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Study of solvent extraction of ^{114m}In(III) using quinaldic acid into isoamyl alcohol

S. Katagi, H. Bagla*

Nuclear and Radiochemistry Laboratory, K.C. College, Dinshaw Wachha Road, Mumbai–400020, India

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Indium(III) in small doses stimulates the metabolism of human beings. Its compounds are regarded toxic as it damages the heart, kidney and liver and it may also be teratogenic. As an established infection-imaging modality, nuclear medicine plays a vital health-care role in the diagnosis and subsequent effective treatment of this condition. Several techniques in nuclear medicine significantly aid infection diagnosis, including imaging with ^{99m}Tc-hexamethylpropyleneamine oxime, ^{99m}Tc-stannous fluoride colloid labeled leukocytes, ^{67}Ga-citrate and ^{111}In-oxine. In the present investigation a rapid and selective method for the extraction of In(III) using ^{114m}In as a tracer has been developed. The extractant, quinaldic acid has been used for the extraction of In(III) from alkaline medium into isoamyl alcohol. The extractability of In(III) was studied as a function of pH, equilibration period, effect of diluents and diverse ions. The substoichiometric method of extraction for determining the composition of the complex has also been established. The extracted In(III) from the organic phase could be stripped into the aqueous phase using 3N hydrochloric acid. The results obtained were reproducible.

Introduction

Solvent extraction is extensively used as a rapid and selective separation technique for the extraction of In(III) using several derivatives of quinoline as reagents into organic solvents.

Literature survey reveals that quinaldic acid has been used for the determination of Cu(II), Zn(II), Fe(II) and Fe(III).[1] Quinaldic acid has also been reported as a reagent for separation of Cu(II) by its precipitation from Ga(III) and In(III)[2] and also for the separation of indium from As(III), Sb(III) and Sn(II).[3] It has also been used for the extraction of Zn(II) into benzyl alcohol.[4] In nitric acid medium, Ag(I) has been extracted by certain quinoline derivatives[5] whereas DEGTEV et al. have extracted Cu(I) from chloride solution using pyrazolone derivatives.[6] In the present investigation quinaldic acid has been used as a reagent for the selective separation of In(III) from aqueous phase into isoamyl alcohol in 3.0 minutes. The phase separation was found to be very clear with percentage extraction greater than 99%.

Experimental

Quinaldic acid and isoamyl alcohol both were supplied by E. Merck, India. All the other chemicals used were of analytical reagent grade. Solvent extraction separations were carried out using a simple separating funnel.

A stock solution of In(III) was prepared by dissolving In_2O_3 in distilled water containing hydrochloric acid and was standardized as indicated in Reference 7.

^{114m}In and the other isotopes like ^{110m}Ag, ^{86}Rb, ^{133}Ba, ^{60}Co, ^{192}Ir, ^{185}W, etc., were used for the interference study and were supplied by the Board of Radiation and Isotope Technology, Mumbai, India. Gamma-ray emitters were counted on a γ-ray spectrometer in conjunction with a 3.5×3.5 cm^2 NaI(Tl) well-type detector. Beta-emitters were counted on an end-window type G. M. counter.

Extraction procedure

Aqueous solution containing 2.0 mg of In(III) labelled with ^{114m}In was equilibrated with 5.0 ml of 1% fresh ethanolic solution of quinaldic acid. The pH was adjusted to 8.0 with dilute ammonia and dilute hydrochloric acid. The volume of the solution was adjusted by adding distilled water. After adding 10.0 ml of isoamyl alcohol, the solution was equilibrated for 3.0 minutes. The phases were allowed to separate and the volume was found to be practically equal. A 2.0 ml aliquot of each phase was dried and then measured on a G. M. counter. The distribution coefficient (D) was calculated as follows:

$$D = \frac{\text{Activity in 2.0 ml aliquot of the organic phase}}{\text{Activity in 2.0 ml aliquot of the aqueous phase}}$$

Substoichiometric method of extraction

In a series of separatory funnels an increasing amount of In(III) labeled with ^{114m}In with specific activity of 0.973 Ci/g was taken. 5.0 ml of ethanolic solution containing 10.934 mg of quinaldic acid was added. The volume of the aqueous phase was made to 15.0 ml with distilled water and the pH of the solution was adjusted to 8.0. The aqueous phase was equilibrated for 3.0 minutes with 10.0 isoamyl alcohol.

* E-mail: hemabagla@gmail.com

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