

Solvent Extraction Separation of Phosphorus for the Measurement of ^{32}P

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1. Introduction

Phosphorus is a major element in life and plays essential roles in the human body. On the other hand, phosphorus organic compound has high toxicity, therefore, the determination of trace amount of phosphorus is important in environment studies. Development of an analytical method for the determination of low levels of phosphorus is very important as a very few analytical techniques yield reliable results for this element at trace levels.

Radioactive phosphorus, ^{32}P ($T_{1/2} = 14.3$ d, $E_{\text{max}} = 1.71$ MeV) is the highest energy beta-emitting radionuclides and now generally accepted as an effective therapeutic agent for chronic leukemia and excess red blood cells. But, ^{32}P used in diagnosis and treatment are generated radioactive waste such as pipette tips, latex gloves, angioplastic balloons, Kim-wipes etc..

We'll analyze ^{32}P in medical radioactive waste in the future. Even if ^{32}P has low level activity and short half-life, we have to control radioactive materials in medical waste. In this work, experiment separation using solvent extraction of inactive phosphorus as preliminary experiments for the establishment of analysis. Phosphorus is extracted tri-n-octylamine (TNOA)/xylene, which is the most suitable solvent and then is measured by UV-visible spectrophotometer.

2. Experiments and Results

2.1. Reagents and apparatus

Ammonium phosphate (Wake Chemical Co.), ammonium molybdate (VI) tetrahydrate (Aldrich Chemical Co.), ammonium phosphomolybdate (Aldrich Chemical Co.) was prepared in 0.02 M HCl and tri-n-octylamine (TNOA, Aldrich Chemical Co.) was prepared for solvent extraction of phosphorus. UV-Vis spectrometer (Perkin Elmer Co.) was used for the analysis of results.

2.2. Experiments

1, 2, 3, 4 and 5 ml of 10 μM ammonium phosphate and the same amounts of ammonium molybdate (VI) tetrahydrate in 5 samples were added to a separating funnel, respectively, by adjusting the total aqueous

volume to 10 ml with 0.02 M HCl (Figure 1). After adding 10 ml of 0.1 M TOA/xylene solution to this mixture, it was shaken for 5 minutes and the aqueous phase was separated. Then 3 ml aliquot from the organic phase was pipetted out and the absorbance was measured by UV-visible spectrophotometer.

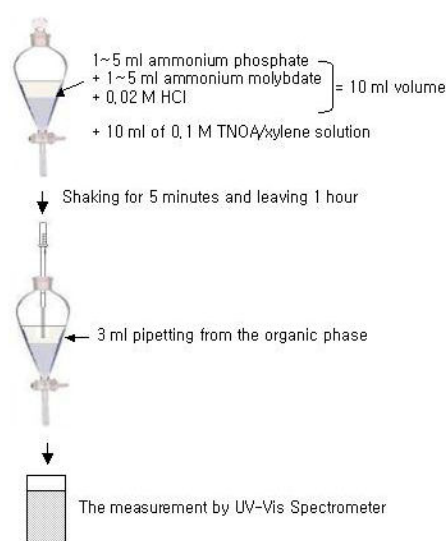


Figure 1. solvent extraction procedure of phosphorus

2.3. Results and Discussion

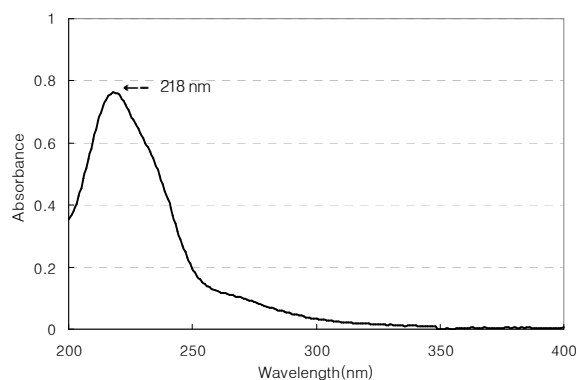


Figure 2. Spectrum of ammonium phosphomolybdate by UV-Vis Spectrophotometer

The spectrum of the solution mixed to 10 μM ammonium phosphate and the same amounts of ammonium molybdate in 0.02 M HCl was shown in Figure 2. The solution had wavelength of 218 nm and

had molar extinction of similar level in the comparison of ammonium phosphomolybdate of the same medium (Table 1). This aqueous solution was extracted to 0.1 M TNOA/xylene solution. Then phosphomolybdate was moved to the organic phase via TNOA as the surfactant (Figure 3). The results of the organic phase by solvent extraction was observed 290 nm using UV-visible spectrophotometer and was shown 75 % yield between phosphomolybdate and mixed solution of phosphate and molybdate.

In the solvent extraction procedure, phosphate and molybdate responded to the same proportion. 5-minutes shaking time was selected because of no any positive influence of shaking for a long time. The extracted percentage of phosphorus at various HCl concentrations showed that the best HCl concentration region for phosphorus extraction is from 0.01 to 0.05 M.

Further work will be extracted to real sample such as medical radiowaste and ^{32}P standard solution and will be analyzed low level of radioactive phosphorus using liquid scintillation counting system.

Table 1. Comparison of Molar extinction with variation of phosphate and molybdate medium

Medium	Molar extinction	R ²
(NH ₄) ₃ PMo ₁₂ O ₄₀ xH ₂ O (aq.)	71483	1.00
(NH ₄) ₂ HPO ₄ + (NH ₄) ₆ Mo ₇ O ₂₄ 4H ₂ O (aq.)	72129	0.98
(NH ₄) ₃ PMo ₁₂ O ₄₀ xH ₂ O (org.)	18135	1.00
(NH ₄) ₂ HPO ₄ + (NH ₄) ₆ Mo ₇ O ₂₄ 4H ₂ O (org.)	13610	0.98

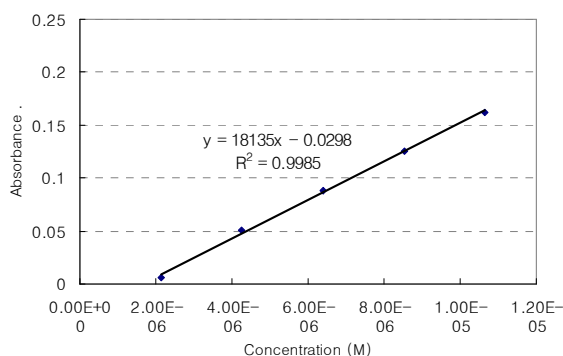


Figure 3. Absorbance of ammonium phosphomolybdate extracted to organic phase of 0.1 M TNOA/xylene solution at 290 nm.

3. Conclusion

The solvent extraction method of phosphorus be used for the chemical separation of ^{32}P from other co-existing radionuclides and sample preparation. This method is applicable as sample preparation of liquid scintillation

counting for ^{32}P analysis in medical radioisotopes and various environmental materials.

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