

A Review of Vanadium Microalloying in Hot Rolled Steel Sheet Products

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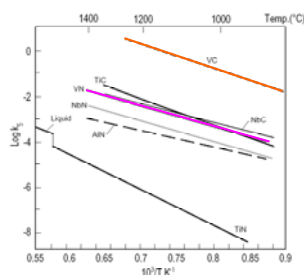
Today I would like to present an overview of the advantages of vanadium as a microalloy addition for hot rolled sheet steel products. Several microalloy systems are available to the sheet metal producer, including niobium, titanium and vanadium. Vanadium has generated renewed interest as a microalloy for sheet products with the advent of the new thin slab direct rolling mills, where processing limitations have highlighted some of vanadium's unique advantages.

Important Metallurgical Properties of Vanadium In Steel

- High Solubility of V(C,N) in Austenite
- Low Solute Drag Coefficient of V in Austenite
- Nitrogen is the Preferred Element in V(C,N) Precipitation

The important metallurgical properties of vanadium in steel can be grouped into three main categories, with property and processing benefits resulting from each major feature. The first metallurgical property to be discussed is the high solubility of the carbonitrides of vanadium in austenite. Second, the benefits of the low solute drag coefficient of vanadium, often not considered when rolling flat products, will be reviewed. And last, the positive interaction of vanadium with nitrogen which provides an effective use of the residual nitrogen in steel will be discussed.

Solubility of Microalloy Carbides and Nitrides



This chart shows the relative solubility of various forms of microalloy carbides and nitrides. First note that for each of the microalloy elements, the carbide form is more soluble than the nitride. The solubility of VC is very high, easily dissolving in austenite, and only precipitating on cooling after the ferrite has formed. TiC, NbC, and VN have very similar solubility, which is interesting because they are by far the most important of the precipitation strengtheners. The difference in solubility between the carbide and nitride forms of each microalloy is much larger for Ti and V than for Nb. Since the solubility of C in austenite is high, the C level in the steel will control the amount of Nb dissolved in the austenite during reheating. The carbon level has virtually no effect on the solubility of vanadium during reheating. For titanium, the nitride form is virtually insoluble at normal reheating