Development of new pretreatment method for biorefinery scheme of woody biomass

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1. Introduction

Recently, utilization of woody biomass, which is noncompetitive with the edibles, has been studied as renewable energy. However, alternative-fuel (made from biomass) production is ineffective to reduce the carbon-dioxide (CO_2) emission. So, I focused attention on Biorefinery (BR) technology. It is possible to reduce the use of fossil resource and to produce valuable chemicals. The improvement in pretreatment and saccharification of cellulose is essential for the development of BR scheme and reduction of CO_2. Thus, in this study, I examined the effect of new pretreatment method on the subsequent enzymic saccharification.

2. Experimental section

(2-1) Pretreatment

Japanese cedar was used as raw material. 2 g of sample and 18 g of distilled water (or 50% acetone aqueous solution) were loaded into the batch-type reactor. Under the several conditions, acetic or formic acid was added as catalyst. The reactor was immersed in an oil bath at the predetermined temperature (180-220 °C). After the desired time had elapsed, the reactor was removed from the oil bath and rapidly quenched in a water bath. Solid-liquid separation of products was performed by filtration, and each product was analyzed.

(2-2) Enzymic Saccharification

1 g of the pretreated sample and the 20 mL of citric buffer solution (0.1 mol/L, pH = 5) were added into the reactor. Cellulase was used as enzyme for saccharification. The concentrations of enzyme and substrate were 20 $mg/g_{\text{-dry}}$, 50 $g_{\text{-dry}}/L$, respectively. The reactor was heated at 50 °C for 48 h. Solid-liquid separation of products was performed by filtration, and the liquid product was analyzed by HPLC for sugar.

(2-3) Estimation of Carbon-Dioxide emission

I tried to estimate the CO_2 emission from the presented process, which consists of rough crushing, pretreatment, and enzymic saccharification. I compared this process with non-pretreatment. Estimation procedure was based on the previous report[1].

3. Results and discussion

Hemicellulose and lignin are removed to some extent from biomass sample through the pretreatment. Fig.1. shows the effect of the removal ratio of lignin on the enzymic saccharification ratio (including reference data[2]). These results indicate that the saccharification ratio increased with the removal ratio of lignin. The saccharification ratio for the treated sample with acetone solution at 220 °C became three times as much as that for the non-treated one.

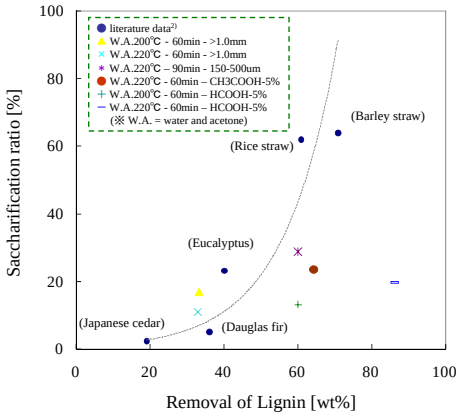

Fig.1. Relationship between the removal ratio of lignin and the saccharification ratio

From table 1, we found that it was difficult to reduce CO_2 emission due to the heat for pretreatment. However, this process has the advantage of converting woody biomass into chemicals. Moreover there is a possibility that further heat recovery and active enzyme in the presented process bring about the superiority and the reduction in CO_2 emission.

Table 1 Estimation of CO_2 emission

Pretreatment Condition	[kg-CO_2/kg]	Pretreatment	Enzymic Saccharification	Total
Nontreat-Coarse crusher	Electrical Quantity	0.11	0.03	0.14
	Heat Quantity	-	0.23	0.23
(Japanese cedar >1.0mm)	Total	0.11	0.26	0.37
Fine grinding	Electrical Quantity	4.46	0.01	4.46
	Heat Quantity	-	0.05	0.05
(<0.1mm)	Total	4.46	0.05	4.51
Consolidation- Addition of acid	Electrical Quantity	0.03	0.01	0.04
	Heat Quantity	0.66	0.00	0.66
(CH_3COOH−5%)	Total	0.69	0.01	0.70

4. References

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2) Satoshi Kumagai, Noriyuki Yamada, Tsuyoshi Sakaki, Nobuyuki Hayashi; *Journal of the Japan Institute of Energy*, **86**, 712-717 (2007)