High-performance Steels for Energy Exploration

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ABSTRACT

While consumption of energy in the world is rising, there is growing interest in high-performance steels for energy exploration. This includes steel for low temperature applications, i.e. storage of liquefied gas (Ni-steels) as well as steels for offshore applications and line pipe steels. Modern high-performance steel grades with high strength or special mechanical properties produced by sophisticated metallurgical, rolling and heat treatment techniques fulfil the demands and enable the construction engineers to gain economical and ecological advantages during operation and manufacturing of constructions in the field of energy exploration, especially by light-weight construction. In spite of the increased usage of steels with higher strength these steels feature an outstanding tenacity, an advantageous cold forming quality and an excellent suitability for welding. The evaluation of the modern high-strength steel plate components by novel safety concepts, based on fracture mechanics, has shown additionally, that those steels exhibit a toughness level permitting safe operation of welded structures even under critical service conditions.

KEY WORDS

High-Strength Steels, Shipbuilding, Offshore-Constructions, Nickel Steels, Fracture behaviour, Linepipe steels

INTRODUCTION

Special applications in the manufacturing of constructions for energy application require materials which fulfill special demands. Modern steel production techniques make steel grades available that perfectly fit to these demands regarding their mechanical and functional properties. These modern high-performance steel grades are produced by a specific cycle of deformation and heat treatment processes combined with highly sophisticated metallurgical techniques. Production, processing behaviour, properties and fields of application for modern high-performance steel grades for energy applications are shown in particular for nickel steels for low temperature applications and high-strength steels for offshore constructions. Additionally a short overview of the basic features of plates for line pipe application is given.

PRODUCTION AND PROCESSING OF MODERN HIGH STRENGTH STEEL GRADES

The development of high-strength structural steels, which began at ThyssenKrupp Steel already approximately 40 years ago, is shown in (Fig. 1).

Fig. 1: Development of high strength steel grades

The desired minimum yield strengths of modern steels can only be achieved through special metallurgical, rolling and/or heat treatment techniques. Steels with higher yield strengths are produced by thermomechanical rolling (TM), thermomechanical rolling in combination with accelerated cooling (TM & ACC) or water quenching and tempering (QT).

The use of techniques like TM-rolling or quenching and tempering requires at first an adequate steel compositions and alloying concepts, which could only be reached by progress in metallurgy. Modern ladle metallurgy relieves the converter process and allows a very precise attitude of the targeted chemical composition. The processing steps of steelmaking for modern high-performance steel plates are shown in (Fig. 2).