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HOTSPOT ANALYSIS OF CARBON FOOTPRINT IN FERRO-NIOBIUM PRODUCTION

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INTRODUCTION

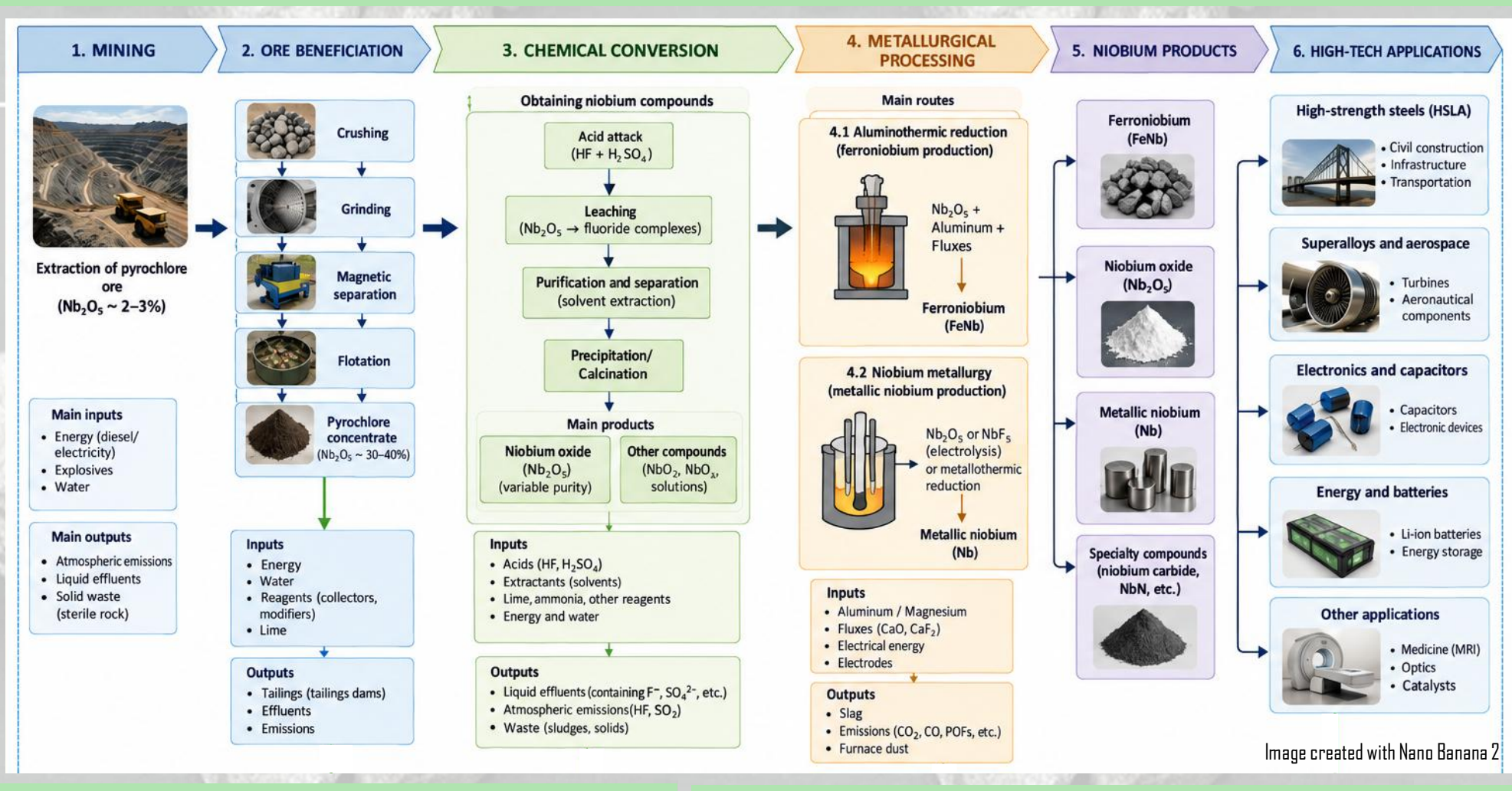


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OBJECTIVES

The present study aimed to carry out a hotspot analysis within a cradle-to-gate life cycle assessment (LCA) to quantify the carbon footprint (CFP) and identify the main contributors to GHG emissions in FeNb production.

EXPERIMENTAL

GOAL AND SCOPE DEFINITION

- LCA framework according to ISO 14044 [1].
- System boundary: cradle-to-gate (Mining, processing, and refining. Functional unit: 1 kg FeNb.

LIFE CYCLE INVENTORY (LCI)

- Inputs and outputs adapted from [2,3].
- Chemicals, energy and waste treatments datasets from database Ecoinvent 3.7.1.

LIFE CYCLE IMPACT ASSESSMENT (LCIA)

- Impact indicators were calculated using the IPCC 2021 method (ISO 14067).
- Uncertainty calculation by Monte Carlo Simulation.

RESULTS AND DISCUSSION

The CFP of FeNb production was 8.01 ± 0.39 kg CO_2 eq./kg FeNb. Fossil fuel emissions represented the dominant hotspot, contributing 7.33 ± 0.30 kg CO_2 eq./kg FeNb (92%).

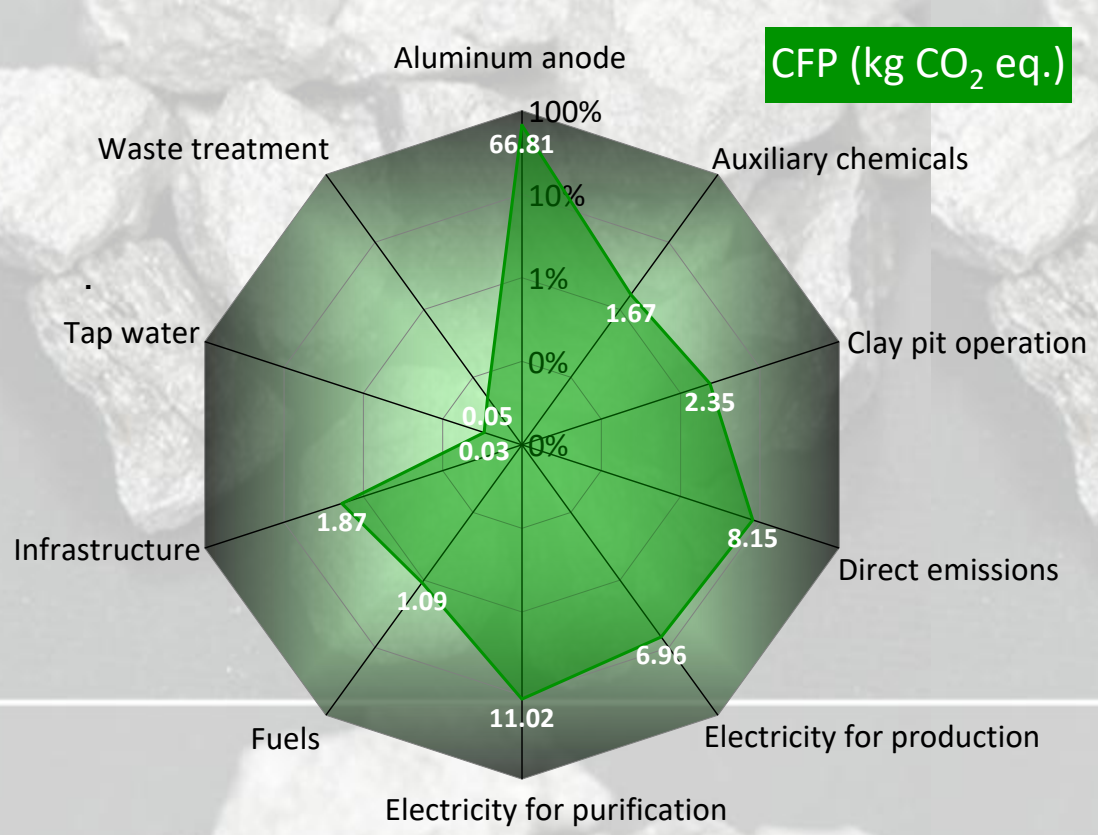


Figure 1. Hotspot analysis of FeNb production.

CONCLUSIONS

The production of FeNb presents global warming impacts largely dominated by fossil energy use. The identification of these hotspots could provide valuable guidance for environmental improvements toward more sustainable niobium-based alloy production systems.

REFERENCES

[1] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, Environmental Management — Life Cycle Assessment — Requirements and Guidelines. ISO 14044:2006(E). 2006

[2] DOLGANOVA, I. et al. Life cycle assessment of ferro niobium. *The International Journal of Life Cycle Assessment*, v. 25, p. 611–619, 2020.

[3] LIMA, L. S. et al. Life cycle assessment of ferroniobium and niobium oxides: Quantifying the reduction of environmental impacts as a result of production process improvements. *Journal of Cleaner Production*, v. 348, p. 131327, 2022.

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