SEPARATION OF THORIUM FROM MONAZITE

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Introduction

The fact that thorium is present in monazite in relatively small amounts and in association with larger quantities of chemically similar rare earth elements makes its separation a matter of considerable difficulty. A method which is often used in separating thorium from the rare earths in acid solutions of monazite is based on the fact that thorium phosphate is much less soluble in acid solutions than the corresponding rare earth phosphates. Solutions of monazite in sulphuric acid are therefore neutralised to the requisite acidity for the precipitation of thorium phosphate either by dilution with large quantities of water or by adding magnesia, ammonia or sodium hydroxide. A study of the exact conditions under which ammonia can be used in an effective separation has been made and the results are embodied in the present paper. Pure Travancore monazite which has been freed from zircon, rutile and siliceous impurities was used in these investigations.

Experimental Procedure and Results

An analysis of the thorium content by the pyrophosphate method as indicated by Scott in his book *Methods of Chemical Analysis* gave a value of 7·6% thoria. The solution of monazite used was prepared by digesting the mineral with twice its weight of hot concentrated sulphuric acid in the usual way, and adding the pasty mass to a sufficient quantity of ice-cold water. Some initial experiments which were made using acidic solutions of monazite as well as solutions of a mixture of thorium and rare earth oxides obtained from monazite showed that thorium precipitated as phosphate at higher acidities than it did as hydroxide. Also the product was purer. All experiments were therefore made on stock sulphuric acid solutions obtained directly from monazite.

The pH values of equal volumes of a diluted solution were varied by the addition of the required quantities of dilute ammonia solution. Measurements of pH were made on a Beckmann pH meter using a glass electrode. The light bluish grey precipitate obtained in each case consisted of thorium as phosphate together with rare earths as hydroxides. The

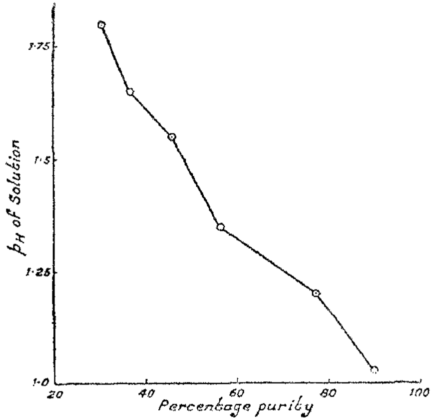

FIG. 1. Graph showing variation of percentage purity of Thoria with pH

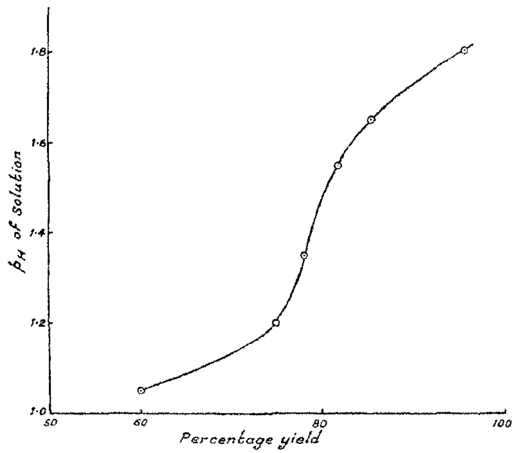

FIG. 2. Graph showing the variation of percentage yield of Thoria with pH

precipitate was filtered off after standing for a few hours and washed to free it from acid. It was found that dilute ammonia solutions gave better results than concentrated solutions when used for altering the pH. Within a pH range of 1·0–1·25, it was found that a slight change in pH gave a much more voluminous precipitate.

Some initial experiments on the β-ray activity of the thorium phosphate precipitates and the oxalate precipitates obtained from the corresponding filtrates showed that there was in both cases a gradual decrease of activity with increasing pH. This can be explained as due to the fact that although the percentage yield of thorium increased, the purity decreased with increasing pH. A chemical analysis which was then carried out on the precipitates confirmed the above conclusions. The results are given graphically in Figs. 1 and 2 which show respectively the percentage purity and percentage yield as functions of the pH.

It is seen that at pH = 1·8 over 95% of the thorium separates out, but the purity is only 30%. Such mixtures, however, which are enriched as regards their thorium content can be treated again in the same way to give purer samples of thorium at lower pH values. Some experiments made at pH = 1·2 in a second treatment of the precipitate gave a yield of about 85% as thoria, the percentage purity also being about 85%. The addition of small amounts of sodium phosphate to the solution enhanced the yield.

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