BUSHVELD VAMETCO ALLOYS

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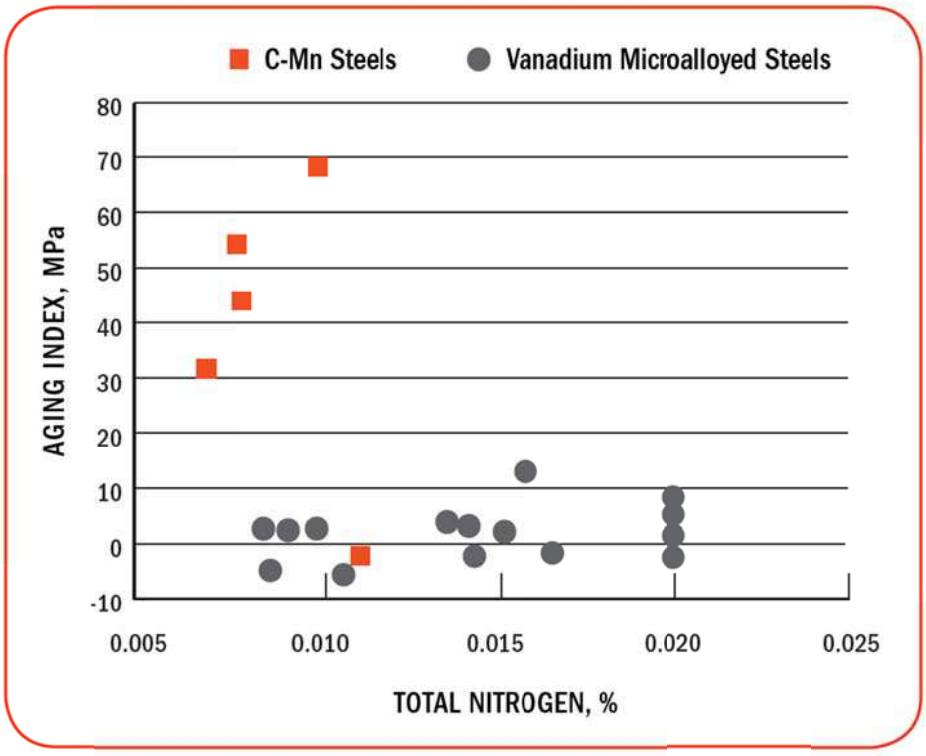
Concerned About Strain Aging? Not When Vanadium is Present!

For some steelmakers, adding nitrogen would seem to be the fastest way to send a heat to the scrap yard. So-called "free" nitrogen causes strain aging in carbon steels, increasing yield strength and brittleness after cold working. Strain aging is particularly detrimental in sheet products where it reduces formability. However, when a nitride former such as vanadium is present, nitrogen does an about face and becomes an extremely useful element. In high-strength, low-alloy steels – commonly called HSLA steels – nitrogen combines with vanadium to become a very cost-effective strengthener. Of the three nitride-forming elements – vanadium, aluminum, and titanium – vanadium is the only element that effectively strengthens steel by combining with nitrogen.

Commercial Verification

A technical paper presented at ISSTech 2003 in Indianapolis in April 2003 showed that vanadium sharply reduced strain aging in commercial HSLA steels. As shown in the graph below, plain-carbon steels containing as little as 0.006% nitrogen showed significant strain aging after simulated coil cooling. On the other hand, strain aging was virtually eliminated in vanadium-strengthened HSLA steels containing as much as 0.020% nitrogen.



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No Strain Aging When Vanadium Is Present!

This is good news for steelmakers using electric-arc furnaces since this process can yield over twice as much nitrogen as the basic-oxygen furnace. With an ever-increasing percentage of steel being made in the electric-arc furnace, the average nitrogen level of steel products is constantly rising. Using vanadium to strengthen high-strength, low-alloy steels converts nitrogen from an undesirable impurity into an effective alloy. Steelmakers melting in basic-oxygen furnaces can also safely obtain additional strengthening from their vanadium additions by raising the nitrogen level of steel. In the presence of vanadium, this higher nitrogen does not create a strain-aging problem.

Lower Costs, Too

The additional strength obtained from nitrogen allows steelmakers to reduce strengthening costs in high-strength, low-alloy steels. Without nitrogen, up to 40% more vanadium is needed to reach the same strength that is achieved when vanadium and nitrogen act together as vanadium nitride. As a result, vanadium and nitrogen can reduce vanadium-strengthening costs by between 20 and 40%. That's the reason for the popularity of Nitrovan® vanadium -an alloy that helps steelmakers achieve the vanadium-to-nitrogen ratio that optimizes strength. Available in 12% and 16% nitrogen grades, the product supplements the nitrogen in the steel bath while providing vanadium for vanadium-nitride strengthening. To obtain maximum strengthening from these two elements, the natural slow-cooling cycle of the coil should be completed after rolling. This cycle maximizes the precipitation of vanadium nitrides that provide strengthening while eliminating strain aging. For strip steels, coiling temperatures of 600 to 630 deg. C (1,100 to 1,150 deg. F) followed by slowly cooling the coil optimizes vanadium-nitride precipitation.