Acid Dissolution of Depleted Uranium from Catalyst using Microwave

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1. Introduction

The separation process of uranium is one of the most important fields in nuclear industry because uranium is used primary in nuclear power plants. Uranium ores are treated by either acid or alkaline reagents. Uranium can be dissolved by acid or alkaline solutions. There are two oxidation states in which the hexavalent form, the oxide of which is UO_3, and the tetravalent form, the oxide of which is UO_2.

However, depleted uranium(DU) has also been used as a catalyst in specialized chemical reaction such as ammoxidation. The preferred catalyst for propylene oxidation with ammonia was a uranium oxide-antimony oxide composition. The active phase of catalyst was known as $USbO_5$ and USb_3O_{10}[1]. There is pentavalent form. Waste catalyst containing DU was generated and stored in chemical industry[2].

In this work, we removed DU from catalyst by acid dissolution.

2. Methods and Results

In order to remove uranium from catalyst, nitric acid, hydrochloric acid, aqua regia and counter aqua regia were used.

2.1 Chemicals

The MAC-3 catalyst which manufactured by Solutia Inc. was used. The chemical composition of MAC-3 shows in Table 1[3]. The nitric acid and hydrochloric acid were used as general grade reagents.

Table 1. Chemical Composition of MAC-3 Catalyst

Components	**Chemical Formula**	**Concentration (%)**
Silicon dioxide	SiO_2	45~55
Antimony oxide	Sb_2O_3, Sb_2O_4, Sb_2O_5	25~30
Uranium	U	5~10
Iron Oxide	FeO, Fe_2O_3, Fe_3O_4	1~ 5

2.2 Analysis of MAC-3 Catalyst

The size and chemical composition of MAC-3 were analyzed using SEM-EDX and summarized in Fig. 1 and Table 2. The sizes of MAC-3 are to about 100 ㎛ and composition of uranium is about 9 wt%.

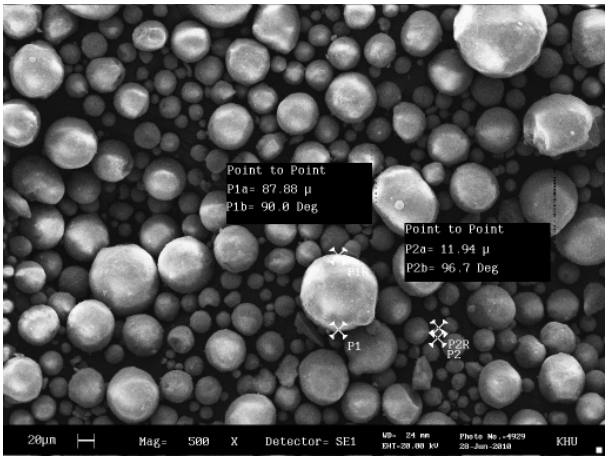

Fig. 1. Size of MAC-3 Catalyst

Table 2. Uranium Content of MAC-3 Catalyst

Particle		P1	P2
Size (μm)		87.88	11.94
Element (wt%)	Si	25.9	24.32
	Sb	20.75	25.61
	U	7.62	8.68
	Fe	3.69	4.82

2.3 Acid Dissolution of Uranium

0.2 g of catalyst and 10 ml of each acid solution were placed in digestion vessel. The digestion vessel was heated to 170 ℃ in MARS-5 microwave reaction system. After 40 minutes, acid solution was cooled filtered with 1 ㎛ filter paper. The uranium content of filtered solid was analyzed using SEM-EDX and summarized in Table 3. The uranium content of hydrochloric acid treated is lower than that of other acid treated. And the uranium concentration of filtrate solution was analyzed using ICP-AES and summarized in Table 4. The uranium concentration of hydrochloric acid solution is higher than that of other acid solution. As the results, hydrochloric acid is more effective to remove DU from catalyst.

Table 3. Metal Composition of Filtered Solid

Acid Solution		HNO_3	HCl	HNO_3:HCl (1:3)	HNO_3:HCl (3:1)
Element (wt%)	Si	23.02	0.74	21.61	24.14
	Sb	16.63		19.14	19.63
	Fe	2.84		3.82	4.42
	U	6.18	1.49	7.16	6.56

Table 4. Uranium Concentration in Filtrate Solution

Acid Solution	U (ppm)
HNO_3	24.5
HCl	67.2
HNO_3:HCl(1:3)	49.8
HNO_3:HCl(3:1)	10.4

3. Conclusions

In this work, hydrochloric acid is more effective to remove DU which has pentavalent from catalyst than nitric acid, aqua regia and counter aqua regia.

REFERENCES

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