Development of a technology to render incineration ash harmless using the exhaust gas of gas engines.

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1. Introduction

As natural gas use in the refuse incineration plant, it is used by the auxiliary burners and also is utilized in recent years by the cutting peak power when the incinerators start. However, only by the cutting peak power, if it sees through every year, the gas engine will stop at temporary operation and will have become idle equipment. Even during the operation of refuse incineration plants, in order to enable them to generate electricity, it is necessary to promote waste heat utilization of gas engines. Thus, we developed a new technology. It is a technology that renders incineration ash harmless using the exhaust gas of gas engines, and using this harmless ash. In Europe, storing incineration ash over several months makes it react with CO2 in the air, thereby changing its state and reducing its propensity to leach. However, in this method, a long time is required for processing. In addition, a vast stockyard for storing incineration ash is required. Therefore, this method is difficult to carry out in the urban areas of Japan.

The technology reported this time reduces the amount of elution of Pb in incineration ash in a short time using CO2 and heat that are contained in the exhaust gas of gas engines. Since it can process in a short time, a vast stockyard is unnecessary and can solve the problem of the conventional method.

For the refuse incineration plant, incineration ash is used effectively by utilizing the idle gas engine, and there are advantages which can reduce the amount of land reclamation. Moreover, for gas utilities, there are advantages which can work a gas engine for a long time.

2. Principle of detoxification of Incineration ash

As shown in Figure 1, incineration ash contains Pb used in electronic substrates and pigments that can pose problems for beneficial use. The amount of Pb eluted into water is called the “the amount of elusion” and the amount of Pb contained in incineration ash is called “the amount of content.”

Figure 2 illustrates the principle of ash detoxification. The reaction for transforming PbO into $PbCO_3$ is promoted using CO_2 and heat in the exhaust gas. $PbCO_3$ is much more chemically stable than PbO and can be used to reduce the amount of elusion into water. In addition to its transformation into $PbCO_3$, PbO also changes into a very unstable state called mineralization, which has been suggested is effective in reducing the Pb content. We are investigating whether this is definitely effective. In this test, fine ash with a high Pb content was screened to reduce the Pb content in order to render the ash completely harmless.

In Japan, detoxification criteria are set by the Ministry of the Environment: the amount of Pb elusion is limited to less than 0.01 mg/L and the Pb content is limited to less than 150 mg/kg. Figure 3 shows a proposed flow of materials if this technology is installed in a refuse incineration plant.

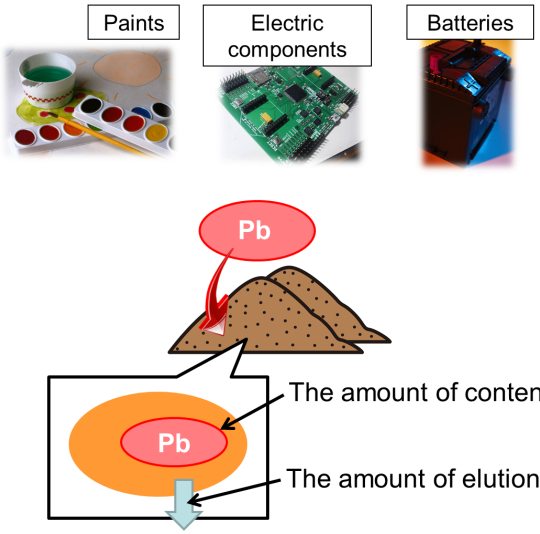

Figure 1. Definition of amount of Pb elusion and Pb content in incineration ash

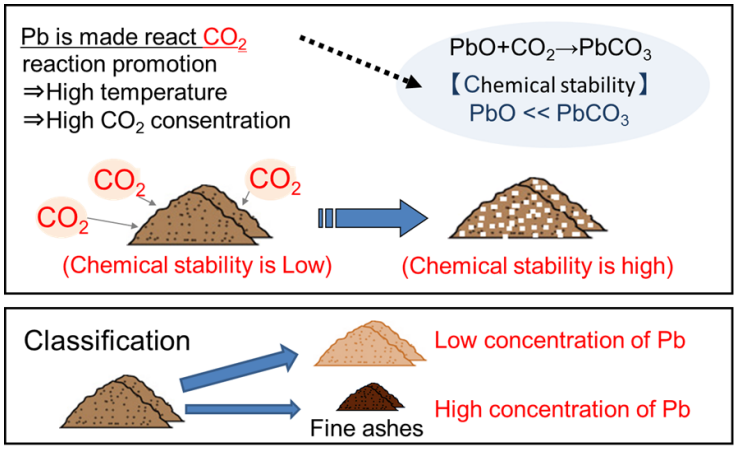

Figure 2. Principle of detoxification of incineration ash

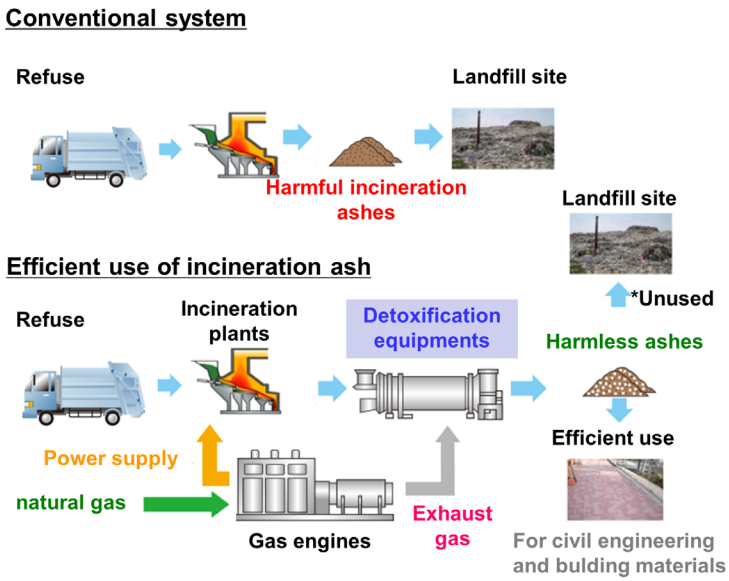

Figure 3. Proposed installation of an ash detoxification system in a refuse incineration plant

3. The demonstration test equipment

In this development, based on laboratory evaluation, we fabricated a 1/10 scale demonstration test model of an ash detoxification system (daily processing capacity: 2 tons, kiln diameter: 950 mm, kiln length: 5000 mm) to be installed in a refuse incineration plant, and examined the effectiveness of the system in the detoxification of incineration ash on a demonstration test scale. Figure 4 is a picture of the demonstration test equipment. Figure 5 shows the flow of materials. A rotary kiln-type ash detoxification system was used, taking into account the ease of agitation and ease of continuous processing. The incineration ash can be effectively put in contact with the exhaust gas by feeding the exhaust gas into the kiln while stirring the ash in the kiln. The ash and the exhaust gas flow in opposite directions. The ash is continuously fed from the hopper into the ash detoxification system by a screw feeder.

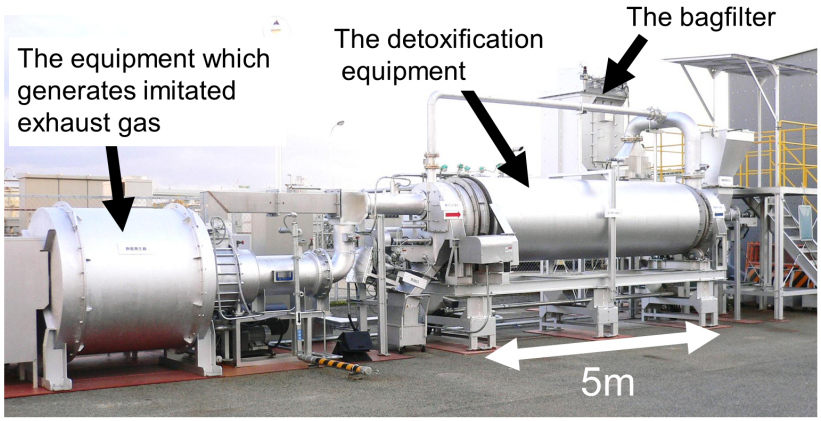

Figure 4. Picture of the demonstration test equipment

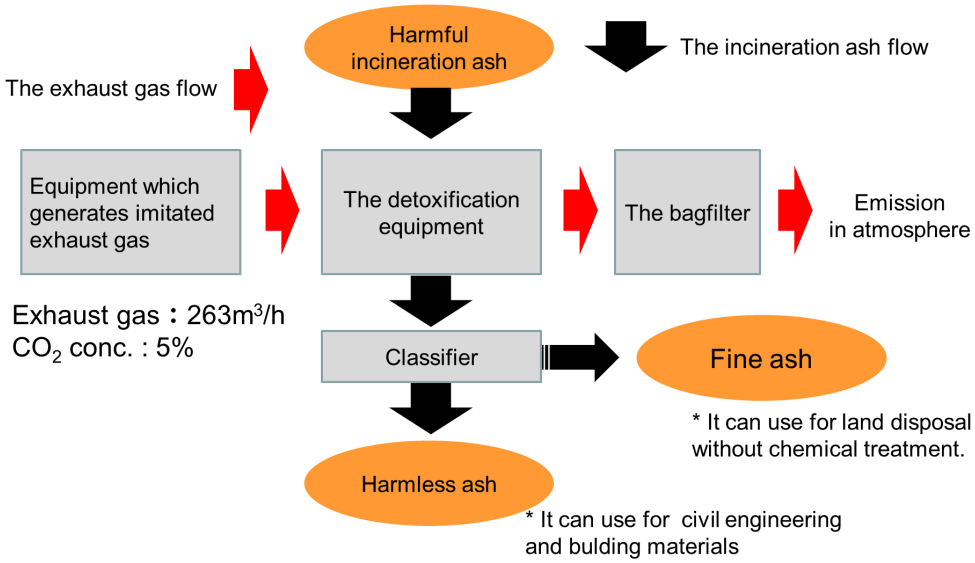

Figure 5. Materials flow in the demonstration test equipment

4. Test method

The test samples used were taken from a stoker incinerator's bottom ash at a municipality's refuse incineration plant. Wet ash with large foreign objects removed was fed into the ash detoxification system at a rate of 100 kg/h. The state where the temperature of the ash in the kiln was stable was defined as its steady state. The ash was processed at four different temperatures: 250, 300, 350, and 400 deg C.

To fully meet the criteria for Pb content, the ash was screened to remove fine ash with high Pb content. 2mm condition was used, and ash particles larger than 2 mm were analyzed to evaluate the system's effectiveness. Whether or not the ash must be screened is under evaluation.

5. Test results

Figures 6 and 7 show the results of a comparison of the amount of elusion and Pb content between incinerator ash immediately after being sampled (non-detoxified ash) and detoxified ash. Three samples, each at a different temperature, were prepared from the detoxified ash and analyzed. As shown in Figure 6, the amount of elusion was 0.09 to 0.23 mg/L for the non-detoxified ash and decreased to less than 0.005 mg /L when detoxified at temperatures of 300 deg C and higher. This shows that the amount of elusion can be reduced below the government limit of 0.01 mg/L. As shown in Figure 7, the Pb content was 100 to 320 mg/kg for the non-detoxified ash and this decreased below the government limit of 150 mg/kg when detoxified at temperatures of 250 deg C and higher and screened to obtain ash particles larger than 2 mm.

These results show that the 1:10 scale demonstration test equipment can detoxify incineration ash. In the test, the ash was screened to obtain ash particles larger than 2 mm, and, as a result, the amount of incineration ash suitable for beneficial use was only 40% of the total amount.

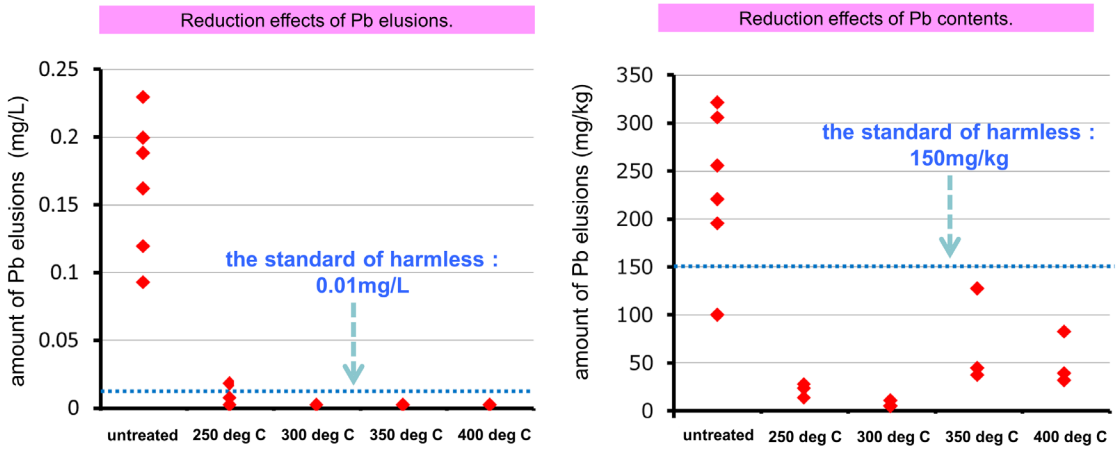

Figure 6. Effectiveness in reducing the amount of Elusion and content

6. Usefulness of ash from the ash detoxification system

As shown by the test results, the amount of incineration ash to be landfilled can be reduced by 40%. If the ash detoxification system is installed in a refuse incineration plant with a daily processing capacity of 400 tons per day, about 12,000 tons of incineration ash is discharged per year, of which 4800 tons, or 40%, can be used for beneficial purposes. As a result, the remaining

lifespan of landfill sites can be extended and the cost of landfilling can be reduced. Landfill costs can be reduced by 48 million yen a year when calculated using the unit landfill cost (about 10,000 yen per ton) in Japan.

7. Conclusions

The demonstration test showed that both the amount of Pb elusion and Pb content in incineration ash can be reduced below government limits by processing at 300deg C and screening with a 2 mm condition. The evaluation results showed that 40% of the ash can be used for beneficial purposes and consequently the amount of incineration ash to be landfilled can be reduced. This can be viewed as a promising technology for expanding the sale of town gas used in refuse incineration plants.

8. Next Steps

(1) We will further evaluate the detoxification conditions and detoxification system to determine conditions for obtaining the effects of detoxification in a shorter time.

(2) It is important to use detoxified incineration ash for beneficial purposes. We will develop beneficial uses for building and civil work materials.

(3) In this test, only 40% of the total amount of incineration ash was suitable for beneficial use. We will work to optimize the detoxification conditions, such as the screening size, to increase the percentage of incineration ash for beneficial use.