

# **The evolution of mineral processing in extraction of rare earth elements using liquid-liquid extraction: A review**

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## **A B S T R A C T**

The attempt to extract rare earth elements (REE) has started over a century ago using activated carbon and continues until today with various methods involved to improve the extraction yield. Instead of solid-liquid extraction, the use of liquid-liquid extraction (LLE) has been more common due to the convenient arrangement of the process. Solvent extraction is the main process applied in LLE of REE and along the way, various kind of solvent extractants have evolved. The use of traditional extractants (e.g., benzene, heptane, and kerosene) in LLE has been diverted to the application of conventional extractants (e.g., tributyl phosphate (TBP), di-(2-ethylhexyl) phosphoric acid (D2EHPA), and Cyanex 923 to increase the extraction efficiency. Apparently, the disadvantages of conventional extractants have led to the application of ionic liquid (IL) in the evolution of extraction of REE. IL was found as a potential extractant for REE due to its ability to extract certain metals, green solvent, and has the flexibility to create different combination of cation and anion. However, conventional extractants appear to be more effective in the extraction of REE compared to IL. Therefore, the complex solvents are then compromised and synergised to create better extractant with both advantages between conventional extractants and IL. Most synergistic extractants (SE) appear to be more effective in the extraction of REE and able to reduce the use of chemicals. These advantages make SE more desirable in solvent extraction. This paper highlights the evolution of REE extraction using various kind of extractants with advantages and disadvantages discoveries based on various literatures.

### ***Keywords:***

Rare earth elements; Liquid-liquid extraction; Ionic liquid; Synergist; Conventional extractant