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DEVELOPMENT OF HIGH STRENGTH LOW CARBON LEAN MICRO-ALLOYED STEEL WITH OPTIMIZED TOUGHNESS

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ABSTRACT

Strengthening by microalloying permits a remarkable reduction in carbon content which greatly improves weldability and notch toughness. As the strength requirement has increased, a shift from traditional ferrite/pearlite (FP) microstructure produced by a conventional alloy design to a ferrite/acicular ferrite (F/AF) microstructure has been necessary. The ultimate steel microstructures and final properties of steel are shown to be highly dependent on both controlled rolling and accelerated cooling conditions. Two steel grades one having richer chemistry alloyed with Nb-V-Mo-Ti and other lean chemistry with Nb-Ti addition thermomechanically processed in such a way that Mo containing steel yielded polygonal ferrite-bainite structure. Whereas, high reduction per pass and high cooling rate in Nb-Ti steel resulted into fine acicular ferrite and bainite microstructure. This steel possessed attractive properties in terms of YS: 584-592MPa, UTS: 763-803MPa, %EL: 29-31, YS/UTS: 0.72-0.77 and charpy impact energy of 210-222J compared to that of Nb-V-Mo-Ti bearing steel with polygonal ferrite and bainite structure with YS: 487-490MPa, UTS: 566-576MPa, %EL: 32-34, YS/UTS: 0.84-0.86 and Charpy impact energy of 328-344J. The properties so achieved have been related to microstructural variations from polygonal ferrite and bainite to acicular ferrite and bainite.

Keywords: Nb-Ti micro-alloyed steel, Reduction schedule, Temperature after ACC, Cooling rate, Solid solution and precipitation strengthening, Acicular ferrite and bainite