

The Effects of Vanadium, Niobium, Titanium and Zirconium on the Microstructure and Mechanical Properties of Thin Slab Cast Steels

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SUMMARY

The evolution of precipitation and microstructure during a simulation of the thin slab direct rolling process, in six vanadium based, low carbon, steels with V, V-N, V-Ti-N, V-Nb, V-Nb-Ti and V-Zr additions was studied by optical microscopy, analytical transmission electron microscopy (TEM), energy dispersive X-ray analysis (EDAX) and parallel electron energy loss spectroscopy (PEELS). Tensile properties and Charpy vee-notch toughness of the final strip were also determined. The effects of microalloying additions and processing conditions, including equalisation temperature (1200°C, 1100°C and 1050°C) and end water cool temperature, on the austenite and ferrite grain sizes, as well as the type and composition of the precipitates, were determined. The relationship between the microstructure and the properties in the steels was also ascertained.

KEY WORDS: vanadium, nitrogen, vanadium-niobium, vanadium-titanium, vanadium-zirconium microalloyed steel; thin slab direct rolling; equalisation temperature; end water cool temperature; microstructure; precipitation; mechanical properties.

INTRODUCTION

Thin slab casting and direct rolling (TSDR) technology has brought global changes to manufacture of hot rolled coil, due to its higher productivity and lower energy requirement. However, both the microstructural development during TSDR and the mechanical properties of the final coil may be expected to differ from equivalent steels which have undergone conventional rolling (CCR).¹⁻⁴⁾

Compared with the thick slabs (200-250mm) used in CCR, thin slabs (30-90mm) are cast at higher speeds (up to 6 m/min) and the rapid solidification results in reduced segregation.⁵⁾ In CCR processing, the austenite is metallurgically conditioned by the phase transformations that occur during slab cooling and reheating. The austenite grain size after soaking and at the start of the rolling process is then usually smaller than it was in the original cast slab, being