New Developments on Arctic Steels by Application of TMCP Technology

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ABSTRACT

Explorations of new oil and gas fields in harsh arctic surroundings and the possibility of passing through the Northeast Passage lead to new challenging requirements for offshore constructions. Further developments of steel grades are of basic importance to meet the increasing demand on plates for structural applications.

The challenging new requirements for existing steel grades are an improved toughness at lower temperatures without decrease of strength and an adapted weldability.

Therefore, advanced base material properties of heavy plates as well as HAZ (Heat Affected Zone) behaviour have been developed by optimizing of the chemical composition and utilization of TMCP (Thermomechanical Controlled Process) technology.

In this paper, the development of high-strength heavy plates with improved low temperature toughness is described and illustrated with a recent application. Plates of grade S420G1/2 up to 65 mm thickness and Charpy impact properties down to -80 °C and CTOD (Crack Tip Opening Displacement)-properties down to -50 °C were successfully produced and delivered for the construction of an offshore loading tower in Siberia.

KEY WORDS: Offshore; steel development; arctic; low temperature; CTOD.

INTRODUCTION

During the last years, the demands on constructions and therefore on steel plates have been increased. Because of the low actual oil-price the investigations in the arctic region were reduced (Reuter, 2015; Meinert, 2015). However, there is still a rising potential for more export terminals in Arctic areas due infrastructure constraints over land because of the possibility of passing through the Northeast Passage. Thus more offshore constructions like terminals and platforms can be expected for the future (Fig. 1). Lower ambient and service temperatures have to be considered. Lowest Anticipated Service Temperature (LAST) in the North Sea is -10 °C, whereas structures in the arctic region should anticipate for a service temperature between -50 and -60 °C. In order to ensure safe service in winter periods, sufficient fracture toughness shall be proven for highest thickness involved at the anticipated LAST.

Weldability testing of the applied materials is used to ensure sufficient fracture toughness after fabrication welding. GCHAZ (Grain Coarsened Heat Affected Zone) and IC/SCHAZ (Intercritical/Subcritical Heat Affected Zone) are verified for fracture toughness while welded with the ultimate lowest and highest heat input anticipated during fabrication welding. Arctic application represents the severest challenge for structural steel plates. In order to improve the workability and weldability one aim of the design of the production of steel plates is to reduce the carbon equivalent.

A precise understanding of the metallurgical mechanisms and parameters controlling the microstructural evolution during processing provides the basis for a customized and optimized design. The most important elements of the metallurgical approach are low carbon chemistry, a well balanced alloying, good reproducibility of a high level of steel cleanliness and homogeneity.

The availability of high quality slabs and the use of TMCP technology (DeArdo, 2009; Schütz, 2001; Schwinn, 2011) makes tailor-made solutions for demanding applications possible.