LIFE CYCLE DATA

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Ni
Nickel

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1. What are life cycle data?

Life cycle inventory (LCI) data provide an overview of in-puts and outputs for a defined number of processes. The nickel LCI data cover the mining, beneficiation, smelting and refining of nickel. On the input side they include, inter alia, the amount of ore mined and processed, electric energy, fuel, water, explosives, and process chemicals. On the output side they cover e.g. emissions to air and water, as well as waste. These data are shown in relation to 1kg of product, which is either 1 kg of Nickel metal or 1kg of ferronickel.

2. What are life cycle data used for?

Life cycle data are used by various stakeholders for different purposes. Downstream users such as the stainless steel industry use them for calculating the energy used and carbon dioxide emissions related to the production of stainless steel. End-user industries might use them to assess the environmental profile throughout the entire life cycle, and regulators to assess environmental implications from producing certain raw materials. Companies themselves might use them to compare different production processes.

3. What are so-called 'impact categories'?

Process in-puts and outputs can be aggregated and presented in terms of impact categories. The life cycle community has defined a total of 15 impact categories. The most relevant ones are global warming potential (which describes the total of emissions as CO2 equivalents, including carbon dioxide, methane and other relevant gases) and primary energy demand (the total amount of energy which goes into the production of a1 kg of product, including electrical energy from various sources including fossil fuels).

4. Why are life cycle data updated?

Life cycle data reflect many factors such as the nature of the ore bodies, the process technologies involved, and the mix of energy sources (carbon based, hydro, nuclear, renewable, etc.) that the electrical grid supplies to the processing companies. An update of the life cycle data reflects such changes that might have occurred over time. New mines and the closure of old mines might have an influence, as well as new process technologies or changes in the supply of electrical energy.

5. Which nickel products were covered by the LCI update?

The LCI update covers the production of nickel metal and ferronickel as these are the products of greatest interest to the stainless steel industry, the largest user of nickel. Other products such as nickel compounds and Nickel Pig Iron (NPI) were not part of the investigation.

6. Are the resulting data reliable and robust?

The LCI update covers the main production technologies as well as the main nickel producing regions except China. It accounts for 52% of nickel metal and 40% of ferronickel production. The reference year (2011) had normal production operations in all participating companies. The LCI update was conducted and all data verified by the LCA/LCI consultancy with the greatest experience in applying in applying life cycle assessment methodology to the production of metals. The goal and scope as well as the final results were peer-reviewed by a LCA expert from the scientific community.

7. Which companies participated in the exercise?

Nine companies with a total of 19 production sites participated in the exercise. The update covers all main global and regional nickel mining companies and nickel producers, including BHP Billiton, Eramet, GlencoreXstrata, Norilsk Nickel, Sumitomo, Talvivaara and VALE.

8. What are the major nickel producing regions and are they all covered in the LCI update?

The main nickel producing countries and regions comprise Russia, Canada, New Caledonia, China, Australia, Brazil, South Africa and Colombia. All major nickel producing regions except China are included.

9. Are all production processes covered?

The LCI update covers all main production processes for nickel metal and ferronickel "from cradle to gate", which means from mining to ore beneficiation to smelting and refining. Transport, energy supply and other horizontal issues around the processes were also included. The study however does not cover Nickel Pig Iron (NPI) production, a process route exclusive to certain Chinese production.

10. Is energy use and the carbon footprint of nickel metal and ferronickel production different from NPI production?

NPI production is known to be very energy intensive. According to a study (2013) on NPI life cycle data, the carbon footprint of nickel metal by traditional metallurgy was estimated to be 10-14 times lower than the carbon footprint of nickel in NPI (relative to 1kg of Ni metal content). For nickel contained in ferronickel the carbon footprint was 2-3 times lower than the from the NPI process route.

11. The nickel and ferronickel carbon footprint and primary energy demand are significant. Is it from an environmental point of view preferable to avoid the use of nickel?

The production of nickel and ferronickel is a front-end investment in life cycle product and resource efficiency and sustainability. They enable more fuel efficient, more durable and longer lasting products. Nickel-containing stainless steels and other alloys are collected at very high rates and recycled with greatly reduced energy requirements and carbon footprints.

12. Why are the results for nickel and ferronickel different?

There are different production processes for nickel metal and ferronickel. Nickel metal is produced from sulfidic and lateritic ores, undergoing either a pyro- or hydrometallurgical treatment followed by refining. Ferronickel predominantly originates from lateritic ores which is converted into an impure product with a nickel content of around 30% and an iron content of up to 70%.

13. What are the parameters in mining influencing the primary energy demand of nickel and ferronickel production?

In mining, the most relevant parameters affecting the energy use (and consequently the carbon

footprint) are the physical location and properties of the ore deposit. Ore deposits in remote areas may require their own power supply with predominantly fossil energy sources. Shallow or massive ore deposits will require less energy per unit of production whereas disseminated and deep ore deposits may be higher in nickel content but more energy intensive to exploit. Also, the trend from sulfide to lateritic type ore deposits will result in an increase of the primary energy demand.

14. What are the parameters in smelting and refining influencing the primary energy demand of nickel and ferronickel production?

The composition of the mineral from which nickel is recovered directly affects the energy use. Nickel can be relatively easily removed from some ore minerals whereas others will require more intensive and complex processes. Also, the recovery of by-product metals that may be present in the ore body will require additional energy. The treatment of impurities also increases energy demand. Finally, environmental protection measures (e.g. off-gas cleaning) also results in additional energy use.

15. Can the data be compared with earlier life cycle data studies?

The two data sets are not comparable due to major differences in data quality and consistency.

16. Why are there sometimes significant differences between the data resulting from the study and data in public data bases such as Eco Invent?

The new data are real data from on-going operations. Data which can be found in public databases such as EcoInvent or the European Commission Life Cycle Database are often old data or even modeled data from

assumptions or extrapolations from partial data of unknown quality. There is a lag between the finalization of a peer-reviewed LCI such has been achieved for nickel and ferronickel and its integration into third party data bases.

17. Can one compare the life cycle data of nickel with other metal commodities?

A comparison of the LCI update for nickel with other metals is not meaningful as the methodologies of data collection, aggregation, allocation and analysis differ. Moreover, the life cycle methodologies associated with metal commodities such as copper, aluminium, steel or stainless steel provide for recycling, leading to significantly lower overall environmental footprints. By contrast, the life cycle environmental benefits of the recycling of nickel are largely reflected in the life cycle data associated with nickel-containing stainless steels.

18. What are the limitations of life cycle inventory (LCI) data?

LCI data provide an insight only into the environmental burdens associated with production in- puts and outputs and, in the case of nickel, do not reflect the role of recycling. Even if recycling was accounted for, LCI data ultimately only measure the debt side of the production of metals. The data do not take into account benefits and impacts (increased efficiencies, prolonged product life, etc.) realized during the use phase and recycling.

19. Is recycling also covered in the update of the life cycle data?

Unlike other metals such as copper, steel, lead or aluminium, the vast majority of the recycling of nickel takes place outside the nickel industry, mainly in the stainless steel industry. It is in the life cycle data of that industry where that the burdens and net benefits of recycling are reflected.

20. Who has access to the nickel and ferronickel life cycle data?

The data as well as the full life cycle update report can be made available upon request through the Nickel Institute website. The data are currently incorporated into the database of thinkstep AG (http://www.thinkstep.com), an international consultancy with expertise in the area of life cycle management. It is expected that the data will eventually appear in other public databases such as EcoInvent (http://www.ecoinvent.org) and the European Life Cycle Database (http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm).

21. Are site or company specific data available?

No. Life cycle data comprise highly sensitive information of competitive importance. If available, they would allow the calculation of production costs, process efficiencies and show production capacities. The LCI data study comprises only aggregated information for the industry globally.

22. Are regional life cycle data for nickel and ferronickel production available?

No. The nickel industry is characterized by a limited number of companies that account for more than 75% of the global nickel production. For confidentiality issues, regional or local data can only be shown in cases that there are at least 3 companies contributing, a situation that does not exist in the nickel industry.

23. Will another update of the life cycle data eventually be done?

The collection of life cycle data is very costly and resource intensive. Any future update can only be contemplated when significant changes – in technology, type and location of ore bodies, etc. – have occurred and have been in operation long enough to have generated a multi-year history of consistent data.

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