Steel Products for Shipbuilding†

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Abstract:

Product designs and properties of 6 steel products for shipbuilding are described. They are new TMCP (thermo-mechanical control process) steel plates, weldable with high heat input, for container ships and LP (longitudinal profle) plates, both contribute to the increase in productivity at shipyards through the large reduction of welding time, anti-corrosion steel plates for crude oil tankers NAC5 which contribute to high performance of ships from the viewpoint of corrosion, cladded steel plates for chemical tankers, anti-corrosion pipes, JFE-MARINE-COP, used in crude oil tankers for loading and unloading crude oil, and shapes for shipbuilding which are produced using TMCP to realize weldability as good as steel plates.

1. Introduction

In recent years, the shipbuilding industry has energetically promoted high performance of ships and improved productivity in construction in response to vessel diversifcation (trend toward exclusive-use ships). In the process, the industry has also pointed out a variety of developmental needs related to steel products, resulting in the creation of new technologies and new products.

This report describes the product design concepts and properties of the following 6 products which were developed by JFE Steel in response to these needs. In the feld of plate, they include new TMCP (thermo-mechanical control process) steel plates for high heat input welding for container ships, which contribute to improved productivity by greatly reducing welding working time, and LP steel plates (longitudinally profled plates, also called taper plates), new anti-corrosion steel plates for crude oil tankers, NAC5, which contribute to higher performance in ships through improved corrosion resistance, and clad steel plates for chemical tankers. Tubular products include JFE-MARINE-COP for crude oil tankers, which improves corrosion wear performance in onboard oil receiving pipes used in loading and unloading crude oil. Among shape steels, JFE Steel has developed TMCP technologies for shapes for shipbuilding which provide weldability equal to that of plates.

2. Steel Plates

2.1 Steel Plate for High Heat Input Welding "EWEL"

With the increase in long distance freight transportation in recent year, the size of container ship has been enlarged rapidly, and even 8 000 TEU (TEU: twenty-feet equivalent unit) class container ships are being constructed recently. To construct such large-scale container ships, high strength and thick steel plates are used, such as 390 N/mm^2 class yield strength and maximum thichness of 65 mm or more. For welding of these thick plates, 1-pass vertical electro gas arc welding (EGW),

† Originally published in *JFE GIHO* No. 2 (Nov. 2003), p. 37–44

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Fig. 1Concept of developing high strength steel plates, “EWEL”, for high heat input welding

which has high welding ef f ciency, has been applied, and the heat inputs in these welding reach ultra-high level Ĭ

Fig. 2 Charpy impact energy of welded joint of EH40 plate

Table 1 Charpy impact energy of KL37 plate

2.2 New Anti-Corrosion Steel for Crude Oil Tankers “NAC5”

As illustrated in **Fig. 3**, the area under the upper deck in crude oil tankers is exposed to mixed atmosphere of exhaust gas and H_2S volatilized from the crude oil. As this area is also subject to cyclic condensation and evaporation of sulfur during day and night, a type of corrosion peculiar to the under deck area, called “vapor space corrosion”, occurs. The average corrosion rate in vapor space is about 0.1 mm/y. However, considering the life of a crude oil tanker to be approximately 20 years, the possibility of deck plate replacement increases. Without replacement of deck plate which cost is very expensive, the resulting ship reliability may be lower.

JFE Steel developed a new anti-corrosion steel for crude oil tankers, NAC5 (New Anti-Corrosion No.5) that can extend the service life of deck plates by approximately 5 years, with the use of ship primer. NAC5 also has excellnt weldability, which is an essential property in shipbuilding materials. JFE Steel produces YS235–355 N/mm^2 class NAC5 plates and shapes in A and D grade.

Figure 4 shows a cyclic corrosion test results simulating the corrosion environment under the upper deck plate with NAC5 and conventional steel without shop

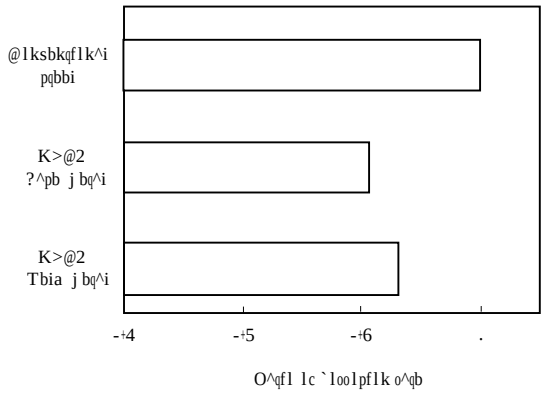

Fig.4 Corrosion test results of NAC5 and conventional steel (Gas : CO_2-SO_2-H_2S-O_2-N_2, 720 h)

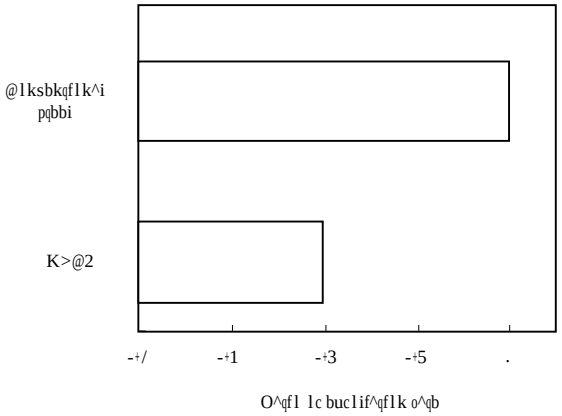

Fig.5 Corrosion test results of cross cut specimens coated by shop primer

Fig.3 Illustration of corrosion under upper deck plate in crude oil tanker

2.4 Clad Steel for Chemical Tankers

Clad steel is a type of composite steel plate in which stainless steel plates or other material (called cladding or clad material) is bonded to one or both sides of a carbon steel or low alloy steel plate (base material). Accordingly, while clad plates possess the strength required in structural members (function of base material), they simultaneously have corrosion resistance or other functions (function of cladding), and are therefore a high performance material with properties which would be difficult to realize in a single material.

Recent years have seen an increasing number of cases in which stainless clad plates were used as hull material for chemical tankers (**Fig. 11**). The cladding (stainless steel) of stainless clad plates for chemical tankers is required to provide corrosion resistance against numerous kinds of chemical cargos, while the base material (carbon steel)

3. Steel Pipes

3.1 Cargo Oil Pipe for Crude Oil Tankers "JFE-MARINE-COP"

Because the onboard piping of oil tankers which is used to load and unload crude oil and seawater, called cargo oil pipes, is exposed to a seawater environment containing crude oil on both the outer and inner surfaces, painted 400 MPa class steel pipes (STPY 400) or Cr-added cast iron pipes are normally used. Moreover, in addition of resistance to seawater corrosion, cargo oil pipes must also have corrosion wear resistance. For this application, the company developed and brings to market a seawater-resistant pipe, JFE-MARINE-COP, which has both the equivallent weldability of 400 MPa steel pipe and the corrosion resistance and corrosion wear resistance of cast iron. The following describes the features and service performance of JFE-MARINE-COP.

3.2 Features of JFE-MARINE-COP

Table 6 shows the chemical composition and manufacturing process of JFE-MARINE-COP. Cu, Ni, and Cr are added to improve seawater corrosion resistance, and Ca is added to prevent preferential corrosion of welds. In the manufacturing process, controlled rolling and JFE Steel's on-line accelerated cooling device, *Super*-OLAC, are applied to secure a homogeneous bainite structure.

The corrosion rate in artificial seawater at 50°C tends to decrease as Cr addition is increased. As shown in **Fig. 12**, JFE-MARINE-COP with 1% Cr addition shows a corrosion rate of around 50% that of 400 MPa class stturf 0% tha f add