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RESEARCH ARTICLE

SYNERGETIC AND EFFICIANT EXTRACTION STUDY OF SOME LANTHANIDE (III) IONS BY USING 8-HYDROXYQUINOLINE WITH GREEN PHASE TRANSFER CROWN ETHER EXTRACTANTS IN ORGANIC MEDIA FROM STRONG ACIDIC MEDIA

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Abstract

The aim of present investigation was the study of extraction ability of 8-hydroxyquinoline in presence of DCH18C6, DB18C6, and DBP18C6 crown ethers for selected lanthanide (III) ions from acidic media to DMSO/$CHCl_3$ solvent system. The influence of nitric acid concentrations on selectivity of extraction were studied in relation to pH, D and α values. The effects of pH of medium, Solvent, Crown ether ligands and concentrations of crown ethers were also studied on synergetic extraction of lanthanide(III) ions. Very interesting results were observed for synergetic and efficient extraction of Ln(III) ions from acidic media to DMSO/$CHCl_3$. The crown ether DCH18C6(Dibenzo Cyclohexyl 18-Crown-6) had shown high separation ability for Ln(III) ions for optimum 5 µM concentration at acidic pH equal to 3.8 from strong acidic media with 8-hydroxyquinoline as compared to original 18C6 and other derivatives. This simple, efficient and rapid liquid-liquid synergetic extraction method of Ln(III) ions and rare earths found perspective applications as an analytical method for their separation and extractive spectrometric determination..

1. Introduction:

Lanthanide(III) complexes with various ligands and Schiff's bases have wide applications in optical imaging of cells, diagnostic pathways, as shift reagents in NMR. Lanthanide ions are trace elements of nature which had got importance in terms of recent applications in electronics, nanotechnology and new emerging areas of space technology. So there is scope for development of novel, cheaper extraction and determination methods for lanthanides and trace metals. In past few decades there is growing interest in the development of novel methods for determination and extraction of rare earths like lanthanides. Solvent extraction methods are methods of separation of metal-ions, their enrichment, purification, identification and analysis. Supramolecular and solvent extraction chemistry both combinely applied to extraction and determination of rare earths. Some of derivatives of crown ethers have well complexing ability with lanthanide (III) ions, hence study of factors affecting their stability is important. The heterocyclic ligands like 8-hydroxyquinoline forms stable colored complexes with Lanthanides. Collectively these agents gives synergetic effect on extraction of Ln (III) ions. Literature survey reveals that few work is done on study of synergetic effect and factors affecting for extraction of Lanthanide(III) ions with heterocyclic extractants and crown ethers. The present work constitute study of such effect of extraction on Lanthanide (III) ions using selected crown ethers and 8-hydroxyquinoline from strong acidic media for extraction, and factors affecting the extraction as well as the development of a novel method for extraction and for extractive spectrophotometric determination of lanthanides from analyte samples like radioactive waste. Furthermore work in this paper includes study of factors affecting synergetic extraction, selection of suitable solvent, crown ether as green phase transfer agent and extractant for separation of lanthanides from aqueous phase to organic phase and the work aimed to set up analytical method of separation and spectrometric determination of rare earths.

2. Experimental method:

A.R. grade lanthanide (III) nitrate salts, crown ethers, 8-hydroxiquinoline extractant and organic solvents were procured from S.D.Fine Chem. ltd. Borosil glass wares and Systronics double beam spectrophotometer were used for extraction and determination of lanthanides. Stock solutions of lanthanide (III) ions containing 100 ppm. of lanthanides(III) were prepared from nitrate salts in 1M HNO_3, first dissolving salts in few ml. of acid and solutions were diluted with double distilled water. The concentrations of acids made from 0.25 to 1M. The crown ethers 18C6, and its derivatives DB18C6[Dibenzo], DBP18C6[Dibenzo Pyrazyl], DCH18C[Dibenzo Cyclohexyl] were used for extraction studies with concentrations from 1µM to 5µM in aqueous medium. The extractant 8-hydroxyquinoline with fixed concentration of 0.1mM in DMSO used for extractions. The effect of pH were studied by maintaining pH of medium using acetate and ammonia buffers. The effects of various solvent system studied using solvents acetone, pet. ether, chloroform. The extraction of lanthanides La(III), Ce (III) and Pr(III), Nd(III) couples were studied in two sets, first using only crown ethers in organic phases and in second synergetic study using the crown ethers and extractant solutions in organic phases from strong nitric acidic media. In first set, extraction of Lanthanide ions were studied by taking 10 ml. of Lanthanide solutions[10 to 100 ppm.], 10 ml. of crown ethers and 25 ml. of organic solvents for phase separation by shaking for 5 minutes in 125 ml. saperatory funnels. The extracted Lanthanides determined spectrophotometrically using Arsanazo(III) reagent at their λmax by first plotting the calibration curves on the basis of Arsanazo (III) complexation with Lanthanide stock solutions. In second set, Synergetic extraction of Lanthanides were studied adding 10 ml. of 8-hydroxyquinoline solution to above set. The extracted Lanthanides in solvent system were determined for colored complexes with extractant Spectrophotometrically. The separation factors(α) and Distribution coefficients(D) for successive lanthanides extractions were determined on the basis of Lanthanide concentrations before and after extraction in ppm. units. The extraction and determination carried out from strong acidic media using varying concentrations of nitric acid. The effect of acid concentrations, crown ethers, solvent system, pH on extraction were studied. All the effects on extraction were studied on the basis of separation factors and distribution coefficients for La(III), Ce (III) and Pr(III), Nd(III) couples.

Here, $D = LnIII_{(org.)} / LnIII_{(aq.)}$ and $\alpha = D_1 / D_2$ where 1 and 2 are successive Ln(III) ions

3. Results and Discussion:

Very interesting results were obtained from Crown ether separation and synergetic extraction of Lanthanides from nitric acid media. It is observed from data that separation ability of DCH18C6 is higher for higher concentration (5 micro-mol./lit.) of acid media(1M) and synergetic effect observed in combination with heterocyclic extractant 8-hydroxyquinoline on the basis of high D values for extraction. The separation factors and distribution coefficients for Lanthanides increases with slight increase in size from Nd(III), Pr(III), Ce(III) to La(III). The Ln(III) and 8-hydroxyqunoline complexes have high stability and DCH18C6 is most suitable for separation of Lanthanides which gives higher D values for extraction of Lanthanides from high concentrations of strong acid media. So DCH18C6 can be used for synergetic separation of Ln(III) ions for complexation with heterocyclic ligands and spectrometric determination.

Graphical abstract :

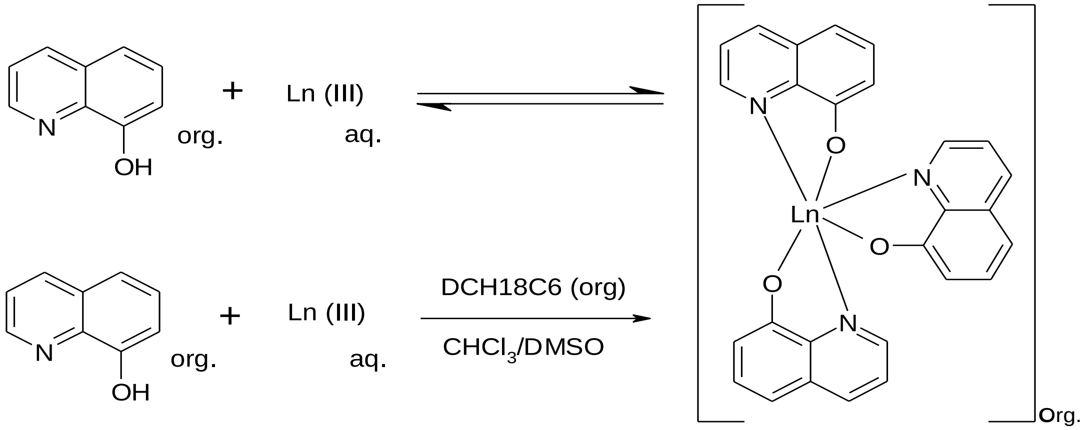

Figure 1: Effect of concentration of crown ethers and selection of crown ether.

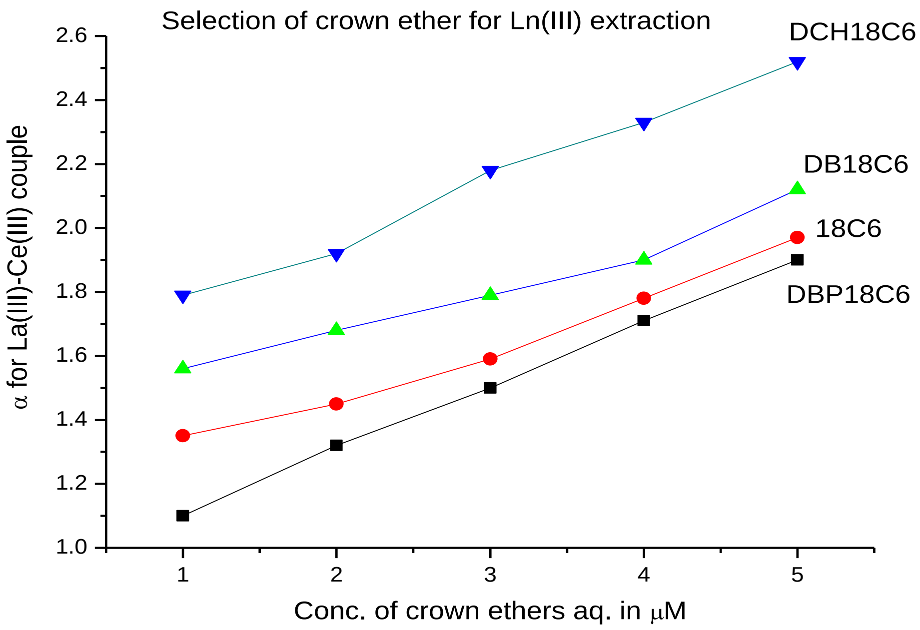

Figure 2: Effect of crown ethers on extraction and selection of optimum concentration

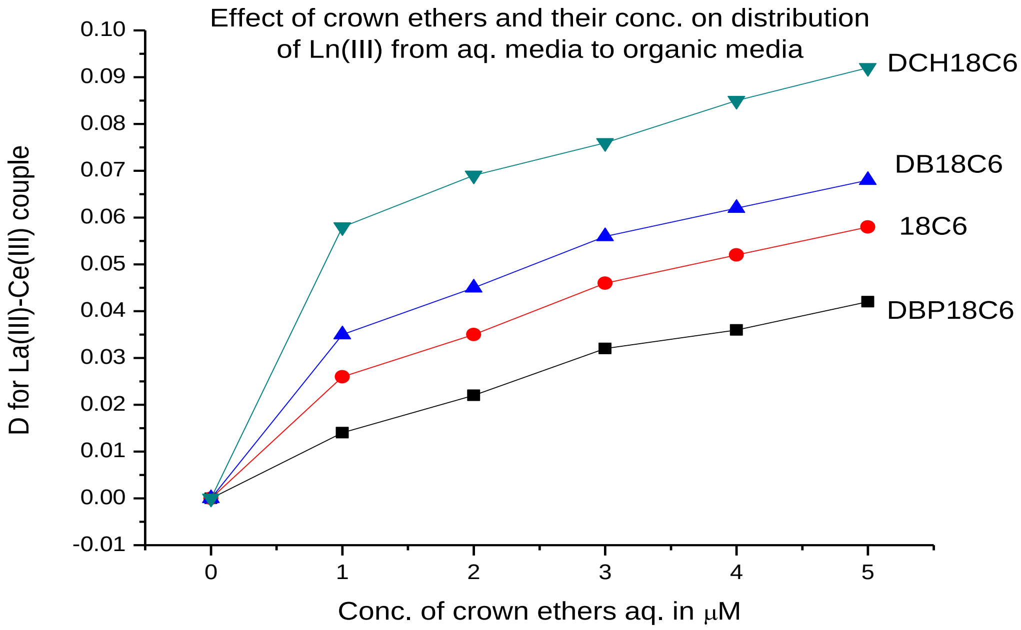

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Figure 3 : Calibration plot for Ln(III)- Arsanazo(III) complexation and extraction with 5μM DCH18C6

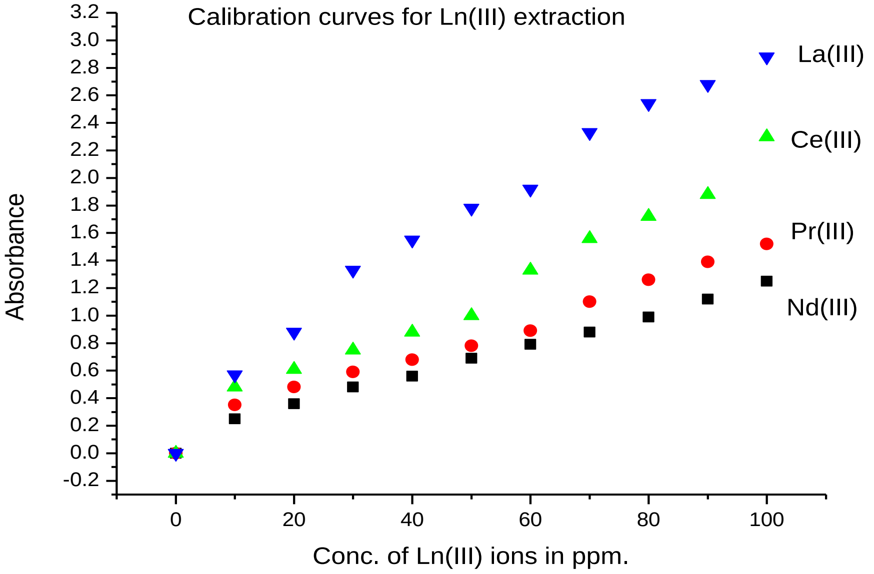

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Figure 4: Extraction distribution coefficients for Ln(III) and verification of selected medium and extractants

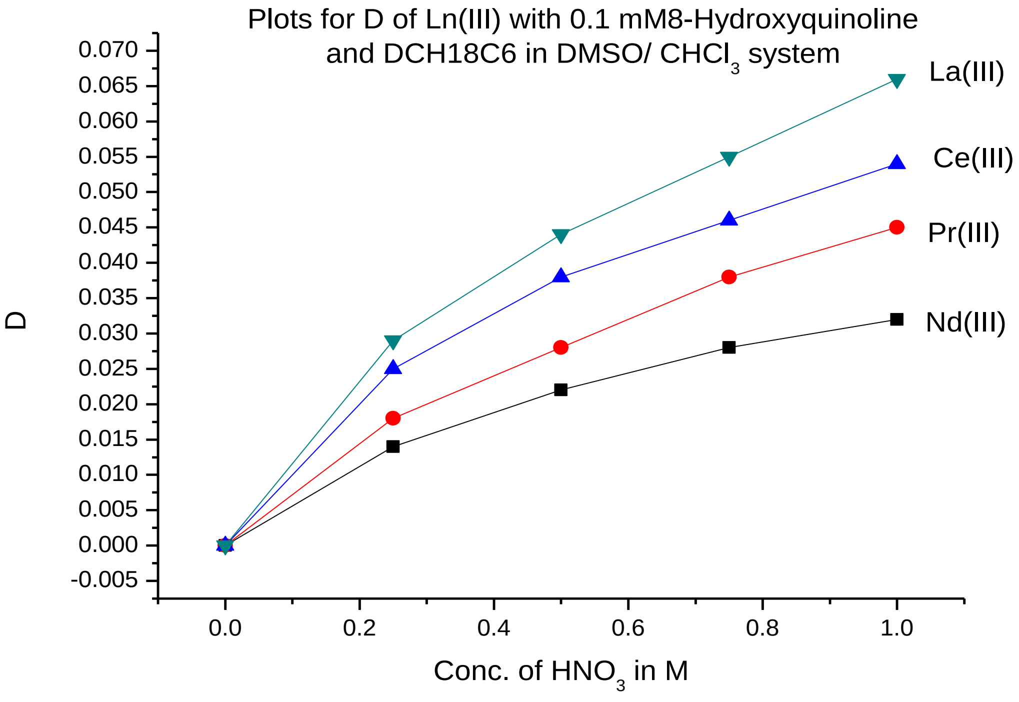
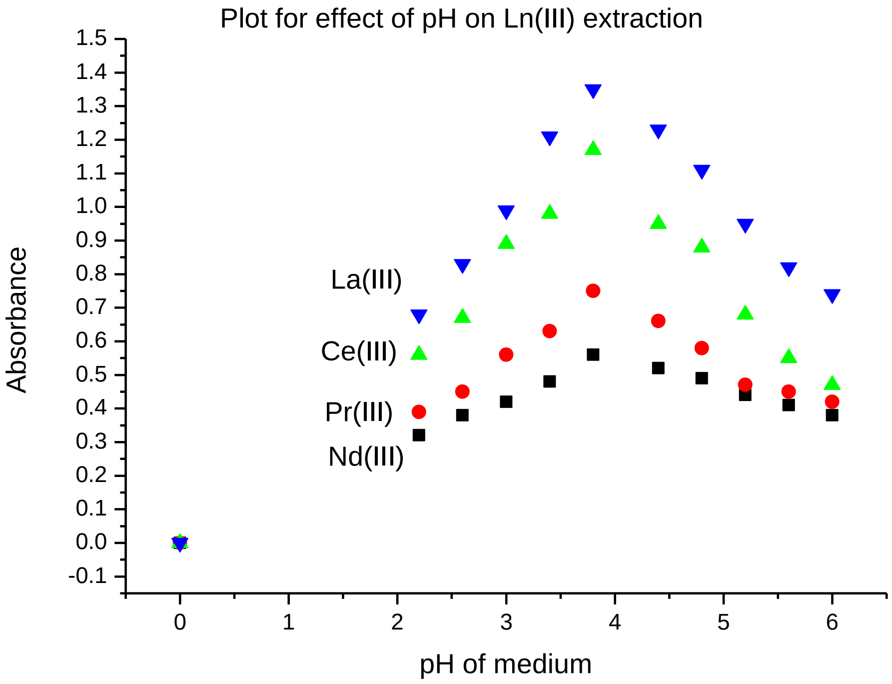


Figure 5 : Effect of pH on extraction of Ln(III) from acidic media to DMSO/ Chloroform system with 8- hydroxyquinoline and DCH18C6



Lanthanides followed high distribution order as La(III)>Ce(III)>Pr(III)>Nd(III). The synergetic effect with 8-hydroxyquinoline and the crown ethers observed according to higher D values. The separation ability α of crown ethers observed was expressed as DCH18C6>DB18C6 >18C6>DBP18C6. The effect of solvent system for separation of Ln(III) ions from acidic media with 1M conc. was observed as Chloroform/DMSO> Acetone/DMSO> Pet. Ether/DMSO. Hence by referring figures from 1 to 5 correct optimum conditions and parameters for synergetic extraction and spectrometric determination of Ln(III) ions were fixed as 1M nitric acid for dissolution and preparation of Ln(III) aq. analyte solution, 5µM aq. DCH18C6 crown ether along with 0.1mM 8-hydroxyquinoline in Chloroform/DMSO system for extraction, and pH=3.8 for efficient extraction of Ln(III) ions.

4. Conclusion :

It was observed that the crown ether DCH18C6 extract Lanthanides from strong Nitric acidic media and given synergetic extraction to Chloroform/DMSO phase in addition with heterocyclic extractant like 8-hydroxyquinoline. Hence this is a novel and cheaper method for separation and spectrometric determination of Lanthanides from samples like radioactive waste. Here we had developed an analytical extractive spectrophotometric method for rapid, efficient extraction of rare earth elements using green crown ether and heterocyclic extractants.

5.Acknowledgement:

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6.References :

[1] Bunzli, J.C.G., J.R. Yersin and C.M., J. Inorg. Chem., 21:1471-1476, 1982.
[2]Demin ,S.V., V.I.Zhilov,A.Y.Tsivadzc, V.V. Yakshin, O.N.V., Russ.J.Inorg.Chem.51:1678-1681, 2006.
[3] Alizadeh, N.M.Shamsipur, Talanta ,40:503-506, 1993.
[4] Egorova, N.S., V.V. Belova, A.A.V.,Russ.J.Inorg.Chem.,50:1781-1785,2005.
[5] Gupta V.K., S.Jain and S.Chandra, Anal.Chem.Acta.,486:199-207, 2003.
[6] Horwitz, E.P.,M.L.D. and D.E.F.,9:1-25, 1991.
[7] Frensdorff, H.K., J.Am.Che.Soc.,93:600-606, 1971.
[8] Bunzli,J.C.G. and C.Piguet, Chem.Rev.,102:1897-1928, 2002.
[9] Inorganic qualitative and quantitative analysis, A.I.Vogel.
[10] Pedersen C.J., J. Am. Chem. Soc.,89:7017, 1967.
[11] Lakkis M., Brunette J.P., Leroy M.J.F., Solvent Extr. Ion Exch.4:287, 1986.
[12] Sastre A.M., Sahmoune A., Brunette J.P., Leroy M.J.F.,Solvent Extr. Ion Exch.7:395, 1989.