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Life Cycle Assessment of Rare Earth Metals Production: Hotspot Analysis of Didymium Electrolysis Process

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Abstract : Nowadays, the rare earth (RE) metals play an important role in emerging technologies that are crucial for the decarbonisation of the energy sector. Their unique properties have led to increasing clean energy applications, such as wind turbine generators, and hybrid and electric vehicles. Despite the substantial media coverage that has recently surrounded the mining and processing of rare earth metals, very little quantitative information is available concerning their subsequent life stages, especially related to the metallic production of didymium (Nd-Pr) in fluoride molten salt system. Here we investigate a gate to gate scale life cycle assessment (LCA) of the didymium electrolysis based on three different scenarios of operational conditions. The product system is modeled with SimaPro Analyst 8.0.2 software, and IMPACT 2002+ was applied as an impact assessment tool. In order to develop a life cycle inventories built in software databases, patents, and other published sources together with energy/mass balance were utilized. Analysis indicates that from the 14 midpoint impact categories evaluated, the global warming potential (GWP) is the main contributors to the total environmental burden, ranging from 2.7E2 to 3.2E2 kg CO2eq/kg Nd-Pr. At the damage step assessment, the results suggest that slight changes in materials flows associated with enhancement of current efficiency (between 2.5% and 5%), could lead a reduction up to 12% and 15% of human health and climate change damage, respectively. Additionally, this paper highlights the knowledge gaps and future research efforts needing to understand the environmental impacts of Nd-Pr electrolysis process from the life cycle perspective.

Keywords : didymium electrolysis, environmental impacts, life cycle assessment, rare earth metals
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