論文 / 著書情報
Article / Book Information

題目(和文)	混合法と熱分解法を用いた杉由来のバイオオイルの品質向上に関する研究
Title(English)	Combination of Cracking and Mixing Method to Improve Cedar Bio-oil Quality
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種別(和文)	論文要旨
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（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	環境理工学創造	専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	（ 工学 ）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

This research aims to develop a low cost and high efficiency upgrading of bio-oil for engine application. The commonly used methods are divided into two types; physical and chemical methods. In this research, both of the two types are discussed and compared with the combination of the both. The physical method analyzed in this research is mixing the bio-oil with biodiesel, and the chemical method is pyrolysis cracking. A two units' reactor is the device for the pyrolysis cracking. The target product is the upgraded oil with higher combustion capability. The reaction conditions and the reaction principle have been investigated. The contents of this thesis are as follows.

Chapter 1. Introduction

In this chapter, the basic background of the bio-oil derived from biomass and the upgrading technology were introduced. The problems about the current situation of utilization and upgrading of bio-oil were discussed respectively. The upgrading methods chosen in the following research were the mixing and the cracking. The advantage and disadvantage of those methods were discussed, and the possibility of combination of the two methods were explained. The attention of the research was paid on the reaction conditions and the reaction principle. The objectives and the originality of this research were stated finally.

Chapter 2. Mixed fuel of bio-oil and biodiesel

Bio-oil produced by the pyrolysis of biomass is highly viscous and has a high water content, which makes it difficult to be used in engines. To overcome these problems, a method of blending bio-oil with biodiesel was investigated in this chapter. This thesis studied the characteristics of the bio-oil derived from Japanese cedar blended with biodiesel, and their possible usage as a fuel for a diesel engine. The suitable mixing ratio, the optimum mixing condition and the possibility of driving an engine were discussed. The investigation included elemental and compositional analysis, the heating value, the density, the viscosity, the water content, the carbon residue and the ash content. The blending ratios of bio-oil to biodiesel applied in the diesel engine are 1:9, 3:7 and 5:5. In the engine test, the 1:9 and 3:7 blends could be well utilized within a short time in the engine, but the 3:7 blend could not realize a long duration operation. The engine test was done based on the US EPA standard where the specific gas emissions were evaluated in addition to the full load performance.

Chapter 3. Cracking upgrading of bio-oil

The objective of this chapter is to find the optimum operating conditions to upgrade the bio-oil using the cracking method in a bench-scale reactor with two heating units. The temperature of each unit was independently controlled using the temperature controllers respectively. A constant stream of N2 was fed

from the top of the reactor for the continuous withdrawal of the products and maintenance of the inert atmosphere during pyrolysis. The liquid products were condensed in a glass receiver submerged in a cooling bath kept at 0° C. The key point of this process is the use of different temperatures for each heating unit. In this way, the upgraded oil has equal quality as the one upgraded by other chemical methods and the zeolite catalyst can be reused. The bio-oil used in this chapter is the same as the one in the last chapter. The catalyst is HZSM zeolite, which is commonly used in bio-oil crack upgrading. The bio-oil and the upgraded oil were characterized by measuring their elemental composition, water content and the chemical composition of their organic fraction.

Chapter 4. Combination of cracking and mixing method to improve the bio-oil quality

In this study, the liquid products collected from Chapter 3 was mixed with the biodiesel used in Chapter 2. The mixing method was the same as Chapter 2. The mixing ratios of 3:7 and 5:5 were tested. The results showed that the new mixtures were completely mixed stably at any mixing ratio. The mixed fuels stood for at least 6 month and no obvious layering was observed. The possible reason is that the polarity of the cracked oil is greatly reduced which lead to a harmony solution with biodiesel. Benzenes and phenols played an important role in this harmony solution. The combustion performance is measured by calculating the cetane index. The model compounds were chosen to verify the reaction principle. To investigate the range of improvement of the upgraded bio-oil by the combination of the mixing and the cracking methods compared with the individual mixing or cracking methods, the quantitative calculation were the main data to measure the fuels.

Chapter 5. Conclusions

This chapter summarizes the important concluding remarks of this thesis.