A Global Portrait of the Mn Industry –
A Socio-economic Perspective

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Introduction

- First global study on the socio-economic importance of the production and downstream uses of Mn
  - Contribution of Mn related activities/use
- One of the first such SEAs for metals
- Work first commissioned by the IMnI in 2012 and carried out in phases
  - First phase developed data on the economic importance of MN
  - Second phase looked at a range of downstream uses, provision of a more regional analysis, and case studies highlighting social expenditure, etc.
- Audience includes IMnI members, national governments, regulators (as part of regulatory defense)
The aim of the study is to develop socio-economic data illustrating the economic importance of inorganic Mn. The study focuses on the use of Mn in various downstream applications.

**Focus of the study**

In addition to Mn ore and Mn alloy, the study also considered the use of Mn in various downstream applications:

**Steel**
- Carbon Steel
- Advanced High Strength Steel
- Construction & Engineering Steel
- Austenitic Mn Steel
- Stainless Steel
- HSLA Steel

**Other Applications**
- Agriculture
- Batteries
- Healthcare
- Aluminium
- Slags & Cement
- Electronics
- Water
Main limitations

- Not all impacts have been quantified
  - Economic value of slags not included
  - Distributors/traders not covered
- Some impacts may not be captured in the right location (e.g. due to trade flows)
- Generic/average multipliers have been used
  - E.g. multipliers for ores based on “Mining and quarrying”
- Estimates are conservative
- Uncertainty due to variations in production efficiencies, use of forecasts, etc.

Mn Ore – Contribution to GDP
Total value (direct & indirect): US$ 21* – 23 billion

*Graph shows our conservative estimate

80% of total economic contribution of Mn ore
Mn Ore – Contribution to GDP
Total value (direct & indirect): US$ 21* – 23 billion

Mn Ore – Employment
Total employment (direct, indirect & induced)
77,000* – 136,600 workers
Mn Ore – Wages from direct employment

Total
US$ 2.7 billion to US$ 4.6 billion

- China: 43% - 51%
- Australia: 16% - 19%
- South Africa: 15% - 17%
- Others: 18% - 21%

Mn Alloy – Contribution to GDP

Total value (direct & indirect): US$ 146 billion

- China: 75%
- India: 8%
- South Korea: 3%
- Ukraine: 2%
- Others: 10%
- S. Africa: 7%
### Mn Alloy – Employment

<table>
<thead>
<tr>
<th>Jobs Type</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Jobs</td>
<td>67,000 to 86,000</td>
</tr>
<tr>
<td>Indirect Jobs</td>
<td>202,000 to 258,000</td>
</tr>
<tr>
<td>Induced Jobs</td>
<td>15,000 to 22,000</td>
</tr>
<tr>
<td>Total Jobs</td>
<td>284,000 to 366,000</td>
</tr>
</tbody>
</table>

### Mn in Steel – Economic Benefits

- In its use as an **alloying material**, there are **no known alternatives** to Mn in the steel making process — critical.
- Mn is basically the most **cost-effective** hardenability intensifier and this is the reason it is used in all standard treatable steels — Nickel is more powerful but more expensive.
- The low price of Mn and the cumulative technical benefits mean that there would be additional costs across the value chain in the event of substitution.
- If No Mn = No steel, then **entire value is Mn dependent**.

Steel industry value in 2013

US$ 964 – 1,446 billion
High Strength Low Alloy (HSLA) Steels

• Mn is critical in steels where high yield strengths are required
• HSLA steels offer a high strength to weight ratio, resulting in:
  – reduction in the quantity of steel required
  – reduction in the weight of the final construction (20-30%)
  – reduction in shipping and transport costs
  – reduction in fabrication costs
  – greater design flexibility, etc.
• There are no alternatives to Mn in HSLA steels — alternative steels may be used, but they do not offer the same benefits
• 7% of global steel - uses include offshore & automotive

Advanced High Strength Steels (AHSS)

• AHSS provide excellent ductility and strength when compared to conventional steels – high energy absorption and fatigue endurance limit
• In automotive applications this can lead to weight reduction, lower fuel consumption, lower associated emissions and improved crashworthiness
• Use of AHSS in motor vehicles could lead to global savings of between 8 and 28 million Mt of CO₂ per year and total global fuel cost saving of ~ US$ 435 - 1,400 billion per year
• Such steels account for around 8% of total Mn consumed in steel (but only around 1% of annual steel production)
Stainless Steel

- Mn is a key component of low-cost stainless steel formulations, notably S200-series stainless steel (21% of all stainless)
- The market for S200 steel is valued at around **US$ 13 billion per year** and could reach **US$ 18.7 billion - 35.7 billion by 2020**
- This niche market would not exist without Mn

Mn in Aluminium Beverage Cans

- Mn is present in almost all aluminium alloys and is the main alloying element used in 3XXX series aluminium alloys – used for beverage cans
- In 2011, ~254 billion beverage cans were manufactured, ~90% were made from aluminium
- Assuming a market value of US 0.01 to US$ 0.05 per unit, the total value of the aluminium beverage can market in 2011 was **US$ 2.5 billion to US$ 12.7 billion**
- Given a market growth rate of 2.4%, the global market for aluminium beverage cans could be worth **US$ 11 billion to US$ 22 billion by 2020**
Mn in Aluminium Beverage Cans (USA)

• The USA is the largest single market for beverage cans, accounting for ~43% of the global market (~109 billion cans in 2011)
• We estimate that in 2011:
  – Around **138,000 people** were employed as a result of aluminium beverage can manufacture in the USA
  – **Total wages = US$ 7.9 billion** (direct, indirect, induced)
  – The aluminium beverage can industry was responsible for as much as **US$ 16.4 billion in total economic activity** throughout the economy of the USA
  – Total **tax revenues** related to aluminium beverage can production = **US$ 1.5 billion** in the USA

Mn in Agriculture

• Mn is a trace mineral that is essential for the metabolism of all living organisms (plants and animals)
• Mn deficiency is common in the soils of many locations globally
  – In Northern Indiana (USA), Mn deficiency could lead to annual losses for soybean producers of between **US$ 196 million and US$ 392 million per year** if Mn-containing fertiliser is not applied
  – In the UK and Ireland, the total benefit of treatment for Mn deficiency in soils growing winter wheat and barley is estimated at ~ **US$ 370 million to US$ 667 million per year**
Healthcare

• Stainless steels account for more than half of the total biomedical metals market - an estimated **US$ 6.7 billion** in 2012
• The global market for biomedical metals is expected to increase by 7.5% annually over the coming years

Mn Slags and Cement

• Cement production accounts for ~5% of global anthropogenic CO$_2$ emissions
• Around 65% of the fuel used in cement production is used in the calcination phase (Carbon Enterprises, 2013)
• Because SiMn slag is precalcined, its use in cement production means that less fuel needs to be burned, which results in CO$_2$ emissions reductions
• Assuming just 1% of clinker produced worldwide in 2012 was made using SiMn slag, the total (global) value of CO$_2$ reductions would be ~ **US$ 5.94 million to US$ 29.16 million**
Conclusion

“The mining of Mn ore and production of Mn ferroalloys make significant economic and social contributions to national and regional economies where these activities take place. Mn is also a critical element with a range of downstream applications”

Conclusions

If Mn could no longer be used?

• Currently no known alternative in steel making.....
• Loss of potential for adopting steel technologies that have the potential to reduce energy consumption and hence CO₂ and other atmospheric emissions
• Impact on uses such as aluminium beverage cans, stainless 200 series, agriculture and fisheries
• Increased costs with use of substitutes across a range of other applications
  – Austenitic or Hadfield steels
  – Electronic applications of manganese ferrite
  – Healthcare applications
  – Batteries
THE END

Thank you for listening!

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