Vanadium: Recession, Rebalance & Resilience

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OVERVIEW (Slide 1)
The vanadium and titanium industries have many similarities, from their positions on the periodic table, to their markets relative size, to their applications in chemical catalysts and pigments, and most importantly, to their use in creating high strength to weight ratio metal alloys.

And much like the titanium market, the last five years have been an extraordinary roller coaster ride for the vanadium market. Through this period, the vanadium industry has experienced unprecedented strong growth, both in supply and demand, as well as historic levels and rates of demand destruction.

Today I would like to examine the impact of what has been the most severe demand shock to the vanadium supply chain in industry history, focusing particularly on events since October 2008, its relation to the steel industry, producer response and the potential risks and opportunities that lie ahead as the global economy recovers. These risks highlight the importance of long-term relationships between vanadium suppliers and the titanium industry.

I would like thank my colleague Robert M. Bunting for his contribution to the information and data presented here.

Uses of Vanadium (Slide 2)
Vanadium has a variety of uses in the metals and chemicals industries. The largest use of vanadium is in the steel industry, where it is used as a steel strengthener, in the form of Ferrovanadium (Chart 1). Today, over 90% of vanadium usage worldwide is in steel making applications. The balance of usage is evenly divided between titanium alloy production, in the form of vanadium-aluminum and other alloys, and chemical applications, in the form of vanadium oxides, vanadyls, and vanadates.

While general economic conditions have varied widely over the past twenty years, the distribution of these industry applications has held fairly constant. However, there is reason to expect that this may change in the future, as developing economies match developed economies in vanadium usage per ton of steel and newly commercialized battery technologies make use of the unique electrochemical properties of vanadium.

Vanadium Sources (Slide 3)
Similar to Titanium, vanadium is a common, widely dispersed element. It frequently occurs as a minor constituent in other ores – notably in iron ore and uranium ore. In addition, there are many specific vanadium ore bodies. Vanadium also occurs in fossil fuels, for example in crude oil from the Caribbean...
region and in coal (notably in China). Burning vanadium-bearing fossil fuels creates vanadium-bearing ash from which vanadium can be extracted. Processing vanadium-bearing oil results in spent vanadium-bearing catalysts which can also be processed to extract the vanadium.

This chart shows worldwide capacity for production of vanadium from these various sources, and the relative production and capacity utilization as it stood in 2008.

Because vanadium occurs in so many different forms, its production depends more on the comparative economics of extraction than anything else. Because there so many sources of vanadium, it is the comparative cost of building an extraction facility and the cost or processing in that facility that determines whether or not any given source or project is viable.

Vanadium-bearing iron ore is by far the biggest and, in general, the most economical source of vanadium. Such deposits occur in South Africa, China, Russia and New Zealand. Slag from the consumption of iron ore (in steel production) varies from 10% to 25% V₂O₅ contained. Since this slag is a by-product of steelmaking and the cost of extracting vanadium from it is relatively low, this tends to be the lowest cost vanadium source.

Looking at the other sources of vanadium we can see that the next significant source is vanadium ore. Most production from straight ore is currently in South Africa with a smaller amount of such production in China. Many other vanadium ore bodies exist in Russia, China, Canada, Australia and South Africa. High capital costs of new plant and high operating costs of most ore sources make production from ore less likely to be viable unless vanadium demand resumes the steep growth seen up to October 2008. This point was demonstrated by the January 2009 bankruptcy declaration of the Windimurra Vanadium Project in Australia, the second such declaration by this group this decade.

Oil and coal residues, and spent catalysts make up most of the balance of current production (mostly in the USA).

Rising Uranium prices stimulated the resumption of vanadium generation from uranium/vanadium ores in 2008 (in the USA). This source of vanadium (as by product) is expected to continue to grow steadily over the next few years.

**Vanadium and the Steel Industry (Slide 4)**

The fortunes of the vanadium industry and steel industry are closely tied together. Steel making is not only the largest user of vanadium, but also the largest source of vanadium, through the processing of vanadium bearing iron ore resulting in vanadium bearing slag byproduct. So it’s important to consider activity in the steel industry when reviewing the vanadium Industry.

Up to September 2008 worldwide steel production had risen very sharply for about six years. In line with this, vanadium consumption also rose sharply – notably in China. Since then, as steel production worldwide has collapsed, so has vanadium consumption. **(Slide 5)** In fact, by the spring of 2009, the annualized vanadium consumption rate had fallen to near 150 million pounds per year, a nearly 40% decrease from the summer 2008 high of 265 million pounds per year. The demand destruction that has
occurred since October 2008 is unprecedented in the vanadium industry, resulting in prices falling to levels not seen since January of 2004. Since hitting this nadir in April, vanadium prices have rebounded 75% through August of this year, for reasons I'll explain later.

(Slide 6) illustrates how inextricably the fortunes of vanadium are tied to steel. In this graph of annual vanadium consumption and steel production, you can see clearly how they track together. A shift to production of steels with higher strength has further increased the growth in vanadium consumption when compared with the volume of steel produced. But, since October 2008, this growth in usage per ton of steel has not been nearly enough to offset the vanadium consumption lost due to the sheer size in the downturn in steel production.

The steel industry consolidation that took place earlier this decade created high industry concentration that could exercise volume discipline in the face of dramatic demand decline facing the global economy. By the spring of 2009, worldwide crude steel production fell by over 30% on an annualized basis from its summer 2008 high. Developed economies, such as the U.S. and Europe, saw an even greater fall-off, with capacity utilizations falling below 50%. (Slide 7)

The recent sole bright spot in the steel production picture has been China, which in August 2009 was on track to break production records for the month. The effect of the stimulus directed by the Chinese government has been instrumental in restoring global demand for vanadium. In respect to the size of its economy, the Chinese stimulus program is nearly 40% larger than that put in place by the U.S. And by virtue of its command economy, China was able to quickly implement the stimulus program, which is heavy on infrastructure improvements, including new highways using (Grade 3) re-bar, and rail lines, both strong vanadium applications for steel.

The impact of the U.S. stimulus program on the U.S. steel industry is expected to be much smaller by comparison. Planned programs are estimated to require 10 to 15 Million tons of steel, roughly equivalent to one month’s steel production.

Vanadium Supply

In response to the decrease in demand, vanadium producers decreased their production. This was not always the Vanadium industry’s response when faced with such business conditions in the past. But industry consolidation earlier in the decade, the closure of smaller operators in China for environmental reasons, and other factors has created a producer base more capable of responding quickly to changing economic conditions.

(Slide 8) During 2008, China overtook South Africa to become the world’s largest vanadium producing country. It is estimated that in 2008, China produced 90 Million pounds V₂O₅ as oxide, peaking in the second quarter at an annualized rate of 115 Million pounds V₂O₅. Looking at the turbulent second half of 2008, it appears as though China’s vanadium production fell to an annualized rate of 75 Million pounds V₂O₅ – based on Chinese net exports and apparent internal consumption. Interestingly, due to temporary market dislocations, China was actually a significant importer of vanadium pentoxide in 2009.
(Slide 9) South African production in 2008 was around 68 Million pounds V$_2$O$_5$ (as oxide equivalent units after processing). By the middle of 2009 they were producing at a 50 Million pound V2O5 annual rate. The electricity supply situation that impacted the vanadium market in 2008 continues. According to Eskom, the South African Utility, the electricity supply situation is expected to remain vulnerable for the next five to seven years.

(Slide 10) Russia’s annual production rate was around 42 Million pounds V$_2$O$_5$ (oxide equivalent) in 2008, dropping below 30 Million pounds V$_2$O$_5$ by June 2009.

Production in both South Africa and in Russia dropped sharply in the fourth quarter of 2008 due to the high correlation in both countries between steel production and vanadium slag generation.

The other notable event with regard to vanadium supply was the resumption of vanadium supply from the processing of uranium/vanadium ore in the U.S. 1.2 Million pounds of V$_2$O$_5$ were produced in the second half of 2008 from this source.

Vanadium Supply/Demand Balance

(Slide 11) shows the balance between vanadium production (by region) and vanadium consumption (also by region) in 2008. At first glance, this suggests that the market was notably well balanced, with production exceeding consumption by one million pounds V2O5 – not a significant difference.

(Slide 12) shows the annualized balance between production and consumption in the fourth quarter of 2008 alongside the same comparison for the full year. This shows that in the last three months of 2008, even though vanadium production dropped quite sharply, the drop in consumption was even more pronounced — showing an inventory build-up of approximately sixteen million pounds V$_2$O$_5$.

In addition, and this is very important and common to all commodity markets, a reduced level of consumption releases inventory from the supply pipeline. For example, if vanadium consumers typically hold one month of inventory and their consumption suddenly drops to fifty percent, then they instantly have two months of inventory. So if vanadium producers attempt to cut production to maintain a market balance, they need to halt all production for a month and then resume production at only 50% of the previous level. Furthermore, this only addresses maintaining a balance in vanadium stocks held by consumers. In addition to this, one has to consider producer inventories and “pipeline” inventories in the same way — so it is quite possible that producers would have to halt all production for, perhaps, three months, before resuming production at 50% of the previous level — just to maintain a market balance. This, of course, never happens in vanadium or any other commodity — so markets become over supplied instantaneously whenever there is a sharp drop in consumption.

When we look at vanadium production versus vanadium consumption over the last decade (Slide 13), we see a market often out of balance, either “too hot” or “too cool”. Since 2006, supply and demand have been closely matched, despite experiencing both unprecedented growth and decline within a short period.
(Slide 14) The first half of 2009 saw producers significantly cut production across the board. As a result inventories dropped from an oversupply position to a marginal level today at all producers. The industry is now ramping up to meet growing demand.

(Slide 15) shows the extent to which vanadium inventories (in the form of oxide and downstream) had built up during the fourth quarter of 2008. About half of this inventory build was from reduced consumption, the balance from the “pipeline” effect described above.

As consumption has resumed, the pipeline effect described has reversed and the combined “demand” from consumers and pipeline has created an initial surge in demand which producers of vanadium have reacted to meet. This has resulted in the recent rise in vanadium market prices, recovering to levels seen in 2007.

Vanadium and the Titanium Industry

It should be noted that the vanadium requirements of the titanium industry are significantly different than that of the steel industry. The typical vanadium percentage in a titanium alloy is 4 percent and sometimes as high as 10%. The typical vanadium percentage in a major steel alloy application, such as Grade 3 re-bar, is 0.04%. Also, steel applications are typically static; versus the dynamic environment seem by most titanium alloys. This results in much more stringent quality requirements of the chemical and physical form of vanadium products in the titanium applications versus steel applications.

While I’ve made a point of the strong relation of vanadium to steel, it is interesting to note the correlation between U.S. Titanium Mill Product Shipments and vanadium pricing. Local peaks of Titanium mill shipments in 1989, 1997 and 2008 have coincided with local peaks in the London Metal Exchange Price for vanadium pentoxide.

Summary

(Slide 16) Looking back, we can see the vanadium market was oversupplied from October 2008 due to collapsing demand from its dominant consumer – the steel industry, as well as reduced demand from the titanium industry. Vanadium producers have responded by cutting production. It would seem these cuts in production have been deep enough to arrest the growth in worldwide vanadium product stocks (oxide and Ferrovanadium).

Looking forward to a global economic recovery, where both demand and supply are racing forward, there is increased potential for a sudden dislocation. To maximize the integrity of their supply chain and minimize the risks of such dislocations, the titanium industry should encourage and strengthen long-term bonds with their vanadium sources. These relationships should include long-term commercial and technical ties not only with their master alloy suppliers, but also with the Vanadium oxide that the master alloy is made from and even the sourcing of the Vanadium bearing raw material.
Vanadium: 
Recession, Rebalance, 
& Resilience

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INTERNATIONAL TITANIUM ASSOCIATION
ANNUAL CONFERENCE
WAIKOLOA, HAWAII
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USES OF VANADIUM

- Steelmaking - 93%
- Chemical and Catalyst - 4%
- Titanium - 3%
VANADIUM CAPACITY UTILIZATION

- Steel Slag: 78%
- Vanadium Ore: 68%
- Oil & Coal Residues: 69%
- Spent Catalysts: 68%
- Uranium By-Products: 10%

Capacity Utilization

- Capacity
- 2008 Production
WORLDWIDE CRUDE-STEEL PRODUCTION RATE
Through June 2009

Source: Strategic Minerals Corporation
WORLDWIDE VANADIUM-CONSUMPTION RATE

Through June 2009

Source: Strategic Minerals Corporation
WORLDWIDE STEEL PRODUCTION VS. WORLDWIDE VANADIUM CONSUMPTION
Through June 2009

Vanadium Consumption

Steel Production

Source: Strategic Minerals Corporation
VANADIUM SUPPLY TRENDS

CHINESE PRODUCTION

12-Month Moving Average

Through June 2009

Millions of Lbs. of V₂O₅ per Year

Source: Strategic Minerals Corporation
Millions of Lbs. of V$_2$O$_5$ per Year

VANADIUM SUPPLY TRENDS
RUSSIAN PRODUCTION
Through June 2009

12-Month Moving Average

Source: Strategic Minerals Corporation
LAST QUARTER 2008 -- SUPPLY INCREASES

Last Quarter Annualized

Supply

- All Others: 14
- U.S.A.: 23
- China: 77
- Russia: 29
- South Africa: 60

Consumption

- All Others: 18
- FSU / CIS: 18
- North America: 26
- Western Europe: 38
- China: 44
- Other Asia: 41

Millions of Lbs. of V₂O₅
VANADIUM PRODUCTION VS. CONSUMPTION
Global 12-Month Moving Average -- Annual Rates

Source: Strategic Minerals Corporation
VANADIUM PRODUCTION VS. CONSUMPTION

July 2008 to July 2009

Source: Strategic Minerals Corporation
EXCESS VANADIUM-OXIDE / FERROVANADIUM INVENTORY
January 2007 – June 2009 Estimated

Source: Strategic Minerals Corporation
SUMMARY

- The Vanadium Industry Has Reacted to Bring Production in Balance with Consumption
- The Vanadium Industry Will Continue to be Strongly Influenced by the Steel Industry
- The Vanadium Industry Is Committed to Meet the Titanium Industry’s Long-Term Product and Quality Needs
- The Vanadium and Titanium Industries Need to Strengthen Long-Term Relationships