DEMONSTRATION ON THERMAL TREATMENT OF ASBESTOS-CONTAINING DISASTER WASTE FOR SAFE DISPOSAL AND ENERGY RECOVERY

Y. Kodera[1]*, K. Sakamoto[2] and H. Sekiguchi[3]

[1]National Institute of Advanced Industrial Science & Technology (AIST), 16-1 Onogawa, Tsukuba, Ibaraki 305-8569 Japan
[2]Street Design Corporation, 6-9-30 Shimo-odanaka, Nakahara-ku, Kawasaki, Kanagawa 211-0041 Japan
[3]Tokyo Instute of Technology (Tokyo Tech), 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8550 Japan
*e-mail: y-kodera@aist.go.jp; phone +81-29-861-8045, fax +81-29-861-8434

Abstract

A new treatment process was demonstrated to show the effective treatment of asbestos and energy recovery from wood wastes at 5-ton/day scale in Kamaishi city, one of the most serious disaster area in the Great East Japan Earthquake. The treatment facility consists of two core systems, a carbonizing furnace (Furnace No.1) and a fixed-bed steam gasification furnace (Furnace No.2). The wastes contain asbestos with inorganic building materials, a flux for melting asbestos, wood and plastics (mainly polyethylene). Asbestos-containing wastes were treated in Furnace No.1 at about 850 °C for the residence time about 15 min under partial-combustion conditions. Wood wastes gave charcoal with formation of hot flue gas. The resulting charcoal was gasified in Furnace No.2 to give water gas in the presence of super-heated steam at about 900 °C, which was given in a heat exchanger of the flue gas from the Furnace No.1. Asbestos with a flux was converted into a harmless powder and charcoal was converted into water gas, which was further used in a diesel engine to generate electricity.

Keywords: *asbestos, carbonization, steam gasification, wood, waste*

1. Introduction

Landfill has been a conventional disposal method of asbestos-containing demolition wastes. Huge amounts of landfill capacity are already consumed in the disaster. Considering the risk of asbestos emission from landfill sites, some companies developed thermal transformation of needle-shape crystalline of asbestos into harmless form usually under 1200 to 1500 °C. Some researchers and companies also reported a melting process at the lower temperature ranges using a flux containing alkaline compounds.

Here we demonstrated a new energy-saving process for melting asbestos by using combustion heat of wood and plastics in a first furnace. This process is also used for producing a flammable gas in a second furnace by the stream gasification of charcoal, which was obtained through partial combustion in the first furnace. Material balance and energy balance were calculated to compare other types of thermal treatment such as pyrolysis.

2. Materials and Methods

Three types of wastes were used as a feed (Table 1).

Table 1. Sample components. (wt%)

Sample	Inorgatic contents	Combustible components	Moisture
Wood	5.95	79.45	14.60
Building material	60.87	22.46	16.67
Plastics	2.10	96.91	1.00

The asbestos contents of wastes of building material is shown in Table 2.

Table 2. Asbestos in building materials. (wt%)

Chrysotile	Amosite	Crocidolite	Tremolite /Actinolite
11.0	18.0	15.5	1.4

Figure 1 shows a schematic diagram of the facility for asbestos treatment and energy recovery of the wastes.

Operation procedure is as follows:

1) Waste samples were shredded in a shredder equipped with an air-tight shield.
2) In a carbonization furnace (Furnace No.1), preloaded wood sample was ignited and the internal temperature was maintained at about 850 °C under the controlled air supply.
3) After mixed with a flux, the mixed samples of wood, building material and plastics were transferred to the furnace No.1 through a screw feeder.
4) A solid residue of charcoal and ash from asbestos-containing building material was continuously discharged from Furnace No. 1 through a screw conveyer.
5) The solid residue was transferred to a fixed-bed gasifier (Furnace No.2) that was heated at about 900 °C under the flow of super-heated steam.
6) The resulting water gas was supplied to a dual-fueled engine to generate electricity.

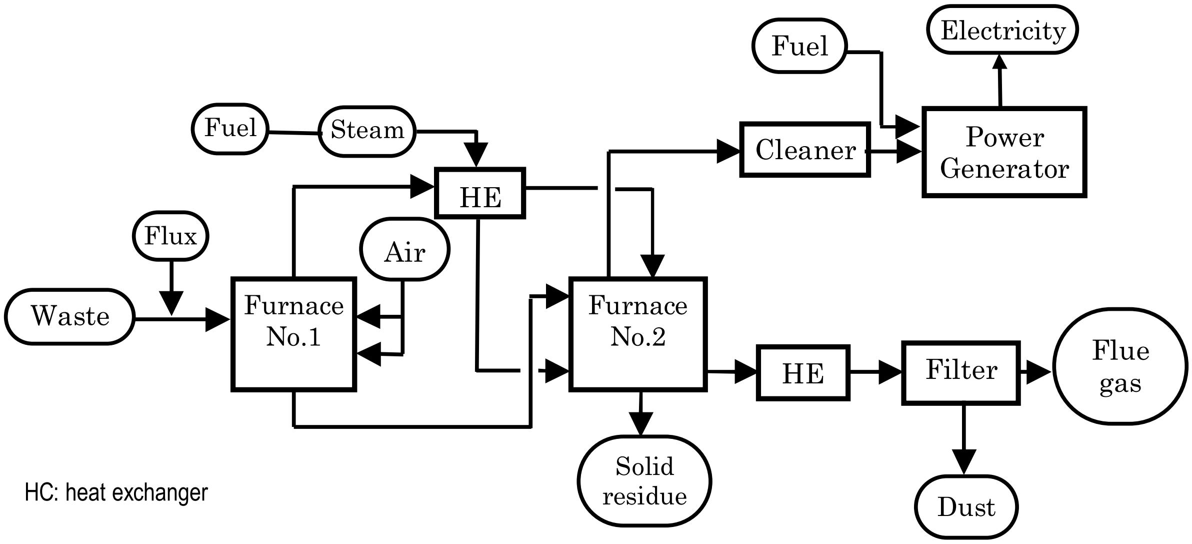

Figure 1. Schematic diagram of a treatment facility of disaster wastes

3. Results and Discussion

Each input materials are converted into the products in Furnace No.1 as Eqs. 1 through 3.

wood → charcoal + combustion flue gas + steam (1)
building material + flux → ash (2)
plastics → combustion flue gas (3)

Moisture in building material and plastics also gives steam. Conversion of asbestos in the building material into harmless ash proceeds under the conditions of the temperature range over 850 °C and a reaction period of about 15 min. A screw conveyer for taking solid residue out of Furnace No.1 were controlled to satisfy the conversion conditions with monitoring the temperatures in the furnace.

Typical results of the demonstration were summarized in Tables 3.

Table 3. Material balance of Furnace No.1 and 2

Input		Output	
Component	Rate,kg/h	Component	Rate,kg/h
Wood	100.0	Solid residue (ash and charcoal)	30.2
Building material	22.9		
Plastics (PE)	22.0		
Flux	5.0	Water gas	43.7
Air from blowers	999.6	Cumbustion flue gas	3,217.0
Steam	30.0		
Intaken air	2,100.0		
Total	3,279.5	Total	3,290.9

Asbestos in the building material were transformed into harmless ash, which was confirmed by microscopic analysis. In the analysis, no asbestos fiber was found in 3000 samples. And asbestos was not found also in combustion flue gas.

Solid residue containing charcoal (30.0 kg/h) and ash (15.3 kg/h) was supplied to Furnace No.2 through a screw conveyer attached to Furnace No.1, and treated under a stream of super-heated steam at 900 °C. Hot flue gas from Furnace No.1 was used a heat source to generate super-heated steam and for heating Furnace No.2.

Water gas (54.4 kg/h) was obtained, and was supplied to a power generator. The gas composition was shown in Table 4.

Table 4. Composition of water gas from Furnace No.2

Component	Content, volume %
Hydrogen	24.6
Carbon monoxide	5.9
Nitrogen	41.4
Oxygen	1.0
Methane	0.3

The high Nitrogen content was probably due to the combustion flue gas intaken from Furnace No.1 through a screw conveyer.

4. Conclusions

Disaster wastes containing building material with asbestos, wood and plastics were treated in two furnaces. Volume reduction of wastes was achieved through partial combustion followed by steam gasification. Asbestos was converted into harmless power during live charcoal burning. No asbestos was found in solid residue and flue gas.