Influence of Silica Gel Size on the Removal of Rare Earth Elements from Aqueous Solutions using Modified Silica-PAN/Acetyl Acetone

Deepika Laskhmi Ramasamy, Eveliina Repo, Mika Sillanpää

Laboratory of Green Chemistry, Lappeenranta University of Technology

Abstract

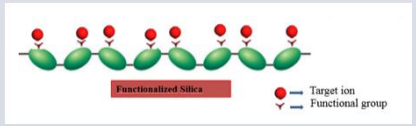
This research study aims to determine the influence of silica gel size (A.B,C) for the recovery of precious metals and rare earth elements with high efficiency in the lower range of concentration till 25 ppm in acidic medium. Optimization of reaction conditions with various chelating and analytical ligands were carried out in order to achieve the highest recovery efficiency. This study also includes the effect of pH, dosage, temperature on the removal efficiency.

Key words – Silica gel, Activated silica, functionalized silica gel.

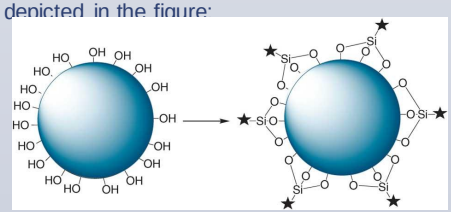
Aims and Objectives

- Functionalization and characterization of the novel adsorbents.
- Optimization of the process conditions.
- Recovery of target metals such as Cerium, Lanthanum, Erbium, Europium and Scandium using modified adsorbents.

The probable mechanistic pathway of adsorption for such compound is shown below:



Schematic representation of silylation is depicted in the figure:



Materials and Methods

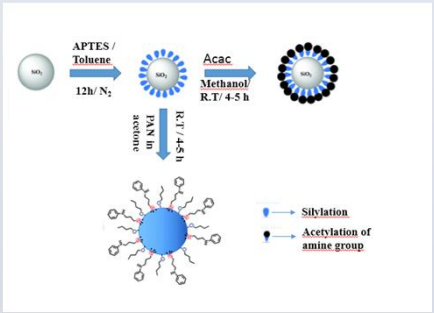
Materials :

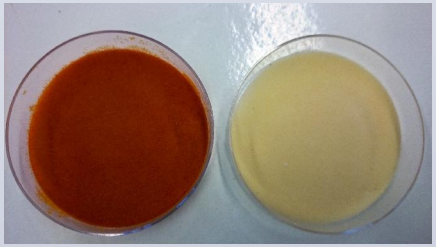
Silica gel, 3-Aminopropyl-triethoxy Silane, Toluene (C_7H_8), Ethanol (C_2H_5OH), Acetone (C_3H_6O), 1-(2-Pyridylazo)-2-raphthol, PAN ($C_{15}H_{11}N_3O$)*and* Acetylacetone ($C_5H_8O_2$).

Method :

- Silane coupling agents - 3-Aminopropyl-triethoxy Silane.
- Functionalization of modified silica surface
  - ➢ PAN
  - ➢ Acetylacetone (Acac)

Schematic pathway of functionalized silica surface is shown below –

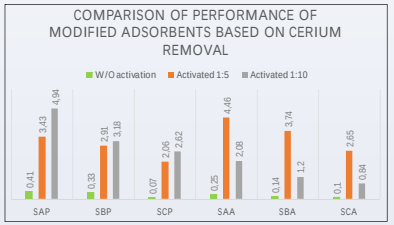


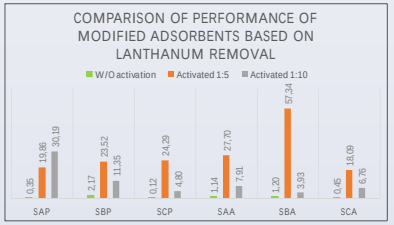


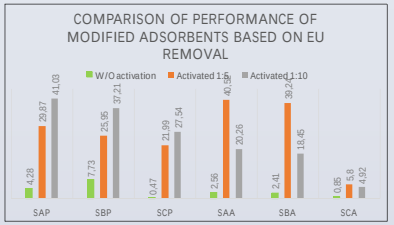
PAN modified Silica Acac modified Silica

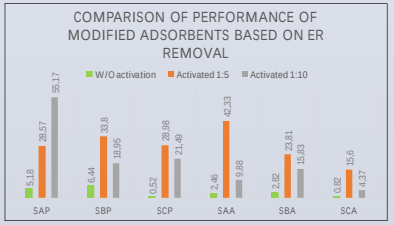
Results and Discussion

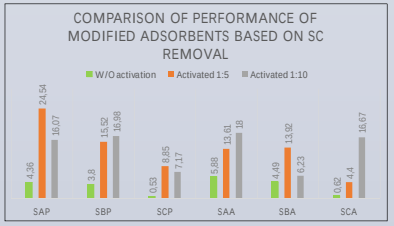
Reaction condition: pH 6, 24h, 220 rpm, R.T.











Conclusions

- Comparing the results with different silica gel sizes, the best performance was obtained with Silica A (0.015 – 0.04mm) having minimum particle size.
- Comparing the different functionlized silica gels, the PAN modified Silica gel gave better results as compared to other modified silica gels.
- Comparing the modification with different ratio of chelating and analytical ligands onto the surface of silica functional OH groups, PAN modified silica gel worked better with 1:10 ratio in most of the cases while acac modified silica gel gave good results with 1:5.

Prospects

- Evaluate the efficiency of the prepared adsorbents in the target metal recovery for real world mining effluents.
- Kinetic and adsorption modeling for further information of the underlying mechanism.
- Establish selectivity through experiments using competing ions

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