PRODUCTION OF CLEAN AND HIGH-CALORY POWDER FUEL FROM MIXTURE OF WASTE PLASTICS AND WASTE BIOMASS USING SUBCRITICAL WATER

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Abstract

The mixtures of waste plastics and waste biomass (garbage, agricultural wastes and others) are difficult to treat properly. These mixtures are mainly incinerated with auxiliary fuel or landfilled. In proposed technique, the refractory waste mixtures are converted to high-calory and clean powder fuel using subcritical water. The calorific value of the fuel is 25-30MJ/kg and almost equal to that of coal. The fuel hardly has sulfur and chlorine atoms and does not produce toxic effluent gas.

Keywords: *Waste plastic, Waste biomass, Powder fuel, Subcritical water*

1.Introduction

Utilization of large amount of waste substances such as waste plastics and waste biomass is very important in 21st century. Environmentally friendly subcritical water has been studied to convert the wastes to useful fuels or energy with high efficiency and short reaction time, where subcritical water is hot and high-pressure water at 100-300°C and 0.1-20MPa. In this presentation, we explain the production of clean and high-calory powder fuel from the mixture of waste plastics and garbage in subcritical water.

2.Materials and Methods

Figure 1 shows the photo of a bench-scale plant for the production of powder fuel from waste plastics and waste biomass using subcritical water. This was a batch-type apparatus. The reactor was made of SUS 316 with 0.3m^3 in inner volume and it had a horizontal agitator inside. The target waste was the mixture of waste plastics and garbage. The waste mixture was put in the reactor and hot steam was charged into the reactor for heating and supplying subcritical water. The waste mixture was stirred well with 10rpm in subcritical water and hot steam at around 200°C and 1.6MPa for 30 min. The mixture was converted to small powder fuel with high calorific value. Then the fuel was dried easily and rapidly.

3.Results and Discussion

The waste mixture of plastics and garbage discharged from a supermarket was treated by subcritical water at various temperatures using the plant shown in Figure 1. Figure 2 shows the appearance of the products. At 150°C, both plastics and garbage did not decompose much. A lot of them remained as they were before the treatment. On the other hand, the waste mixture changed to the powder fuel with less than 5mm in diameter and mixed together completely at 205 °C. The color of the waste mixture changed black and the slight carbonation occured on the surface of the mixture.

The heating value of the powder portion was measured at the treatment temperature of 150-205 °C. The results are shown in Figure 3. The heating value increased with

Fig.1 Bench-scale plant for production of powder fuel

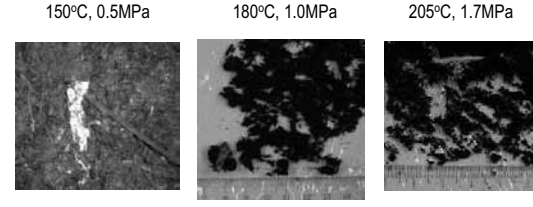

Fig.2 Temperature dependence of appearance of product treated by subcritical water at 30min

the treatment temperature. It was almost the same as that of coal, when the reaction temperature was around 205°C. This was because the waste plastic dispersed well at the treatment temperature above the melting temperature of the plastics. The powder fuel was a composite fuel with 2-layer structure: the center was plastic particle and the surrounding was partly carbonated biomass powder. Furthermore it hardly contained sulfur, which is converted to toxic sulfur dioxide in the combustion process.

At the treatment condition of 205°C and 1.7MPa in which the heating value of the powder fuel was highest, the influence of the treatment time on the heating value was investigated. The results are shown in Figure 4. The heating value was constant at around 28MJ/kg and the powder changed little in appearance, when the treatment time changed from 10 to 30 min.

Next the influence of the rotation number was examined and the results are shown in Figure 5. The heating value was also constant at around 28MJ/kg, when the rotation number was changed from 3 to 15 rpm.

The incineration test of the powder fuel produced from waste polyethylene and rice straw was carried out using a biomass boiler shown on the left-hand side in Figure 6.The fuel could burn stably for more than 12 h, as shown on the right-hand side in Figure 6. The concentrations of toxic substances such as dioxins, nitrogen oxide, hydrogen chloride and others were below the regulation values.

4.Conclusions

Subcritical water is powerful and environmentally friendly solvent for the utilization of biomass containing a lot of water. The proposed technique is expected to work in earthquake disaster areas in East Japan. It can convert waste plastics and garbage to energy, and it can improve poor sanitary condition in disaster areas.

Acknowledgment

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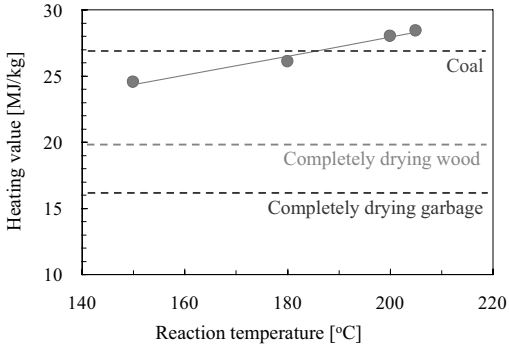

Fig.3 Temperature dependence of heating value of powder fuel produced by subcritical water (0.5-1.7MPa, 30min)

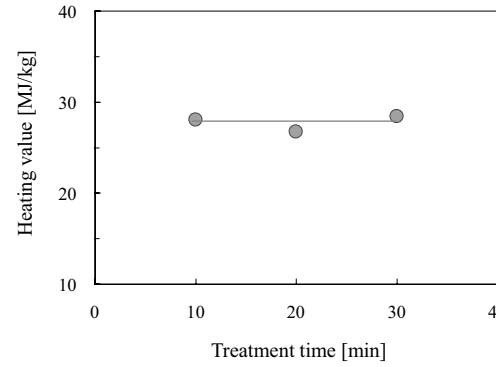

Fig.4 Treatment time dependence of heating value of powder fuel produced by subcritical water (205°C, 1.7MPa,10rpm)

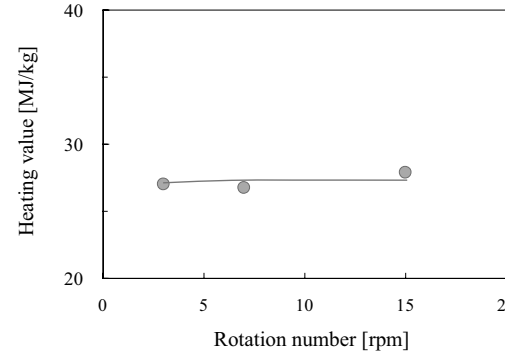

Fig.5 Dependence of heating value of powder fuel produce by subcritical water on rotation number of agitator in reacto (205°C, 1.7MPa, 30min)

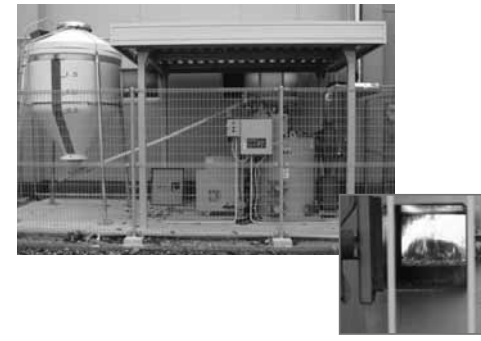

Fig.6 Appearance of boiler and combustion state of powder fu