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AMG is a critical materials company

Global Trends
CO₂ emission reduction, population growth, affluence, and energy efficiency

Demand
Innovative new products that are lighter, stronger, and resistant to higher temperatures

Supply: AMG
Sources, processes, and supplies the critical materials the market demands
Critical Raw Materials

The EU identified 20 critical raw materials* to the European economy in 2014, focusing on two determinants: economic importance and supply risk.

The US identified 30 critical materials* which are vital to national defense, primarily through assessing supply risk.

AMG has a unique critical materials portfolio comprising:
- 5 EU critical raw materials
- 4 US critical raw materials
- Highly engineered Titanium Alloys for the aerospace industry
- High value added Aluminum Master Alloys
- Vanadium, Nickel and Molybdenum from recycled secondary raw materials

AMG Business Units

• AMG Critical Materials
  - Vanadium
  - Superalloys
  - Titanium Alloys & Coatings
  - Aluminum Alloys
  - Tantalum & Niobium
  - Antimony
  - Graphite
  - Silicon

• AMG Engineering
  - Engineering
  - Heat Treatment Services
AMG Vanadium Overview

- US location (Cambridge, OH) is a key asset with stable customer base in **net import market**
- Provides environmental management services to the North American petroleum industry
- Preferred supplier status – largest & most reliable producer in North America
- Produces ferrovanadium and ferronickel-molybdenum from spent catalyst to the North American steel markets
- Ferrovanadium is used in high strength low alloy steel production to increase strength, toughness and weld ability
- Ferronickel-molybdenum is used in stainless and specialty steels and aerospace applications

**AMG Vanadium is the most advanced, lowest cost, environmentally friendly spent catalyst recycling facility in North America**
Ferrovanadium Processing Routes

- Three FeV processing routes
  - Primary, Co Product, and Secondary
- AMG Vanadium produces FeV via secondary route
  - No intermediary production of V2O5
  - Eliminating environmental contaminations
Vanadium Production and Consumption

- China is the dominant global producer of vanadium

- Global production in 2014 was estimated at 95,000 MTV and consumption was estimated at 92,700 MTV, thereof an excess supply of 2,300 MTV putting pressure on prices

- Steel market consumes 90% of global production and 5% each for chemicals and masteralloys

- Vanadium containing steel market share increasing as specific consumption (kgV/MT steel) continues to increase

- **Rationalization of supply is underway with supply decreases in Australia, South Africa and China**
Metal Index Price History

Source: Ryan's Notes Ferrovanadium NA Transaction Mid; LME Nickel Cash Daily Official $ per tonne Monthly Average; Platt's Metals Week Monthly Report Moly Dealer Oxide Low
Market – Global Vanadium Production

- Co-Product: 60%
- Primary: 25%
- Secondary: 15%
Global Steel Production

- Vanadium consumption is closely tied to the steel industry
- Steel production drives up to 60% of the global vanadium supply through the production of V bearing slag
- The Chinese steel industry represents 55% of global V production through V bearing slag
- **Steel production from V bearing ore has a direct impact on V production**

![Annual Global Steel Production](chart.png)

Sources: World Steel Association
Chinese Vanadium Production

- China has 7 steel mills that collectively produce approximately 40 million MT steel and approximately 43,000 MT V.
- Steel production from vanadium-bearing ore is at the high end of the cost curve due to low iron content.
- Longer term, a trend towards mini-mill steel production will gradually replace integrated steel production as scrap becomes more widely available in China.
- China has approximately 100 million MT excess steelmaking capacity - a rationalization process has begun.

### Chinese Iron Ore is the Lowest Grade Globally
As China Imports more ore, its V content in steel slag declines

<table>
<thead>
<tr>
<th>Country</th>
<th>Iron Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>68</td>
</tr>
<tr>
<td>Sweden</td>
<td>64</td>
</tr>
<tr>
<td>Australia</td>
<td>62</td>
</tr>
<tr>
<td>Canada</td>
<td>62</td>
</tr>
<tr>
<td>Russia</td>
<td>58</td>
</tr>
<tr>
<td>WORLD</td>
<td>44</td>
</tr>
<tr>
<td>China</td>
<td>33</td>
</tr>
</tbody>
</table>

Vanadium production declines!
South African Vanadium Production

- Evraz Highveld produces approximately 13,000 MT V per year:
  - approximately 50% from slag processed primarily in Europe
  - approximately 50% as ore in South Africa
- Evraz Highveld creditors have voted in favor of the business rescue plan submitted by International Resources Limited (IRL) - IRL investment required is $376 Million
- IRL’s plan provides for a wind-down should the offer not be consummated

Evraz Highveld issue is not clearly resolved and they remain a high cost producer of steel
Global Vanadium Demand

**2014 Vanadium Demand by Region**

- China: 47%
- Europe: 18%
- Russia: 6%
- North America: 12%
- Japan: 6%
- India: 3%
- Other: 8%

Sources: Vanitec, TTP²
Global Demand for Vanadium

- Steel growth rate has been 4.9% CAGR 2003-2014
- Vanadium consumption grew 7.6% CAGR in same time period
- Specific consumption (i.e. concentration of V in Steel) represents 2.7% CAGR of the annual growth rate of Vanadium
- A global steel growth rate of 2.5% moving forward results in a forecast vanadium consumption growth rate of approximately 5.2%
- Vanadium demand will continue to grow at a higher rate than demand for steel

*Assumes a 7.0% decrease in Vanadium consumption for 2015 and then flat for 2016 with a 5.2% CAGR thereafter

Sources: Vanitec, Industry Sources, TTP²
• The current high cost of V production is driving rationalization in the market
• Supply increased in 2013 and 2014 primarily due to increases in Chinese steel production
• Forecast decrease in supply in 2015 and 2016 is driven primarily by South Africa and China; offset somewhat by increases in North America and Brazil

• Market is currently over supplied however we expect a rebalancing to occur

Sources: AMG Management Estimates
Cost Curve Misconceptions

• Co-production
  – Russia, South Africa, New Zealand
  – Production cost depends on both Steel and Vanadium economics
  – High cost steel producers
  – Some slag processed on tolling basis or sold

• Primary production
  – South Africa, Brazil, China
  – Production cost depends upon ore grade and logistics

• Secondary production (recycling)
  – Asia Pacific, Europe, US
  – Metal price downside protected
  – Metal price upside shared with generators (suppliers of material)
  – Most environmentally friendly production method

• AMG Vanadium, as a secondary processor, is economically viable at all market price levels

• Metal bearing waste materials will continue to be recycled as other disposal options are limited and high cost
Future Trends & Outlook

• Vanadium Supply is expected to decrease due to market rationalization

• The future of Evraz Highveld remains unclear

• Vanadium demand is projected to continue to grow

• AMG Vanadium, as a secondary processor, is economically viable at all market price levels
AMG Vanadium

- North American producer of ferrovanadium and ferronickelmoly
- Production capacity increased by approximately 100% between 2013 and 2015
- Current production capacity of approximately 7.0 M lbs. of Vanadium contained per year
- Continue to optimize production to provide specification ranges required by our customers
  - “World Grade” FeV with lower Si, S, and P
  - Higher V content – Up to 70% V
  - Low Al content
  - Lower melting point = Better V recovery
- Centrally located in Cambridge, OH, U.S.A.
- Customized packaging and expediting of shipments on site.
- Cost model enables AMG Vanadium to be very competitive in down markets
- Environmentally friendly and low cost producer
  - Recycler of waste from refineries and power plants
  - Pyrometallurgical process minimizes effects on environment

AMG Vanadium is well positioned to be the long term supplier of choice to the North American steel industry
Thank you!

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