PROSPECTIVE LIFE CYCLE ASSESSMENT FOR NICKEL SLAG VALORIZATION BY MINERAL CARBONATION

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Nickel slag management is a growing issue for the pyrometallurgical industries. The generated amounts are significant, but the valorization options are limited and low valuable. In the case of New-Caledonia, which is one of the five largest nickel producers in the world, the cumulated stock of slag reaches several tens of million tons and increases by further million tons each year. Currently, only a small amount of this waste is recovered as sand for concrete production. Moreover, pyrometallurgy highly consumes fossil-fuel energy and electricity for ore pre-treatment and nickel extraction, which produces significant CO_2 emissions.

A new valorization approach is suggested to improve the management of nickel slag and to settle an efficient valorization sector. The process consists of mineralizing CO_2 inside slag to produce silico-magnesian cement and supplementary cement materials which would partially replace clinker into cement. The benefit of this technology in a circular economy perspective is double: to reduce two local stocks (slag and CO_2 from nickel industries) and to produce building materials with a low environmental impact. However, many questions are to be answered for the organization of the sector (e.g. where to capture CO_2, which capture technology to use, where to sell products?) and for the operational conditions of the process (e.g. what mineralization rate to aim, is it required to optimize the process in terms of energy consumption?).

A prospective Life Cycle Assessment (LCA) is achieved with the Brightway framework to assess the organizational scenarios and the operational conditions of the process. The process being currently at a low Technology Readiness Level (TRL), the LCA is projected at the industrial level for a specified time-horizon. It enables to efficiently compare the process with the environmental challenges of the future.

The presentation focuses on the production of supplementary cement materials from nickel slag valorization then its use into the production of cement. The slag valorization sector with CCU is modelled (slag preparation, CO_2 capture, mineral carbonation, drying, supplementary cement materials production, selling with potential export and cement production), then compared with a future conventional cement. The scenarios which ensure an environmental performance are identified, such as the best values for the operational parameters of the process. These results will help to improve the process in development and will assist in the decision making for the settlement of the sector in New-Caledonia.