Effect of Severe Hot Forging and Boron on Mechanical Properties of Carbon Steel

by

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Abstract

Thermomechanical process (hot forging followed by controlled cooling) is one of the common methods to refine microstructure and consequently enhances mechanical properties. Boron is an element that is used for pinning and refining microstructure. Boron is always added together with other alloying elements which are stronger nitride or carbide formers, such as Ti and Nb. Microalloying with boron produces high amounts of BN and BCN which refine the microstructure. Refining the microstructure is the optimal way to enhance strength, ductility and low temperature impact resistance (toughness).

Low carbon bainitic steels microalloyed containing Nb, Ti and V are widely used for the pipeline, construction and automobile industries because of their excellent combination of strength, toughness and weldability. The purpose of adding boron is to improve the hardenability of the steel by promoting bainite or martensite formation.

The purpose of this work is to find out the effect of different boron content and different cooling rates on the microstructure and mechanical properties of thermomechanically carbon steel.

Three alloys were cast with different boron content, dilatation studies were carried out on these alloys to determine critical transformation temperatures. The alloys were then subjected to thermomechanical processing starting at temperature of 1200˚C finishing by air, oil or water quenching. Tensile, hardness and impact tests were carried out at room temperature. Metallographic investigation was carried using optical and scanning electron microscope.

Results show that changing Boron content changes the behavior of steel during thermomechanical processing. Increasing amount of hot reduction refines microstructures. Increasing cooling rate increases the added value of the steel by increasing hard phase formation. Boron has a strong effect in refining microstructure. Increasing cooling rates after hot forging increase strength.