Study of Effect of Equilibrium Time and Concentration on Extraction of Metal Ions Using Ionophore1-(2-Methyl-4-(2-Methylphenyldiazenyl) Phenyl) Azonapthalen-2-Ol

KIRTIYADAV[1] AND VIJAY R. CHOUREY[2]

Kasturbagram Rural Institute Indore, India[1]
Govt. Holkar Science College Indore, India[2]
Corresponding Author: kirtiyadav74@gmail.com

Abstract

Concentration of metal salt and ionophore and time of extraction is an important parameter to determine rate of extraction of metal ions through ligands/ ionophores.The corresponding change in the concentration of metal ions in the membrane phase was determined with effect of time onliquid-liquid membrane extraction studies of transition metal cations (Co^{2+}, Ni^{2+}, Cu^{2+} and Zn^{2+}) using Ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol or (S-IV). The experiment have been carried out at room temperature and extracted amount of metal ions were determined volumetrically. Chloroform is used as Organic liquid membrane. From the results, it has been observed that during the process of extraction the performance of extraction increases as the time of extraction is increases and maximum extraction reached at particular time for particular metal ion and then decreases due to the back extraction process.

Key words: Extraction, liquid-liquid membrane, ionophore, transition metal cations, back extraction.

Introduction:

Concentration of metal salt and ionophore in the liquid membrane extraction studies is the important factors. With the help of these factors ions can be easily separatout from the one liquid membrane phase to another liquid membrane. Thus, it is a very important factor in the field of separation sciences. Solvent extraction[1] process based on simple organic complexing extractants are often used commercially for the recovery and purification of metal ions. Metal ion extraction depends up on number of parameters. Some of these include ligand structure, pH of solutions, solvent, temperature and time of extraction[2].

This paper deals with the study of effect of time of extraction of metal ion from aqueous phase to organic membrane as well as concentration of metal cations (copper (II), Nickel(II), Cobalt(II) and Zinc(II)) with ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol on the process of extraction.

Materials and Methodology

All chemicals, throughout the course of experimental work, used were of AnalaR or GR grade and were used as supplied.

Ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol (S-IV) were obtained from Fluka. Chloroform from Merck was used as solvent systems. Solutions of Metal Salts i.e. $Co(NO_3)_2$, $NiSO_4$, $Cu(NO_3)_2$, $ZnSO_4$ were prepared in doubly distilled water.

Extraction Studies:

In the extraction study aqueous metal salt solution was vigorously stirred with ionophore solution. The amount of the cation extracted by the ionophore was determined by its difference in aqueous phase before and after extraction[3].

Concentration variation:

These experiments were carried out by varying the ionophore concentrations and keeping each metal salt concentration constant. In the same way variation of ionophore concentration were carried out at some other concentrations of same metal salt.

Effect of Time on Extraction:

This investigation has been performed to study the effect of time on extraction. For these work aqueous metal salt solution was vigorously stirred with ionophore solution in Chloroform in different sets of beakers keeping the amount of salt solution, ionophore solution and solvent volume as constant[4]. The time of this process was varied up to half an hour to 4 hours for different sets. The depleted aqueous phase was removed from beaker at some assigned time from beaker to each to measure the change in the absorbance of ionophore after complexation with metal ions and the analysis of metal content. The metal content in aqueous phase was analyzed by volumetric method. To study the effect of time on extraction the graphs were obtained between the time and extracted amount of metal ions by ionophore. Results of extraction are reported in the figure(1 to 6).

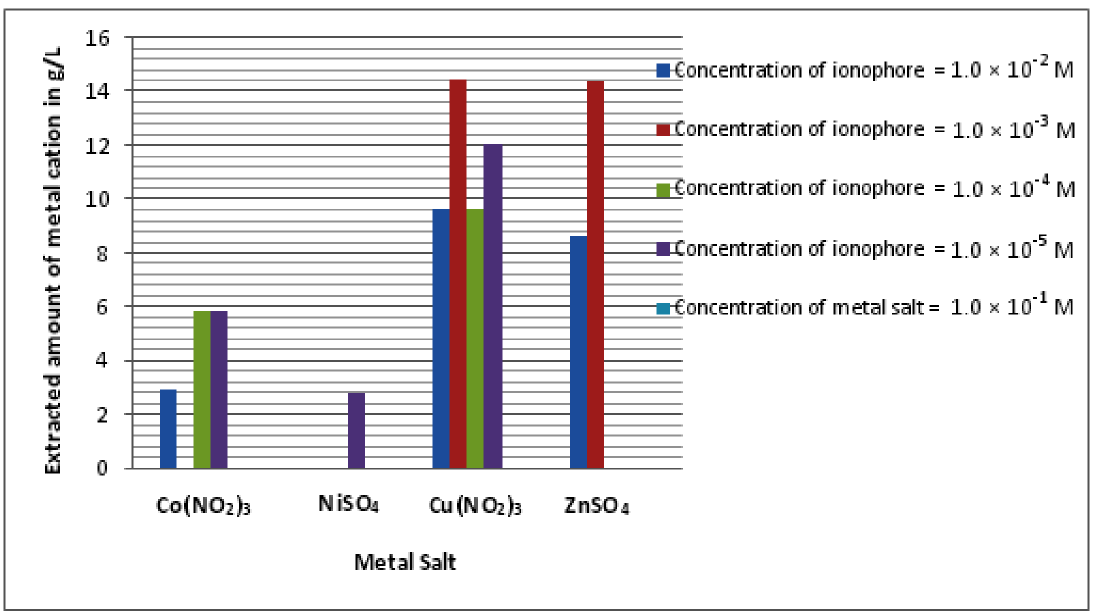

Figure:1 Amount of metal cation extracted at varying concentration (in Molar) of ionophore**S-IV** in Chloroformlayer in 4 hrsduration.

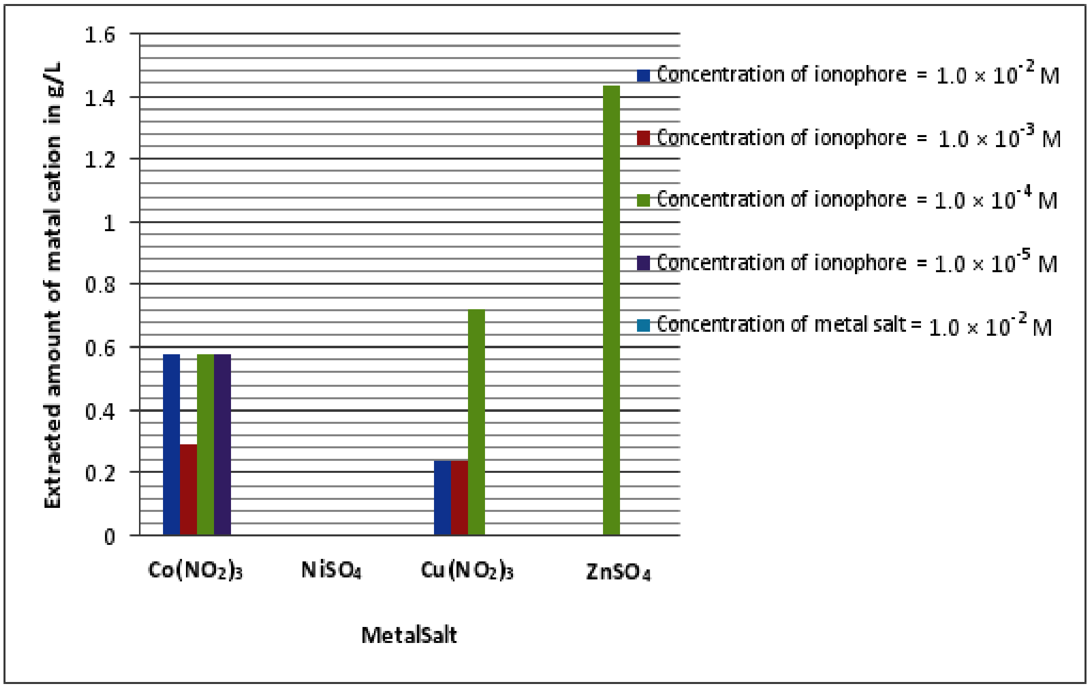

Figure:2 Amount of metal cation extracted at varying concentration (in Molar) of ionophore**S-IV** in Chloroformlayer in 4 hrsduration.

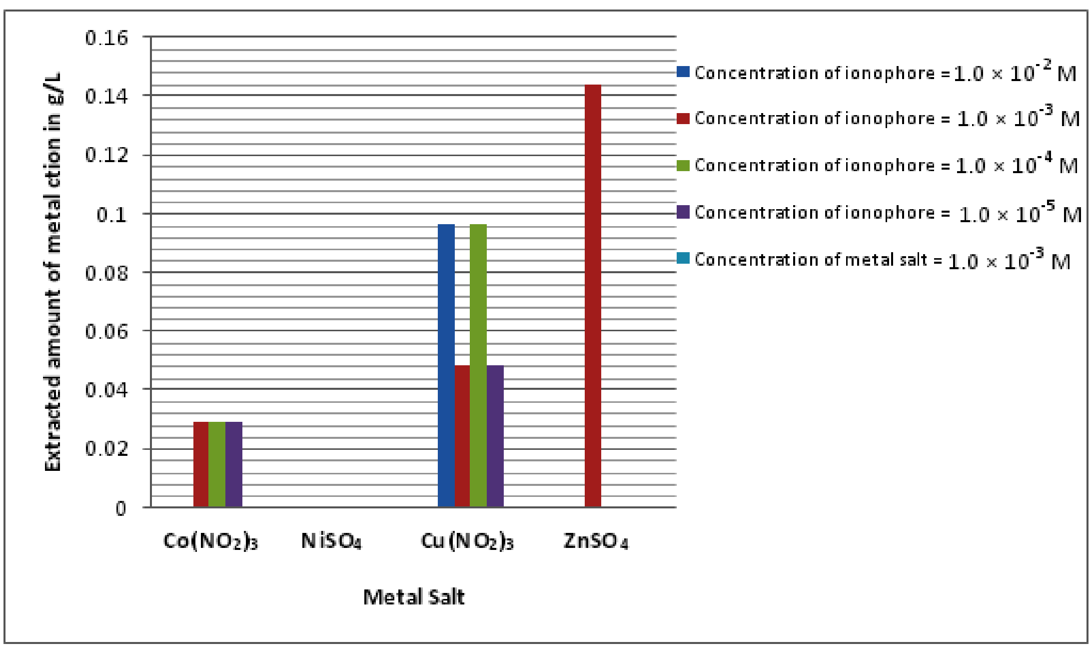

Figure:3 Amount of metal cation extracted at varying concentration (in Molar) of ionophore**S-IV** in Chloroformlayer in 4 hrsduration.

Effect of equilibrium time on Extraction

Metal salt concentration ($Co(NO_3)_2$) – 1.0×10^{-1}M

Ionophore concentration (S-IV) – 1.0×10^{-5} M

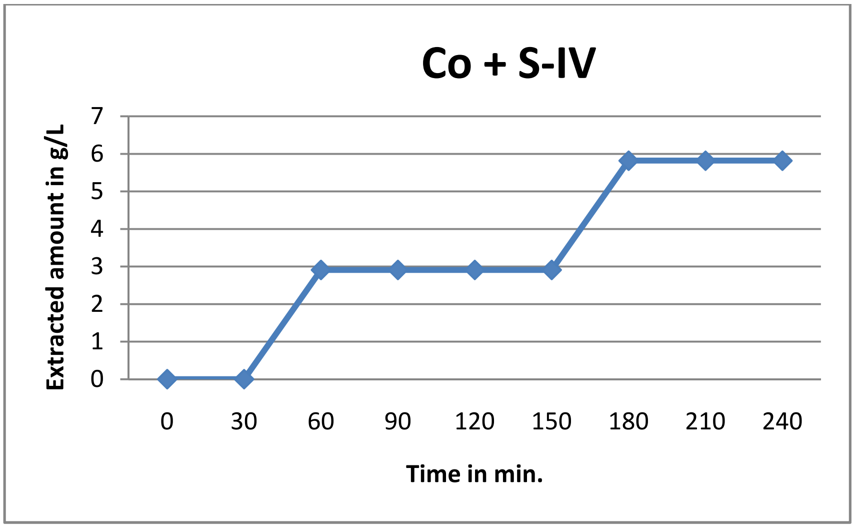

Figure:4 Extracted amount in g/L vs. Time in min

Metal salts concentration (Cu(NO3)2) – 1.0×10^{-1} M

Ionophore concentration (S-IV) – 1.0×10^{-5} M

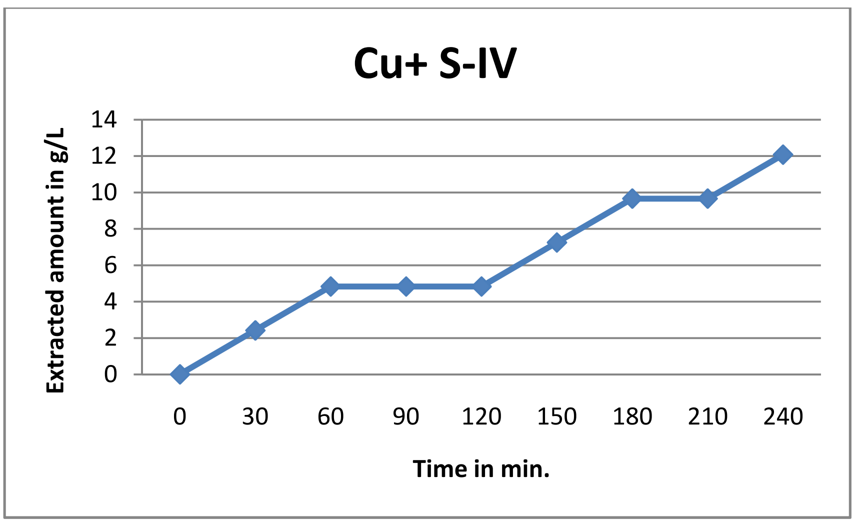

Figure – 5: Extracted amount in g/L vs. Time in min

Metal salts concentration (ZnSO4) – 1.0×10^{-2} M
Ionophore concentration (S-IV) – 1.0×10^{-5} M

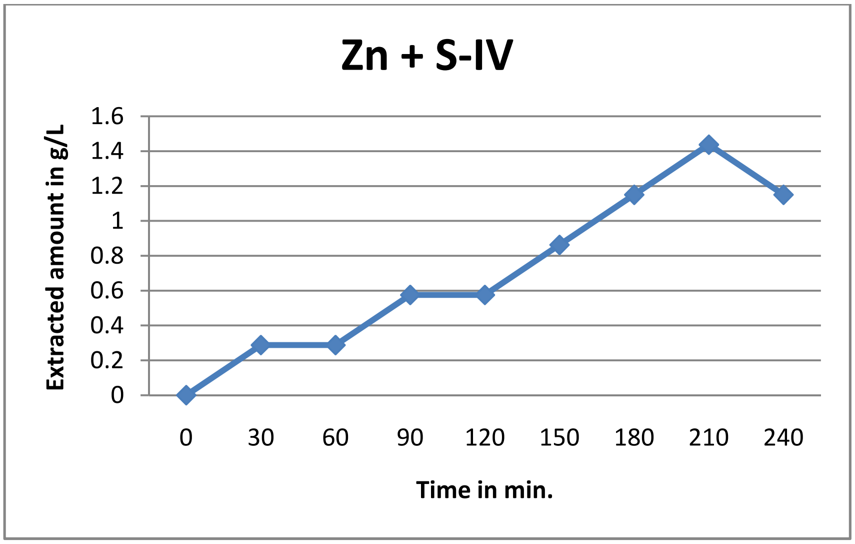

Figure – 6: Extracted amount in g/L vs. Time in min

Results and Discussion:

Results of extraction of MX (metal salt) ($Co(NO_3)_2$, $NiSO_4$, $Cu(NO_3)_2$, $ZnSO_4$) with ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol is discussed in the following Para. Reproducibility of all experiments was checked.

Extraction Studies

Extraction studies were conducted to ascertain the occurrence of complexation between MX salts and ligand in solution state[5]. The studies were focused on the capacity of the various ionophores to extract metal cation from an aqueous phase into an organic phase by complexation. In the present study extraction of transition metal ions (Co^{2+}, Ni^{2+}, Cu^{2+} and Zn^{2+}) with ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-olconducted at various concentration ranges. The results of extraction indicate that the concentration variation affects the complexation of 1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-olwith metal cations.

Effect of metal ion and ionophore concentration variation:

The metal salts concentrations were varied from 1.0 x 10-1 M to 1.0 x 10-3 M and ionophore (S-IV) concentration was varied from 1.0×10^{-2}M to 1.0×10^{-5}M. From figure 4 it is observed that optimum concentration of ionophore is found to be 1.0 x 10-5M for extraction of Co^{2+}, Cu^{2+} ions and for Zn^{2+} ions it is found to be 1.0×10^{-3} M. (fig. 1to 3). The optimum concentration of metal ions for extraction is found to be 1.0 x 10-1 M. From the results the trend of extraction of metal ions with ionophoreis $Cu^{2+} > Zn^{2+} > Co^{2+}$ while Ni^{2+} does not extracted by ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol. From the result it is clear that ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol is better extractant for Cu^{2+} ions.

Effect of equilibrium time on extraction:

In the present work the experiments have been carried out to study the effect of equilibrium time on extraction of transition metal cations (Co^{2+}, Ni^{2+}, Cu^{2+} and Zn^{2+}) with ionophores1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol. All experiments were performed at optimized condition.

The extraction time is defined as the time at which solute is transferred between the two immiscible phases. From the results of extraction it is observed that the extraction performance is increases with increase in extraction time and reached maximum. Time for maximum extraction is different for different metal ions (Co^{2+}, Ni^{2+}, Cu^{2+} and Zn^{2+}) withionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol.

In case of extraction of Co^{2+} -with ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-ol it was found that during the process of extraction equilibrium exist within 180 min. due to the saturation of ions in the membrane phase.[6] A further increase in time results shows the rate of extraction becomes constant due to the attainment of saturation[7] in the membrane phase (figure-4).

In case of extraction of Cu^{2+} with ionophores1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-olrapid increase in extraction with time is observed (figure-5) while in case of Zn^{2+} with ionophore1-(2-methyl-4-(2-methylphenyldiazenyl) phenyl) azonapthalen-2-olincrease in extraction was observed during first 210 minutes. Then further, due to the back extraction[8] process the ions release into the aqueous phase from the membrane phase containing ionophore and rate of extraction is decreases (figure-6).

Conclusion

From the results of experiment performed on the effect of equilibrium time on extraction, it has been observed that during the process of extraction the performance of extraction increases with the time of extraction and maximum extraction reached at particular time for particular metal ion and then decreases due to the back extraction process. This results shows important applications in field of separation sciences. The results reported are in good agreement with the similar type of work performed by the other workers[6,7,8]

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