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METHOD FOR SEPARATION OF AMERICIUM FROM SOLUTIONS CONTAINING THE SAME

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This invention relates to a method for separating americium from solutions containing the same and more particularly to its separation from solutions which contain other trivalent elements.

The artificially-produced transuranic element, americium, is generally supplied for processing in the presence of one or more other elements which elements frequently are trivalent, such as curium or elements of the lanthanide series. As a consequence of the similarity of the chemistry of such trivalent elements, conventional separatory methods have been found to be inadequate when it is desired to separate americium, usually present in minute quantities, from the other elements with which it is associated.

One of the chief objects of my invention is to provide a method for separating americium from other elements with which it may be associated or mixed.

A further object is to provide a method for modifying the trivalent oxidation state of americium prior to separating said americium from another element.

A further object of this invention is to provide a method for separating americium from trivalent elements.

It is a still further object of the present invention to provide a method for recovering residual americium from the products of neutron irradiated americium 241.

Still another object of the present invention is to provide a means for separating americium from other elements based on properties exhibited by americium in the pentavalent state.

Other objects and advantages will become more apparent as the description proceeds.

As disclosed in my copending applications, Serial No. 72,753, filed January 25, 1949, now Patent No. 2,554,476 and Serial No. 72,754, filed January 25, 1949, a new and useful composition of matter containing americium and having a marked radioactive character may be obtained from americium in the pentavalent form. However, before the teaching of those inventions could be utilized it was found necessary to provide a method for the changing of the americium from the trivalent state to such pentavalent state.

As will be apparent to those skilled in the art, various modifications of this method for conditioning the americium may be employed without departing from the scope or intent of this invention. The following examples of suitable methods for treating the americium have been found to be highly satisfactory when working under stringent safety precautions and with relatively small amounts of material. However, this invention should not be construed as being in any way restricted only to small scale operations. On the contrary, the high degree of activity of the transuranic elements enables even small amounts thereof to have great utility and value for employment in large scale industrial processes.

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I have now discovered that by using a suitable hypochlorite, such as sodium hypochlorite, in a solution which contains trivalent americium and one or more other trivalent elements and in the presence of carbonate ions, the americium may be so conditioned for separation that conventional separatory methods may thereafter be employed. Although the exact nature of this phenomenon is not clearly understood, it appears that in an aqueous solution which includes positive ions of the alkali metals such as Li^+, Na^+, K^+ together with negative ions such as OCl^- and $CO_3^=$ the oxidation state of Am (III) is readily changed to Am (V) while the oxidation state of curium and rare earths is unchanged. In any event, under these circumstances the resulting pentavalent americium has been found to precipate from solution slowly as an insoluble compound, presumably either as a carbonate or as a hydroxide (hydrous oxide).

In view of the fact that americium may thus be separated from other elements of similar valence with which it may be intermixed, as a direct consequence of the change of the oxidation state of americium while the oxidation state of its associated elements remains unchanged, various adaptations of this procedure may be effected as indicated below.

For example, it has been found that when a solution containing hypochlorite ions is added to a concentrated carbonate solution containing trivalent americium, the major portion of such americium will precipitate as a nearly white material after standing for twenty-four hours at room temperature, and this precipitated americium will be in the pentavalent state.

It has further been found that a carbonate solution containing such trivalent americium can be heated for five minutes at about 95° C. before adding a hypochlorite solution with equally advantageous results. Moreover, heating for a greater or lesser time within the range of 20° C. to 100° C. has been found to give satisfactory results.

Since the trivalent curium and other trivalent

elements, usually of the lanthanide series, with which trivalent americium is frequently intermixed, do not have the property of changing their valence states under the conditions above illustrated, it now becomes possible to effect a relatively inexpensive, rapid, and clear-cut separation of americium.

The following examples further illustrate the process of the invention.

Example 1

An aqueous 40% K_2O_3 solution containing 1 milligram of americium per milliliter and about $^1/_{1000}$ milligram of curium per milliliter is made about 0.2 M by addition of NaOCl and heated at 95° C. for five minutes. Such mixture is then allowed to stand for a short time and the pentavalent americium precipitate is separated, as by centrifuging, whereupon 95% of the curium originally present is found to remain in the oxidized supernatant liquid and 78% of the americium originally present is found in the precipitate.

Example 2

To 5 microliters of a solution comprising 10 micrograms of americium and approximately $^1/_{1000}$ as much curium and 50 micrograms of rare earth elements are added 50 microliters of a 40% K_2CO_3 solution followed by 10 microliters of a 5% NaOCl solution. The resulting mixture is then heated to 95° C. for five minutes and allowed to stand overnight at room temperature. The precipitate containing the americium in pentavalent form is separated in any suitable manner as by centrifuging. Over 75% of the americium is removed from the solution with only minor traces of curium or other elements mixed with the americium precipitatae.

It will be understood that the above examples are illustrations only and are in no wise to be construed as limitations upon the invention, the scope of which is defined in the appended claims, wherein I claim:

1. In a method of separating americium values from solutions containing trivalent americium ions together with the ions of impurities, the steps comprising oxidizing said solution with a hypochlorite to convert said americium ions to the pentavalent state, thereby providing americium ions having precipitation characteristics differing from the same characteristics of said impurity ions, then precipitating in a concentrated carbonate solution said americium ions away from at least some of said impurity ions, and separating said precipitated americium from the solution.

2. The method of separating americium values present as trivalent ions thereof from solutions containing contaminants including selectively oxidizing the americium to the pentavalent state using a hypochlorite in a concentrated carbonate solution, precipitating the oxidized americium, and separating the precipitated americium from said solution.

3. In a method of separating americium values from solutions containing trivalent americium together with impurities including trivalent elements of the lanthanide series, the step comprising selectively oxidizing said americium to the pentavalent state with a hypochlorite in the presence of carbonate ions.

4. In a method of separating americium values from a carbonate solution containing trivalent americium together with contaminants including curium and lanthanide element in the trivalent state, the steps comprising precipitating pentavalent americium away from said impurities in the solution by oxidizing said trivalent americium with a hypochlorite solution and with heating to a temperature in the range of about 20° to 100° C., and separating the pentavalent americium precipitate from said solution.

5. In a method of separating americium values from a 40% K_2CO_3 solution containing trivalent americium together with curium and elements of the lanthanide series in the trivalent state, the steps comprising precipitating pentavalent americium from said solution by oxidizing said americium with a hypochlorite of a concentration in the range of about 1 to 2½% and with heating of the solution to a temperature in the range of about 20° C. to 100° C., and separating the precipitated pentavalent americium from the solution.

6. In a method of recovering trivalent americium values from a 40% K_2CO_3 solution resulting from the dissolution of neutron irradiated americium 241, the steps comprising oxidizing said trivalent americium to the pentavalent state by making the solution about 1.7% in hypochlorite and heating the solution to a temperature of 95° C., whereby pentavalent americium precipitates from the solution on standing, and then separating the pentavalent americium precipitate from the solution.

7. In a method for separating americium values from solutions containing trivalent forms of the same and impurities including curium the steps comprising adding a concentrated carbonate solution to said americium bearing solution, adding a hypochlorite to the solution forming a precipitate containing pentavalent americium values, and removing the supernatant solution from said precipitate.

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