Effective use of energy from disease cedar of Sanbu region in Japan

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Abstract

Originated cedar region called "Sanbu cedar" has been widely distributed in Sanbu City,Chiba Prefecture, Japan. In recent years, the lack of forestry actors due to the aging and the downturn of timber value are became a problem that the disease cedar more than 80% of the cedar forest. In this study, we investigated to improve the efficiency of gas production and analysis of the products of health cedar and disease cedar by using steam gasification with or without sodium hydroxide at 700 ºC. Based on the experimental data, we are carried out estimation of the synthesis gas produced by the stream gasification of diseases cedar. From these result, the recoverable amount is expected 57548.2GJ / year by disease cedar, it is equivalent to 5.3% (heat utilization rate) total energy demand of the city. It is equivalent of 950 units of annual energy consumption in the home of Sanbu city.

Keywords: *Sanbu Cedar, Biomass, Stream gasification, Sodium hydroxide, Synthetic gas*

1. Introduction

The woody biomass has a great abundance in Japan but the energy applications are not used a large quantities. The effective utilization of biomass energy will not go, due to the high cost of forest biomass collection and transportation, aging and delay of technological development. In recent years, there is a strong demand for the promotion of the utilization of forest biomass further, from the viewpoint of forestry revitalization and job creation. In this study, we assumed that the gas converted to energy by using thinned wood and diseases wood of Sanbu region, Chiba prefecture, and used as a new industry in the region, such as regional transport fuel. Our purpose was "to reveal the experimental conditions while reducing tar gasification is a challenge to efficiently generate synthesis gas useful as fuel" and "to consider the possibility of Sanbu cedar that utilization gas as a fuel in the future region." Therefore, we examined to improve the efficiency of produced gas and, measurement and analysis of the products of pyrolysis gasification experiments of health and disease cedar. Based on the experimental data, we are carried out estimation of the synthesis gas produced by the stream gasification of diseases cedar.

2. Materials and Methods

The sample was used cedar of Sanbu region, Chiba prefecture (size: 1mm) and the catalyst was used sodium hydroxide. The experimental apparatus is shown in Fig. 1. The experimental conditions are shown in Table .1.At first, the biomass and NaOH were loaded into the reactor and heated by an electric furnace while the flowing nitrogen and steam warmed by the heater. After the experiment, the product gas was analyzed by a gas chromatograph (GC-2014ATF) made by SHIMADZU. The liquid product was analyzed by GC/MS.

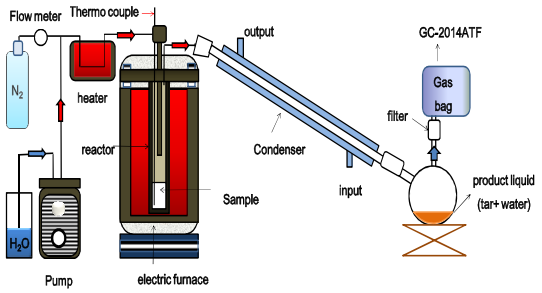

Fig.1 Experiment apparatus of stream gasification

Table1. The experimental condition

Sample (g)	Time (h)	Temp: (ºC)	Temp: rate	N2 flow rate	Catalyst	Gasified agent
10	2	700 ºC	5～15 ºC /min	30ml/min	NaOH: 0～3g	Distillated water 1～10ml/min

3. Results and Discussion

Figure 2 shows the impact of the products (liquid, gas and char) according to the amount of stream by using health cedar (10g) at 700 ºC for 2 hours. From fig.2, we understand that tar decreased with increase in the amount of steam added, but the gas was increased.This is suggested to promote gasification of volatiles by supplying steam, combustible gas has increased due to the decomposition of tar reforming reaction. Increase of the hydrogen concentration is considered that the following reactions by introducing water vapor contribution.

$C + H_2O \rightarrow CO + H_2$ (Water gas reaction)

$CO + H_2O \rightarrow CO_2 + H_2$ (Shift reaction)

From this experiment, we suggested that the addition of steam to the gasification, it is possible to suppress the tar and promote the hydrogen production for synthesis gas.

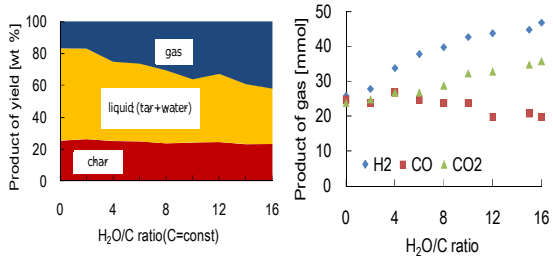

Fig.2. Product yield and the effect of the steam supplied to the gas composition

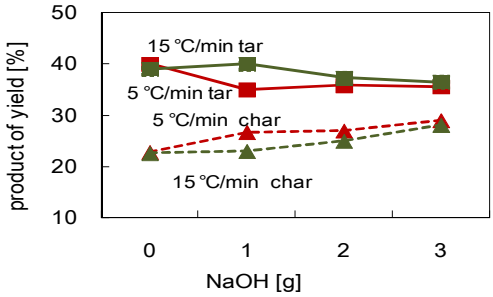

Fig.3. Effect of NaOH and heating rate applied to the product yield

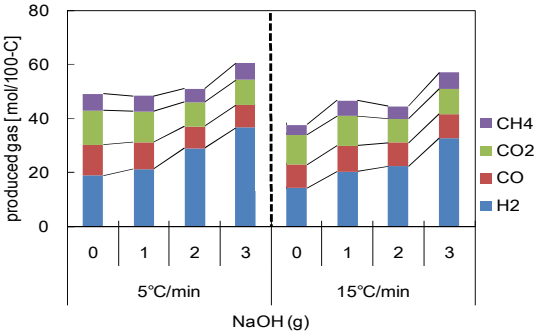

Fig.4.. Effect of NaOH and heating rate applied to the product gas

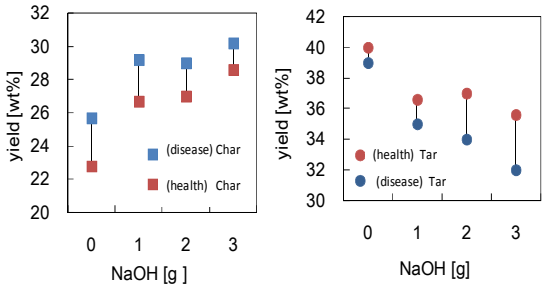

Fig.5. (a) Comparison of disease and health char
(b) Comparison of disease tar and health tar

Effect of NaOH and heating rate applied to the product yield and the influence of heating rate and NaOH applied to the product gas are shown in in fig. 3 and fig.4. Figure 5(a) (b),6,7 are show the comparison result of health cedar and disease cedar gasification at 700 ℃ ,in the case of changing the amount of heating rate and the addition of NaOH. The disease cedar char yield higher than healthy cedar but the tar yield is lower. Addition of less amount of NaOH is difficult to effect the produced gas in disease cedar. It considered that the difference of moisture content and decrease of cellulose components in disease cedar. When the disease cedar and NaOH (1 g) were carried out at 700 ℃ (H_2O / C = 8, 5℃ / min, 2h) , the produced gas can get high efficiency of cold gas, carbon conversion and high calorific value gas fuel (12 ~ 14Mj/Nm^3). Table 2 shows the results of the estimated assumption that the gasification gas of disease cedar is applied to Sanbu region.

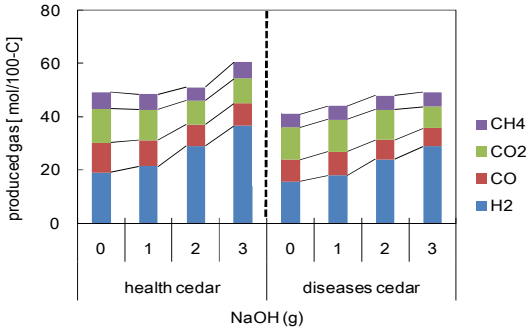

Fig.6. Compare of gas health cedar and disease cedar

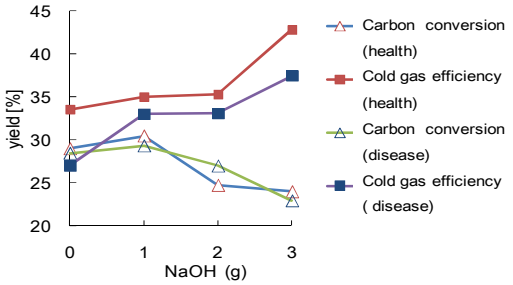

Fig.7.Efficiency comparison of health cedar and disease cedar

Table.2 Estimation results

Crop (t/y)	gas of wood (m3/t)	Calorific of gas (Kcal/Nm3)	Potential abundance (GJ/y)	Expect amount(GJ/y)	
				Thermal	Generation
25698	2.5×10^2	3057	82211.8	57548.2	16442.4

4. Conclusions

The steam gasification of cedar is possible to promote the production of hydrogen-rich fuel gas while suppressing the tar. The efficient gasification is possible by the synergistic effect of addition of NaOH and heating rate. The efficiency of disease cedar gasification and gas production rate is low compared with the healthy cedar, but tar is reduced. By adjusting the experimental conditions, disease cedar can also produce a high calorific gas, because it can be expected to avoid tar problems and possible applied to Sanbu region as a fuel gas.