The Permanent Magnet Market - 2015

by

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The Permanent Magnet Market Will Continue to Grow

• After a potential 2013-2014 economic correction, PM demand will continue to increase

• Today’s drivers will be tomorrow’s drivers
  • Automotive (including electric and hybrid)
  • Consumer Electronics
  • Appliances & HVAC
  • Electric Bicycles
  • Wind Turbines (?)
The *NdFeB* Permanent Magnet Market Will Continue to Grow

<table>
<thead>
<tr>
<th>Production by Country/Region</th>
<th>2012</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>Europe</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Japan</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>USA</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>All Other</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>63</strong></td>
<td><strong>78</strong></td>
</tr>
</tbody>
</table>

Source: “Permanent Magnets 2010-2020”
Caution: Accurate Chinese NdFeB Production Statistics are Elusive!

- Previous chart (2012) – 50,000 Tons
- A recent “company-by-company” build-up suggests the reality of current Chinese NdFeB production may be closer to 80,000 Tons
China’s RE Magnet Exports are Recovering From the 2009 “Hit”

- RE magnet exports reportedly dropped to 9,400 tons in 2009
- RE PM exports rebounded to 16,400 tons in 2011 (2013 “official allocation”: 15,500 tons)
- But: Record year was 2007 – 21,500 tons!

- Source: The Chinese Society of Rare Earths
Will New REO Supplies Meet 2015 Magnet Market Requirements?

- DOE estimates 17,000 additional tons of Pr + Nd oxide by 2015 ("Critical Materials Strategy" Dec 2011)
- This would translate to approximately 28,000 Tons of NdFeB Magnets (Stan Trout, Molycorp – Dec 2012)
- 28,000 Tons of NdFeB magnets would represent an increase of 30-40% of total 2012 estimated production (Equivalent to 10-12% increase/Yr.)
No Major Shift in RE Prices is Expected

• Increases in Western and Chinese REO production will represent a supply “relief valve”

• Much of the new (Western) REO production will end up in China and Japan
  – Neodymium price should be relatively stable
  – Dysprosium will continue to be “dear”
Continued Dysprosium Shortages Will Impact Design Decisions

- Some motors and systems will be designed for lower operating temperature
- Alternate materials (and system designs) will continue to be adopted
- Lower Dysprosium usage will be a necessity – there simply won’t be enough.
- *Industry will design around this issue!*
We will not Have “The New Holy Grail” Permanent Magnet Material in 2015

- Anisotropic Bonded NdFeB
- Sintered Sm-Fe-N
- Iron-Nitride PMs
- Modified Fe-Ni Alloys
- Nano-structured NdFeB
- High Temperature SmCo
- Correlated Magnetization of PMs
- Diffused Dy NdFeB PMs

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Recycling Permanent Magnets Will Not be “The Answer”

• Individual magnet producers will continue to implement “selective” in-house recycling
• Generic magnet (REO)recovery from motors and electronic devices will be limited by economic feasibility
China Will Continue to be “The Big Dog”

• Chinese NdFeB magnet production capacity will continue to increase

• At least 80% of global NdFeB magnet production will be in China in 2015

• *China will continue to be the low cost producer*
The Outcome of Hitachi’s Current Initiative to Manage “Licensed Production” is Yet to be Determined

• We’re approaching the 30th year anniversary of the invention of NdFeB
• Hitachi’s 2012 ITC appeal may not be resolved for some time
• Certain Hitachi patents may be challenged
• Landscape of “Hitachi Licensees” may change
• Benecki guess: “50-50” chance of definitive resolution by 2015
Summary

• 2015 is likely to be a year of attractive growth for the magnet industry

• Two new NdFeB production facilities outside China
  • (Hitachi Metals – US)
  • Molycorp/Mitsubishi/Daido JV – Japan)

• 2015 REO supplies should meet overall magnet industry demand

• Magnet users will “design around” the Dysprosium issue:

• Bottom line: Dramatic change in the RE magnet supply chain is unlikely
Thank You!