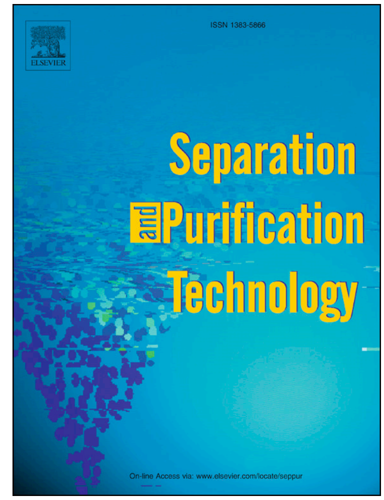
Accepted Manuscript



Novel extractant (2,4-dimethylheptyl)(2,4,4'-trimethylpentyl)phosphinic acid (USTB-2) for rare earths extraction and separation from chloride media

Junlian Wang, Xinyu Liu, Jiashuai Fu, Meiying Xie, Guoyong Huang, Huajun Wang

PII: S1383-5866(18)31997-X
DOI: https://doi.org/10.1016/j.seppur.2018.09.020
Reference: SEPPUR 14918

To appear in: *Separation and Purification Technology*

Received Date: 8 June 2018
Revised Date: 7 September 2018
Accepted Date: 9 September 2018

Please cite this article as: J. Wang, X. Liu, J. Fu, M. Xie, G. Huang, H. Wang, Novel extractant (2,4-dimethylheptyl) (2,4,4'-trimethylpentyl)phosphinic acid (USTB-2) for rare earths extraction and separation from chloride media, *Separation and Purification Technology* (2018), doi: https://doi.org/10.1016/j.seppur.2018.09.020

Novel extractant (2,4-dimethylheptyl)(2,4,4'-trimethylpentyl)phosphinic acid (USTB-2) for rare earths extraction and separation from chloride media

Junlian Wang[a*], Xinyu Liu[a], Jiashuai Fu[a], Meiying Xie [a], Guoyong Huang [b*], Huajun Wang[a*]

[a] *School of Civil and Resource Engineering, University of Science and Technology Beijing, Beijing 100083, China*

[b] *School of Metallurgy and Environment, Central South University, Changsha, 410083, China*

Abstract Scientists have always been seeking more efficient extractants for rare earths extraction and separation, especially for heavy rare earths. In this paper, a novel extractant (2,4-dimethylheptyl)(2,4,4'-trimethylpentyl)phosphinic acid (USTB-2) was synthesized. The structures of the intermediate and USTB-2 were characterized by ^{31}P NMR, ^{1}H NMR, FT-IR and ESI-MS. Its pK_a was 5.62. Its extraction ability was between Cyanex 272 and P507. Its extraction mechanism was cation exchange. Its extraction capacity was larger than that of Cyanex 272 and lower than that of P507. Its solubility in 3 mol/L HCl and deionized water was 11.2 mg/L and 19.0 mg/L, respectively. The Lu(III) loaded in USTB-2 solution can be easily stripped by HCl, HNO_3 and H_2SO_4. It has good separation performance for heavy rare earths. Its average separation factor ($\overline{\beta}$) for adjacent heavy REs from Gd to Lu was 2.18. For some heavy RE couples like Er/Ho, Yb/Tm and Lu/Yb (especially for Lu/Yb), USTB-2 possesses even better separation performance than Cyanex 272. Its extraction efficiency for nonferrous metal ions was in the order Al > Gd > Zn > Nd > La > Co > Cu. The separation factors of Al/Gd, Gd/Zn, Zn/Nd, La/Co by USTB-2 were 2.67, 5.39, 3.35 and 26.67, respectively.

Keywords extractant; USTB-2; rare earths; extraction; separation

1. Introduction

Rare earths (Sc, Y and lanthanides, abbr. REs) are very important in the high-tech fields (such as new energy vehicles, artificial intelligence robots, aeronautics and astronautics) due to their excellent and unique physical and chemical properties. They can generate a large variety of novel materials with different properties when combined with other materials. Most importantly, the quality and performance of the materials can be greatly improved when rare earth elements were doped[1]. However, the high performance materials are closely related to the REs purity. Unfortunately, the REs always coexist in nature and it is very difficult to separate them completely due to their very similar physical and chemical properties.

Solvent extraction is the most common method for REs extraction and separation in industry. And extractant is the most fundamental and important factor that determines the single RE purity and the production cost. Though cascade extraction is an efficient way to improve the single RE purity, the number of stages also depends on the extractant separation performance. So exploring more efficient extractants for REs separation has always been a research hotspot. Various kinds of novel extractants have been created and studied, such as calix[4]arene[2-4], carbamoyl-carboxylic acids[5, 6], phenoxy carboxylic acids[7] and ionic liquids[8-13]. A number of synergistic extractant systems have also been focused on, like P507-isooctanol[14],