

## How Nitrovan® Vanadium Efficiently Strengthens Steels

### Two Strengthening Mechanisms – Not Just One

The two key strengthening mechanisms that account for high yield strengths in low-alloy steels are:

- Precipitation Strengthening
- Grain Refinement

Nitrovan® vanadium – a cost-effective vanadium-nitrogen additive – effectively increases the strengthening obtained from both of these mechanisms. As shown in the accompanying graph, these two mechanisms provide up to 70% of the yield strength in a typical high-strength, low alloy steel.

### More Efficient Precipitates Build Strength

When Nitrovan® vanadium is added to steel, vanadium preferentially combines with nitrogen to form a large number of nitrogen-rich vanadium-carbonitride precipitates. The greater number of these small precipitates strengthens steel more effectively than the coarser vanadium-carbide precipitates formed by ferrovanadium.

### Smaller Grains Formed By Vanadium And Nitrogen

The vanadium and nitrogen in Nitrovan® vanadium also retard the grain growth that normally takes place between passes in the rolling mill. Accelerated cooling after the final rolling pass further enhances nucleation and slows grain growth, providing the desirable balance of strength and toughness that is characteristic of high-strength, vanadium-nitrogen steels.

### Lower Costs, Too

By increasing strength more efficiently than ferrovanadium, Nitrovan® vanadium allows steelmakers to use less vanadium to reach a desired strength level. Reducing vanadium additions yields major cost savings. That is why Nitrovan® vanadium is the preferred addition worldwide for strengthening microalloyed high-strength steels.

### For Further Information...

Contact your Wogen or Bushveld Vametco representative or your Nitrovan® vanadium distributor. Technical information can also be found on the Nitrovan® Vanadium Web site - [www.nitrovan.co.za](http://www.nitrovan.co.za).

