy of this steel are also suitable for pipe products, application as steam piping and headers is expected.

In the development of this steel to pipe products, JFE Steel has completed the creation of a system for standard

production and aims at penetration of the market by providing features which include (1) availability of medium diameter extra-heavy wall pipes and (2) excellent impact properties resulting from a low N design.

### 4. Conclusion

A new steel for boiler piping and tubing application with remarkably improved tensile properties at elevated temperature was developed while maintaining the properties of ferritic alloy steels, including high thermal conductivity, low thermal expansion, and good weldability.

By enabling the use of thinner/lighter weight pipes, this new product offers important advantages to the customer, as it contributes significantly to cost reduction and improved freedom in equipment design.

Today, when the world's attention is drawn to global environmental problems, higher efficiency in thermal power plants, which are large consumers of fossil energy, and effective use of natural energy, are important challenges. To ensure that JFE Steel's piping and tubing for boiler applications, beginning with this pipe, continue to contribute to environmental improvement from the material side, in the future, JFE will promote the development of products with a wide range of unique and original features.

### References

- 1) Japan Patent 2093148. 1996-09-18.
- 2) The Thermal and Nuclear Power. vol. 47, no. 2, 1996, p. 68.