

## How to Maximize Nitrogen Recoveries From Additions of Nitrovan® Vanadium to Steel

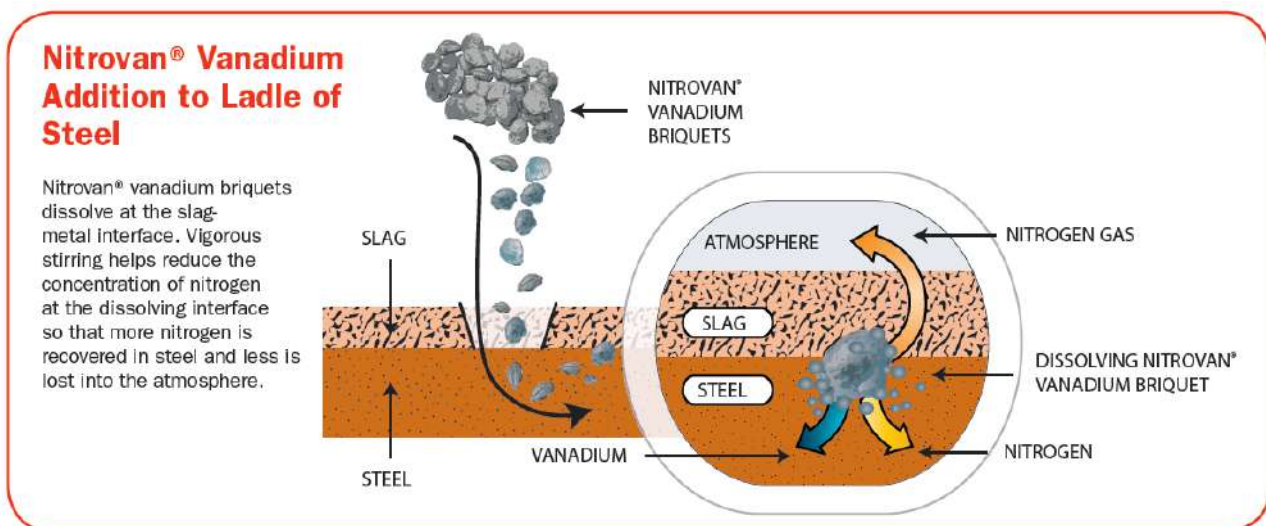
Nitrovan® vanadium is a unique alloy that adds two elements that work together to strengthen steel – vanadium and nitrogen. However, optimum strengthening only occurs when most of both elements are recovered in the molten steel. That requires special addition practices designed to maximize both nitrogen and vanadium recoveries.

Steelmakers have a choice of two grades of Nitrovan® vanadium that contain an average of either 12% or 16% nitrogen. A 0.01% vanadium addition of Nitrovan® 12 increases the nitrogen content of steel by up to 10 parts per million. A 0.01% vanadium addition of Nitrovan® 16 raises the nitrogen content of steel by up to 13 parts per million. These increases are based on a 60 to 70% nitrogen recovery. In comparison, nearly 100% of vanadium added can be recovered with a good addition practice.

While 60 to 70% nitrogen recoveries might be considered low for metallic-alloy additions, it is actually quite high for an element that occurs naturally as a gas. To achieve these high-nitrogen recoveries, steelmakers should avoid localized concentrations of nitrogen that significantly exceed the solubility of nitrogen in liquid steel.

### Vigorous Stirring

The maximum solubility of nitrogen in liquid-carbon steel may be as little as 0.04%. When this maximum solubility is exceeded, the excess nitrogen will bubble out of the steel as a gas and escape through the slag and into the atmosphere. In addition, Nitrovan® vanadium is less dense than steel so that the briquettes will tend to rise to the slag-metal interface. Any nitrogen released from briquettes that dissolve in the slag will also be lost. The bubbles of nitrogen gas that migrate through the slag and into the atmosphere create a “foaming” action in the slag. This lost nitrogen is the major cause of reduced nitrogen recoveries.



Steelmakers can therefore maximize nitrogen recoveries by keeping localized nitrogen concentrations below the solubility limit. That means aggressively stirring the molten steel as soon as Nitrovan® vanadium has been added. This stirring should continue during the 3 to 5 minutes it normally takes for the Nitrovan® vanadium briquettes to dissolve. The aim is to reduce any localized build-up of high nitrogen concentrations, especially since the nitrogen content of the dissolving briquettes substantially exceeds the solubility of nitrogen in steel.

## The Best Addition Practice

As a result, steel producers have found that maximum nitrogen recoveries can be obtained when Nitrovan® vanadium is added to molten steel as the steel is tapped into the ladle. This approach takes advantage of the natural stirring action caused by the stream of metal. Additions during tapping should be completed as quickly as possible after the start of tapping.

Nitrovan® vanadium can also be added later in the ladle, preferably through an opening in the slag. Those additions should be made with as much stirring as possible. Even with aggressive stirring, nitrogen recoveries may be lower than when additions are made during the tap.

Steelmakers should also avoid adding a large number of bags of Nitrovan® vanadium at once. Adding too much material may cause the steel to freeze around the alloy addition, causing erratic dissolution. Large additions also increase the concentration of nitrogen in a localized area, reducing nitrogen recoveries. It is better to add the bags individually, which helps spread the briquettes throughout the molten steel in the ladle.

## Higher Recoveries from Cored Wire

Steelmakers can obtain more predictable and higher nitrogen recoveries -- as high as 70 to 80% -- when Nitrovan® vanadium is added in cored wire. Properly added, cored wire maximizes nitrogen recoveries by plunging the small alloy particles deep into the ladle. This increases the surface area of the alloy that is exposed to the molten steel, minimizing high concentrations of nitrogen. The result is faster dissolution of the Nitrovan® vanadium addition with reduced loss of nitrogen

## Technical Assistance

For further information and assistance on maximizing nitrogen recoveries, contact your Bushveld Vametco representative.