IMnl’s Lifecycle Assessment Project

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Project Overview

- LCA (ISO 14040/14044:2006) provides a comprehensive measurement of environmental performance throughout a product supply chain.
- Hatch is conducting an LCA of the global manganese alloy industry on behalf of the IMnI and its members.
Project Overview (cont.)

- LCA culminates process, mass-energy balance and environmental modeling of 16 manganese mines and smelters, globally.
- LCA provides industry-wide benchmarks for external advocacy and site process optimization:
  - Fuel use;
  - Electricity;
  - Environmental controls;
  - Air & GHG emissions;
  - Water use and quality;
  - Dust emissions;
  - Solid waste generation;
  - Others.
Outline

• Background
  Origins of the project and the IMnI Sustainability Programme.

• Project Scope
  Aims of the project, global industry representation, key expected outcomes.

• Project Status Update
  Current project stage and dates for key deliverables.

• Preliminary Findings
  Selected industry benchmarks, insights, and potential range for environmental and cost savings.

• Next Steps & Opportunities
  Upcoming results, site benchmarking, and other opportunities.
About Hatch

- Employee owned
- Projects in more than 150 countries
- More than 11000 professionals worldwide
- More than US$35 billion of projects now under management
- EPCM, Integrated Teams, Project and Construction Management
- Consulting – process, technology and business
- In-house engineering services for operations
- Serving mining & metals, energy and infrastructure sectors for more than 50 years
Hatch Services and Sectors

- Consulting
- Environmental
- Operations Support
- Project Delivery Group
- Systems & Process Control
- Technologies
- Energy
- Infrastructure
- Metals

Sectors & Business Units

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The Manganese Sustainability Programme

The International Manganese Institute (IMnI) launched a Manganese Sustainability Programme designed to:

1. Achieve a shared understanding of sustainability in the industry,
2. Improve the sustainability of the manganese industry through IMnI activities,
3. Ensure that the industry follows responsible business practices.

A Lifecycle Assessment of Manganese was an important step towards achieving these objectives.
LCA Addresses Metals Systems

- LCA is the most well established tool for comprehensive environmental foot printing, conducted previously by similar metals industries:
  - Steel, Worldsteel (2009)
  - Aluminum, EAA (2010)
  - Copper, ICA (2009)
  - Nickel, NI (2010)
  - Zinc, IZA (2009)
  - Chromium, ICDA (2007)

- Key Industry Drivers:
  - Communicate with the public and regulatory bodies on environmental issues.
  - Cost optimization and environmental risk mitigation through sharing best practices.
The Manganese Alloy LCA Project

Key Participants

- IMnI enlisted Hatch to conduct the LCA, managed by IMnI and with the participation of member company volunteers.
Objectives

• The IMnI identified the Manganese LCA as a key initiative to promote sustainability across the industry.

• **External Industry Communication:**
  • Generate comprehensive environmental data that is accurate and globally representative;
  • Provide a scientific basis for communicating the impacts of the Mn industry to external stakeholders.

• **Internal Environmental & Cost Performance:**
  • Foster sharing of best practices on environmental management within the industry;
  • Provide a global industry benchmark to compare and identify areas of environmental risk and cost saving opportunities within the manganese value chain;
Key Deliverables

• Deliverables geared towards intended applications:

• **Global LCA Report**
  • Globally averaged data;
  • A comprehensive model of a ‘typical’ manganese supply chain by process stage;
  • Representative of the industry as a whole;

• **Site LCA Benchmark Reports:**
  • Comparison to global benchmark data;
  • Identification of hotspots and cost and impact reduction opportunities;
  • Complimentary for participating sites;
  • Upon request for any mine or smelter.
System Boundaries

- LCA includes manganese mine/smelter activities and all associated upstream/downstream processes.
Globally Representative

- Environment and mass-energy balance models of 16 globally representative sites.

Regional distribution of participating sites

8,000,000 t Mn-ore mined
20% of global ore production.

1,200,000 t Mn-alloys produced
10% of global alloy production.
Current Phase of Project

- March 2012 – March 2013
  - Site visits;
  - Data collection;
  - Data validation.

- April 2013 – December 2013
  - Modelling & Analysis
  - Reporting.
Preliminary Findings

Mining - Impact Areas

Manganese ore & sinter (to smelters)

- Extraction & Hauling
  - Diesel Prod.
  - Power

- Crushing & Beneficiation

- Tailings/Waste Storage

- Sinter Plant
  - Coke Battery

- Air emissions
  - Overburden/waste
  - Dust generation
  - Tails/waste
  - Wastewater
  - Air emissions
Mining – Key Metrics

- Extraction & Hauling
  - Diesel: 7.1 kL
  - Overburden: 12.6 kt
  - ROM Ore: 2.0 kt
  - Average haul distance: 3.0 km

- Crushing & Beneficiation
  - Water (make-up): 2.6 ML
  - Electricity: 9.1 MWh

- Tailings/Waste Storage
  - Tails & Waste Ore: 0.8 kt

- Sinter Plant
  - Manganese ore & sinter (to smelters): 1 kt (43% Mn)

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Safety • Quality • Sustainability • Innovation
Mining – Savings Potential

- Energy use, air emissions and solid waste generation correlated to overburden and waste rock:

\[
R^2 = 0.9896, \quad m = 1.4
\]

\[\text{Diesel at Extraction (kL/kt prod.)} \]
\[\text{Overburden/ROM (wt.)} \]

1X Overburden Reduction
$2.0M USD diesel per million tonnes production (mobile equipment).

- Overburden/waste rock strongly linked to fuel costs associated with extraction and hauling.
Mining – Savings Potential

- Waste inputs in ROM feed correlated to electricity demand, water use, and tailings management:

![Graph showing Power Demand at Ore Processing Plant]

- Optimizing selection of ROM can reduce energy costs, tailings storage requirements and environmental liability.
Smelting - Impact Areas

- Preliminary Findings

- Smelting
  - Materials Handling
    - Diesel Prod.
    - Power Plant
    - Coke Battery
    - Si-source/Fluxes
    - Gas Plant
  - Off-gas Processing
  - Slag Processing
  - Refining
  - Crushing & Screening
    - Manganese alloys (to steelmaking)
  - Air emissions
    - Fugitive dust
  - Air emissions
  - Air emissions
  - Sludge/dust
  - Slag/waste
  - MnO Powder
Smelting – Key Metrics

### Materials Handling
- **Smelting**
  - **Off-gas Processing**
  - **Slag Processing**
  - **Refining**

### Crushing & Screening
- Manganese alloys (to steelmaking)

### Power (at furnace)
- **Mn-Alloys**
  - 3.9 MWh
  - 560 kg Coal/Coke
  - 1000 kg Slag (generation)
  - 3.9 MWh + 560 kg + 1000 kg = 1 t-hm SiMn

### Power (at furnace)
- **HC FeMn**
  - 2.7 MWh
  - 510 kg Coal/Coke
  - 770 kg Slag (generation)
  - 2.7 MWh + 510 kg + 770 kg = 1 t-hm HC FeMn

### Diesel
- **Mn-Alloys**
  - 3 L
  - 0.8 kg Particulate emissions
  - 3 L + 0.8 kg = 1 t Mn-Alloys

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Smelting – Savings Potential

- Reducing Primary Dust Emissions
  - Large variation in primary (furnace) dust emissions;
  - Use of by-pass stacks during emergency conditions;
  - Opportunity for PM emission reduction through management of by-pass stack events;
  - Potential to achieve 0.1 kgPM/t-alloy without by-pass stack emissions.

- Energy Recovery from Furnace Off-gas
  - Dependent on furnace technology (closed vs. open);
  - Cost savings and air emission reductions through avoided purchased power.
  - Potential to provide ~10% of furnace power requirements.
Smelting – Savings Potential

- **Electricity Demand**
  - Increases with waste burden and slag generation;
  - Variation between sites shows some potential for further optimization.

Moving from last quartile to industry average, or industry average to best practice:

~ $300k USD/10kt
Next Steps (Upcoming)

- **Global LCA Report**
  - Comprehensive results on production inputs and environmental data:
    - Air emissions;
    - Water quality;
    - Hazardous waste;
    - Energy, etc;
  - Representative of the global industry;
  - A scientific basis for advocacy and stakeholder engagement.
Next Steps (Upcoming)

- **Site LCA Benchmarking Reports**
  - Comparison to global benchmarks;
  - Hot-spot identification;
  - Optimization opportunities;
  - Gap analysis & environmental risk evaluation.
Other Opportunities

- **Life Cycle Cost (LCC) Analysis**
  - Existing LCA data can be expanded to track and optimize operating costs;
  - Impact of price fluctuation and sensitivity of upstream inputs.

- **Regulatory Risk Evaluation**
  - Comparing the manganese industry with other sectors/metals to identify potential for emerging regulations.

- **Detailed Process / Environmental Optimization**
  - Application of Best Available Technologies identified through LCA;
  - Technical feasibility through to detailed design;
  - Pairing LCA models with thermodynamic simulation (e.g. slag phase optimization).
Thank you!

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