High-Strength Titanium-Oxide Bearing Tether Pipe for Tension Leg Platform

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ABSTRACT

A study was made on the manufacturing technology of heavy wall API X70 UOE tether pipe applying thermomechanical control processing (TMCP) plate for tension leg platform (TLP). The requirements for tether pipe for TLP are very severe in both pipe shape and mechanical properties. Titanium-oxide bearing steel (Ti-O steel) is effective in improving the heat-affected zone (HAZ) toughness in the seam weld of UOE pipe made by double submerged-arc welding. The effect of carbon, manganese and niobium contents on the HAZ toughness of Ti-O steel to improve HAZ toughness as well as the optimum expanding condition in the UOE pipe making process to improve roundness and straightness of pipe have been studied. The heavy wall API X70 UOE pipe manufactured in the mill exhibited good roundness and straightness, as well as excellent low-temperature toughness. The commercial heavy wall API X70 UOE pipe shipped to the North Sea in 1993 was the first practical application of the TMCP tether pipe in the world.

KEY WORDS

depth water, TLP (tension leg platform), tether pipe, low-temperature toughness, HAZ (heat-affected zone), roundness, straightness

1. INTRODUCTION

With the exploitation of oil and natural gas resources in deep water, the use of tension leg platforms as offshore platforms has been increasing. The requirements for tether pipe for TLP are very severe in both pipe shape and mechanical properties. In addition to heavy wall thickness, high strength and good low-temperature toughness, excellent roundness and straightness of pipe are required to increase the fracture toughness to alternating loads caused by waves and tides. Tether pipes made by heat treatment of the whole pipe have been put into practical use, but this manufacturing method is inferior in both productivity and production cost. Today, it is possible to manufacture heavy wall UOE pipe having high strength and low-temperature toughness by applying TMCP technology.

This paper describes the manufacturing technology and the properties of heavy wall API X70 UOE tether pipe made of TMCP plate, with emphasis on the effect of carbon, manganese and niobium contents on the HAZ toughness of Ti-O steel, and the optimum expanding conditions in UOE pipe making to improve roundness and straightness of pipe.

2. ACCELERATED COOLING AFTER ROLLING

In order to manufacture the heavy gauge plates of high strength and good toughness with low carbon equivalent (Ceq), TMCP technology has been developed and put into practical use. Accelerated cooling technology was developed to improve the mechanical properties of plates by water cooling immediately after rolling under optimum cooling conditions. It is applied in combination with microalloying and controlled-rolling technologies. The accelerated cooling is roughly divided into two types as shown in Fig.1. Type I is a direct quenching and tempering (DQT) process and type II is an interrupted accelerated cooling in which the plate is subjected to water cooling at a moderate cooling rate only in the transformation temperature region, and then to air cooling (IAC process). The self tempering effect of the interrupted accelerated cooling provides excellent ductility and toughness without tempering.

![Fig.1 Schematic illustration of accelerated cooling process.](image-url)