

## A Study on the treatment of hazardous waste by cement kiln(I)

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### I. Introduction

Most of cement manufacture facilities have thermal processes such as the rotary kiln for producing cement clinker. The great amount of fuel should be supplied to these processes. On the other hand, waste derived fuels(WDFs) such as waste tire and waste solvent can be used for the superior fuel according to their high energy contents, as increasing the needs of waste recycling.<sup>1)2)</sup> Therefore, many researchers have strong interest of the use of such a WDFs for a portion of fuel to maintain high temperature in the rotary kiln. However, There may be concern that the incineration process could exhaust secondary pollutants such as CO, NO<sub>x</sub>, SO<sub>x</sub>, HCl, VOCs, PCDDs/DFs and so on.<sup>3)4)5)</sup> This study, which was aimed to do a pilot-scale test for producing cement clinker with waste solvents as fuel, was conducted to investigate the amounts of fed fuel required and the properties of WDF of its raw material and its emission gas.

### II. Experimental

#### *Operation and sampling*

In this study, the experiment was conducted that the mixing ratios of Waste Derived Fuel to the diesel oil were varied at 0, 15, 30 and 60% . These mixed fuel was injected from the main burner, and the temperature of rotary kiln was maintained around 1400°C. In each experimental stage, gas samples were obtained in front of fabric filter. Figure 1 shows the photograph of pilot-scale cement kiln used in this study.

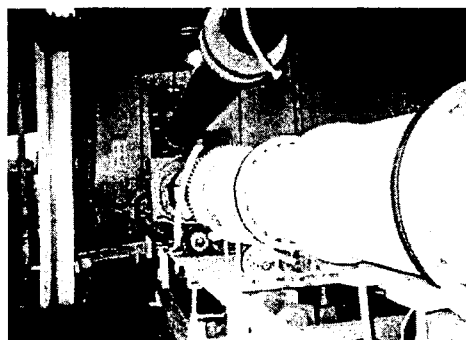


Fig. 1 Photograph of rotary kiln used in this study

#### *Analysis*

Stack gas analyzer was used to analyze the oxygen, carbon monoxide, carbon dioxide, and sulfur dioxide. The samples for HCl and NH<sub>3</sub> were collected in front of the fabric

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filter and analyzed by Korean Standard Method. Those for volatile organic carbons(VOCs) were collected at the same place and analyzed by Low Resolution Gas Chromatograph/Mass spectrometry.

### III. Results and discussion

#### *Waste Derived Fuel*

As a result of analysis, the main components of WDF, which was supplied to rotary kiln, were Methyl Benzoate and Methyl-p-Toluate, and trace organics were Trichlorofloromethane, Xylene, Ethylbenzene, Toluene and Dichloromethane. Energy contents was high enough to use as a fuel(about 7,266 kcal/kg-WDF). The results are shown in the Table 1.

Table 1 Characteristics of waste organic solvents

Item	Content	Concentration
Main compounds	Methyl Benzoate	15-65 % (ave. 35 %)
	Methyl-p-Toluate	55-85 % (ave. 60 %)
Trace compounds	Dichloroethane	15 ppm
	Trichlorofloromethane	1,074 ppm
	Xylene	26,576 ppm
	Ethylbenzene	233 ppm
	Toluene	400 ppm
	Dichloromethane	156 ppm
Energy content		7,266 kcal/kg

#### *Emission gas*

Figure 2 shows variation of the oxygen, Carbon monoxide, carbon dioxide and sulfur dioxide in each stage. As shown in Figure 2, CO concentration was increased and O<sub>2</sub> concentration was decreased as the mixing ratio of WDF increasing.

The SO<sub>x</sub> was hardly detected in emission gas, which may be the characteristic of cement manufacture process. Otherwise, CaSO<sub>4</sub> was formed by SO<sub>x</sub>, combined with Ca component in the raw materials.

The NO<sub>x</sub> concentration was lower than expected value, which may be due to the

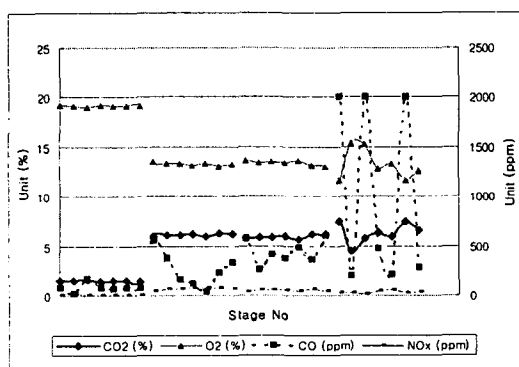


Fig. 2 Properties of Emission gas in each stage

difference of pilot plant operating condition, especially of temperature in rotary kiln. According to the literature, in the real plant, the temperature in cement kiln would be measured up to 1,800 °C, and thermal NOx be up to 400 ppm. But the temperature of rotary kiln used in this study was maintained below 1,500°C. So, it could be considered that NOx concentration was detected so low level while the operation temperature was relatively low.

### *Hypochloric acid and Ammonia*

Figure 3 shows the variation of HCl and NH<sub>3</sub> concentration in emission gas at each stage. As shown in Figure 3, a significant increase of HCl was found after the addition of WDF. HCl was also detected in stage 1. This may be due to high chloride component contained in raw material of cement. It could be supposed that cement kiln dust contain the high HCl.

If the cement kiln dust, which contains the high HCl would be recycled as raw cement material, special attention should be paid.

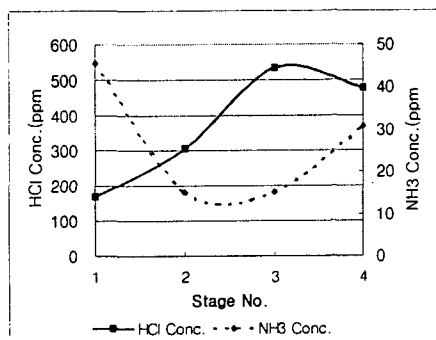


Fig 3. HCl and NH<sub>3</sub> concentration in each stage

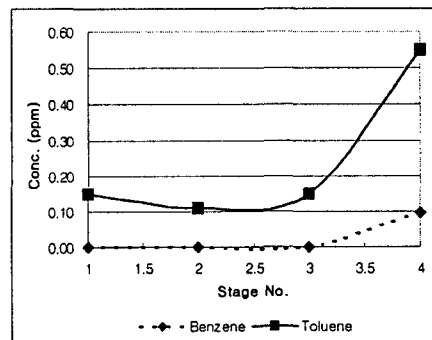


Fig. 4 Comparison of VOCs in emission gas

### *Volatile Organic Carbons*

Figure 4 shows the variation of concentration of toluene and benzene in emission gas. As shown in figure 4, the concentration of toluene was tended to increase and that of benzene was also to increase, as the ratio of WDF to fuel increasing. It was analysed that the concentration of both components be considerably low level, at below 1 ppm.

For example, it was shown that toluene was detected at about 400 ppm in WDF but almost decomposed through incineration process.

## **IV. Conclusion**

When Waste Derived Fuel was injected in cement kiln of pilot-scale, the investigation was conducted to evaluate possibilities treatment of wastes. Some of those experimental

conclusion can be following.

- Waste derived fuel could be used in cement kiln. it has as high energy contents as fuel. But actually in case of use as a fuel, WDF should be strictly controlled so that it has not a harmful influence on cement production.
- The SO<sub>x</sub> was not detected in emission gas, which is the notable feature of cement manufacture, it also was considered that the SO<sub>x</sub> which mainly combined to content of the Ca in the raw materials formed to CaSO<sub>4</sub>.
- In case of the VOCs, the content of the VOCs in emission was estimated that did not cause problems, because the BTEX was almost decomposed.

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