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Development of the Pyrolysis for Volume Reduction of Organic Solid Waste Containing Uranium

Yeong-jong Ju [a], Jeong-myeong Kim [a], Nam-chan Cho [a], Seung-hoon Han [a], Ho-seung Jeon [b], Jun-bae Lee [b], Jang-su Lee [b]
[a]*Kepco Nuclear Fuel Co. LTD, 242 Daeduck-daero 989 bun-gil, Daejeon 34057*
[b]*Jeontech CO. LTD, 77 Hanggung-ro, Suwon, Kyeongki-do 16261*
[*]*Corresponding author: jmk@knfc.co.kr*

1. Introduction

As a treatment method for the final disposal of general solid waste, the management of waste is comparatively convenient with incineration, landfill, recycling, etc. However, since the management of radioactive waste is strictly applied, development of appropriate treatment process is necessary. Organic solid radioactive waste is produced from nuclear research centers, radiopharmaceuticals and nuclear fuel fabrication plants, etc. [1] Physicochemical treatment techniques such as cement solidification and incineration have been applied to treat the solid waste [2].

Incineration technology is one of the stable heat treatment techniques that have been proven for a long time. The incineration technology has the advantage of the largest volume reduction rate of waste. But because gaseous pollutants are generated at a higher temperature, amount of pollutants which is emitted at high temperatures such as dioxin and NOx is higher than other heat treatment methods. On the other hand, pyrolysis technology doesn't generate exhaust gas, dioxin, and NOx compared with incineration technology, because pyrolysis is reacted at low temperature. It is expected that the amount of uranium particles from syngas of pyrolysis is also small due to less scattering of heavy metal substances compared to incineration technology.

In this study, the result of pyrolysis process was investigated for the volumetric effect of uranium - containing organic solid waste generated in a nuclear fuel processing facility.

2. Methods and Results

2.1 Waste Treatment.

The Properties of organic solid waste containing uranium are divided into two categories: unsorted solid waste(Cotton gloves, Towels, White textile, Yellow textile, Mask, Paper box, Wood) and composite(Latex gloves, Safety shoes, Vinyl gloves, Plastic). The crushed waste samples are shown in Figure 1.

Figure 1. The Crushed Organic Solid Waste

Figure 2. Feedstock before and after palletization

The properties of the solid waste used in the experiment are shown in the table below. To control the quantity of the waste, 200kg of waste was molded into pellets.

Table 1. The Composition of Solid Waste

Contents		wt. %	Weight (kg)
Dry Active Waste	Cotton gloves	6.7	13.4
	Towels	9.2	18.4
	White textile	8.0	16.0
	Yellow textile	8.0	16.0
	Mask,	9.6	19.2
	Paper carton	7.5	15.0
	Wood	5.0	10.0
Complex Waste	Latex gloves	8.0	16.0
	Safety shoes	4.5	9.0
	Vinyl glove	18.0	36.0
	Plastic	15.5	31 .0
Sum		100	200.0

Figure 3. The Pelletized Soild Waste

2.2 Pyrolysis Process

To reduce the volume of organic solid waste from nuclear fuel fabrication facilities, Pyrolysis process was selected for the experiment.

The pyrolysis process is composed of a main body of a softener for reducing the volume of the waste, a condenser for recovering the remaining char after the pyrolysis reaction and a condenser for recovering the oil. And Syngas is discharged after burning process using a gas burner.

The yellow part of the process diagram shows a thermometer for temperature control of the reactor and gas.

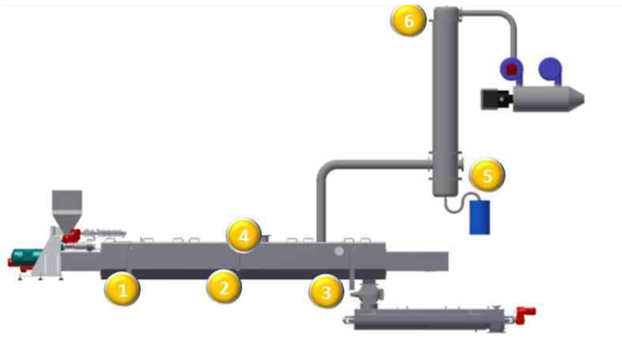

Figure 4 The Pyrolysis System Scheme

2.21 The Reduction Rate

In order to derive the optimum operating conditions of the waste, the volume and weight of the sample were measured by various temperature and retention time of the sample, and the rate of utilization was calculated based on the measured volume and weight. Experimental results show that the maximum volume reduction rate is 87% when the sample is reacted at 600℃,

Table 2 The Pyrolysis Reaction Results

Contents	Unit	Run 1	Run 2	Run 3	Run 4
Temp.	℃	600	575	550	700
R.T.*	min	20	30	40	20
E.G.R.**	wt.%	79.7	76.0	77.8	81.3
P.D.***	kg/L	0.22	0.22	0.22	0.22
C.D.****	kg/L	0.35	0.3	0.3	0.28
W.R.R.*****	%	79	76	78	81.3
V.R.R.******	%	87	82	84	85.1

* : Reaction Time
** : Exhaust Gas Rate
*** : Pellet Density
**** : Char Density (Solid density of finishing reaction)
***** : Weight Reduction Rate
****** : Volume Reduction Rate

2.2.2. The Produced Gas Composition

In order to properly treat syngas from the heat treatment process, properties of the generated gas were analyzed using Micro GC. Most gases are hydrogen, methane, carbon monoxide and hydrocarbons. And air pollution prevention equipment are required for the treatment of these substances.

The properties of the analyzed gas are as follows, and it is not significantly different from the pyrolysis properties of general waste.

Table 3. The Composition of Synthesis Gas

Compound	Concentration (v/v %)	Limit Dection
H_2	32.48	0.01
O_2	0.18	0.01
N_2	0.44	0.01
CH_4	3.38	0.01
CO	14.14	0.01
CO_2	7.22	0.01
C_2H_4	16.67	0.01
C_2H_6	15.58	0.01
H_2S	3.5	0.01
C_3H_8	9.92	0.01

3. Conclusions

In order to reduce the volume of organic solid waste in nuclear fuel fabrication facilities, a pyrolysis process was developed. The volumetric reduction of the solid waste was shown to be up to 87% when this process was applied. It was confirmed that the treatment was possible.

The results of this study suggest that the development of the pyrolysis process is the optimal treatment method to achieve homogenization of waste in the treatment of organic solid waste generated in nuclear fuel fabrication facilities and satisfy both stability and waste reduction.

However, additional char treatment facilities will be needed for final disposal, and the research is expected to be carried out later.

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