The proof studies of novel aluminum precipitation technique for fission Moly production.

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1. Introduction

Molybdenum-99 is the parent nuclide of Technetium-99m (^{99m}Tc), which is extensively used in nuclear medicine. ^{99m}Tc has promising nuclear properties such as short half-life time of 6 hours and low gamma-ray energy of 140 keV. So it is widely used in medical field to visualize human organs. The fission of ^{235}U induced by a thermal neutron is the most prominent method for large-scale production of ^{99}Mo.

In this present work, we demonstrated the optimized condition and new way of ^{99}Mo production using aluminum precipitation technique. Since, if it is possible to precipitate a large amount of aluminum from the dissolved target solution, it can reduce the amount of waste generated during the separation, recovery and simplify the post-treatment process of waste liquid. Thus the new process developed in this present work has excellent advantage on large scale ^{99}Mo production.

2. Experimental Method and Results

2.1 Dissolving and Precipitation process

This simulation process was based on the modified ROMOL-^{99}Mo production method. The dissolution of Al-alloy clad target was carried out by digesting solution in a mixture of 3M NaOH/ 4M $NaNO_3$ at 70 ℃ for 1h without H_2 generation. During the dissolution, NH_3 gas was generated and release through vent system [1, 2]. Then the dissolved solution was filtered by first filtration system using 0.1 ㎛ glass fiber filter. Since this dissolving reaction accompanied by-products like metal complex with doped metal alloys. Subsequently, the recurved solution was shift to the precipitation reaction vessel and added 1M $(NH_4)_2NO_3$ buffer solution which converts the solution from high to low pH and the vessel was heated up to 75 ℃. After the precipitation reaction, the solution was allowed for second filtration using 30 ㎛ metal fiber filter unit. Finally, the contents rate of Mo was identified by AA. And the remained filter cake was characterized by XRD, SAM and EDX.

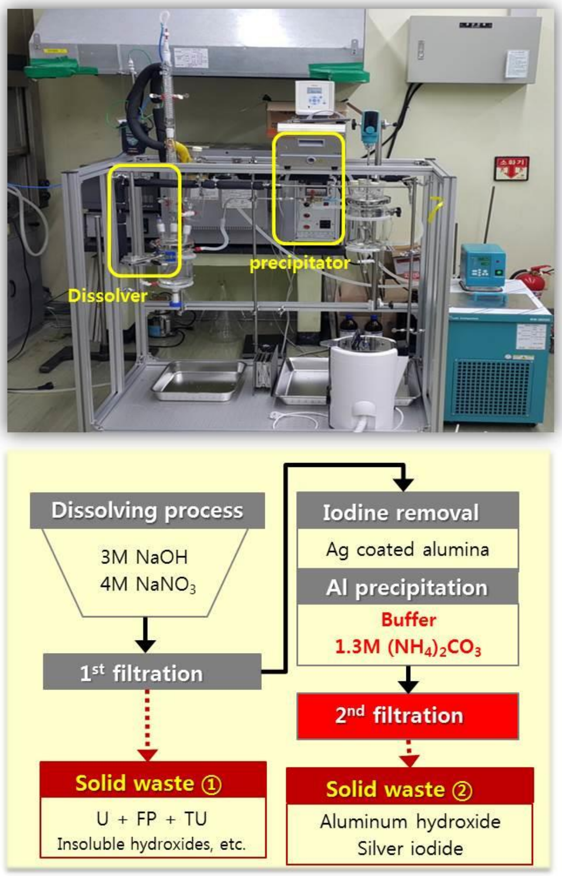

Fig. 1. The photograph of FM manufacturing facility and scheme of simplified experimental methods

2.2 Analysis

Filtrated cake, the precipitated aluminum cake is important for the production process like time and waste reduction. Two conditions had been determined to optimize the whole reaction. That is, the experimental results were compared with a low temperature (at room temperature) condition and high temperature condition (at 75 ℃). The low temperature (at room temperature) precipitated reaction product demonstrates the formation of aggregates of amorphous poly aluminum hydroxide, and it shows that the aggregates has Mo adsorption rate that has effectively dropped the yield of the resultant product. (After precipitation recovery rate: 70% or less)

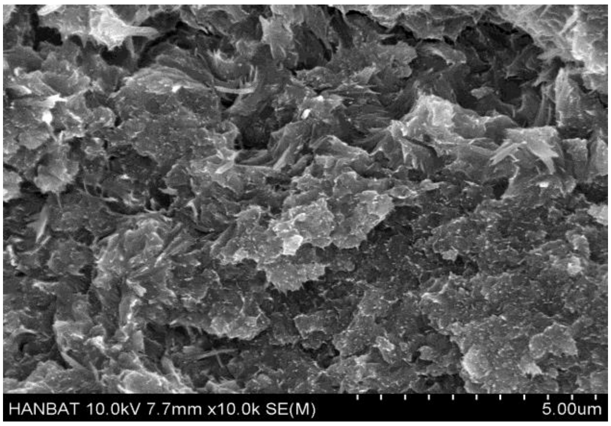

Fig. 2. SEM image of precipitated aluminum at 25℃ condition shows the formation of sheet-like morphology of aluminum hydroxide crystals.

But at high temperature (at 75 ℃) condition had created a precipitate of the crystalline particles. And recovery rate of Mo was found to be higher than that of low temperature condition. (After precipitation recovery rate: 90% or more)

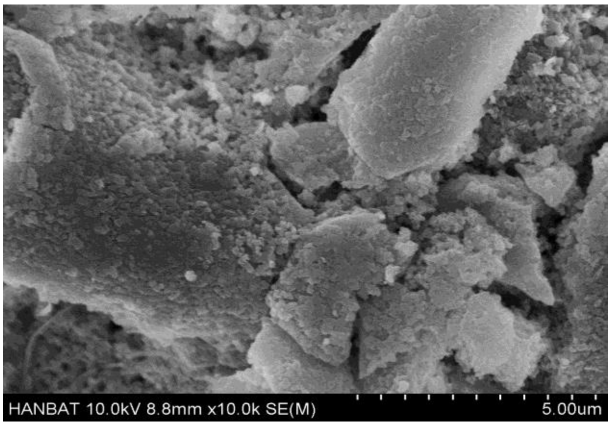

Fig. 2. SEM image of precipitated aluminum at 75℃ condition displays the formation of micro-particle sized aluminum hydroxide crystals.

2.3 Active tracer test

The Mo recovery rate of MoO_4^{2-} ions was confirmed maximum 92% yield through AA analysis at cold test. Moreover 90% yield recovery was confirmed using Active MoO_4^{2-} in hot tracer test; this result is comparable to the cold test.

3. Conclusions

In summary, the modified new technique confirmed that it is easy to acquire MoO_4^{2-} from the fission product in the form of crystalline precipitate. This was obtained by optimizing the process by controlling the pH from 14 to 11 at the vessel temperature 75 ℃. Furthermore, it is confirmed that the filtered cake recovered by this new process not allowed any adsorption of MoO_4^{2-} with recovery rate higher than 90%. In addition, no trace of ^{99}Mo content was observed in the filtered cake. From these above investigations it is confirmed that the improved process can expected to produce >90% yield in fission moly production.

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