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PYROCHEMICAL PROCESS OPTIMIZATION FOR STRATEGIC METAL PREPARATION

Optimisation d'un procédé pyrochimique de préparation de métaux stratégiques

Rare earths are mainly composed of lanthanides and are used for electronics compounds, batteries and permanent magnets (for instance wind turbines engine). This project focus on the production and recycling of one of those metals: Neodymium. Neodymium is obtained by Nd_2O_3 electrolysis in a molten LiF-NdF_3 salt at 950°C to produce a liquid Nd-Fe alloys on Fe cathode (1) or 1050°C for pure liquid metal on inert cathode (2):

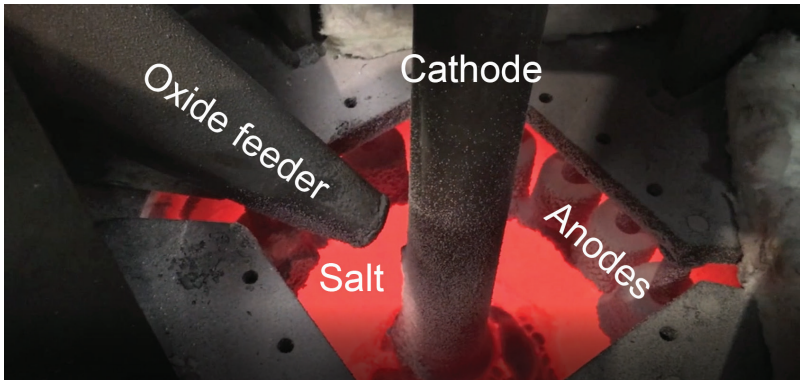
$$xNd_2O_{3(salt)} + yFe_{(s)} + \frac{3}{2}xC_{(s)} \rightarrow Nd_{2x}Fe_{y(l)} + \frac{3}{2}xCO_{2(g)} \quad (1)$$

$$2Nd_2O_{3(salt)} + 3C_{(s)} \rightarrow 4Nd_{(l)} + 3CO_{2(g)} \quad (2)$$

Liquid metal is denser than salt and decants before being collected. Nowadays, actual process works with a carbon anode oxidized into CO_2. The optimization of the process concerns multiple aspects. The first one the monitoring of the oxide feeding to assure enough oxide quantity on the anode for the reaction and to prevent sludge formation. Oxide concentration can be controlled insitu by electrochemical methods at working temperature and verified with an oxide analyzer.

Another aspect is the anodic gases production. Without sufficient Nd_2O_3 amount, the anodic reaction produces CF_x which isolate the anode and stop electrolysis; this phenomenon is called anode effect (AE). The objective is to prevent AE by understanding it, CF_x can be analyzed and quantify by IR-spectroscopy. In the same time, other materials (without carbon) are investigated for inert anode and produce O_2, inspired by all works done on a similar process (aluminum's production).

At last the surface tension of the liquid metal and the coalescence of metallic drops produced during electrolysis are important to ensure decantation and recovery of the Neodymium. The surface tension can be analyzed with the sessile and pendant drop methods using the X-Ray visualization setup.



Industrial pilot for rare earths production by electrochemical process in molten salt