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学位論文全文に代わる要約
Extended Summary in Lieu of Dissertation

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学位論文題目：
Title of Dissertation

Characterization of cellulose recovered from palm fiber waste and its derivatives
（パームファイバー由来廃棄物から抽出したセルロースのキャラクタリゼーションとそのセルロース誘導体）

学位論文要約：
Dissertation Summary

In Indonesia, oil palm is a leading plantation crop, with contributed to around 12 % of the country's nonoil and gas export. Unfortunately, palm oil industry generates large quantity of wastes whose disposal is a challenging task. In a typical palm oil mill, almost 70 % of the fresh fruit bunches are turned into wastes in the form of empty fruit bunches, fibers and shells, as well as liquid effluent. Therefore, this behavior contributes significantly to global climate change by emitting carbon dioxide and methane. Moreover, it is a challenging to change this condition, so the by-product from palm oil production have value and make the environment remain maintained. In this study, for the effective utilization of palm fiber waste as a raw material, the extraction of cellulose from and the preparation cellulose derivatives using the cellulose extracted from the palm fiber were investigated.

Experiment result showed that the cellulose from palm fiber can be successfully extracted using two cellulose extraction methods: American Society for Testing and Materials (ASTM international method), which is maceration and delignification method, combined with hypochlorite treatment, which used a sodium hypochlorite treatment solution; and the dissolving method, which involved pre-hydrolysis, the kraft process, O (oxygen)–H (sodium hypochlorite) –P (peroxide) bleaching and acid post-treatment. The ASTM method (Treatment time: 3 h) followed by processing with the hypochlorite treatment gave the product with a highest α-cellulose recovery rate (82.5%). The dissolving method with a phosphoric acid of 3% (on solid) in the pre-hydrolysis process and 11% sulfidity (on solid) in the kraft process gave the product with the highest α-cellulose recovery rate (89.0%).

After being extracted using ASTM method followed by ozone treatment we investigated on solubility of cellulose and chemical composition in cellulose extracted from palm fiber. The initial holocellulose, α-cellulose,

and lignin contents of the extracted cellulose were 88.0 %, 81.9 %, and 8.75 %, respectively. The extracted cellulose was treated with ozone and NaOH solution. Ozone treatment for 5 h at 40 °C using 3 % citric acid decreased the lignin content from 8.75 % to 2.71 %. Under these conditions, the degree of polymerization of the cellulose decreased to 29 from 160 and the carboxyl content increased to 2.05 mmol/g. When the solid phase was treated with NaOH after ozone treatment, the mass of the solid phase decreased as the ozone treatment time increased. The lowest mass was 0.43 g. Additionally, the mass of cellulose regenerated from the liquid phase increased with increasing treatment time. The highest mass of regenerated cellulose was 0.54 g. The masses of the solid phase and regenerated cellulose obtained without ozone treatment under the same conditions were 0.76 g and 0.18 g, respectively. These results suggest that ozone treatment improves the solubility of cellulose by converting hydroxyl groups in the cellulose to carboxyl groups and reducing the degree of polymerization (DP).

Further using ASTM methods with 3 h reaction followed by ozone treatment, the best condition to produce carboxymethyl cellulose (CMC) with the addition of NaOH and the amount of NaMCA was conducted. Ozone pretreatment, NaOH concentration and the additional amounts of NaOH and NaMCA had the significant factors on characterization of CMC such as DS, solubility and purity. The solubility increased with increasing the DS of CMC. These results were caused by the addition of NaOH and NaMCA, which affected the improvement of the solubility and DS of CMC. The optimum condition for DS, purity and solubility was the addition of 10 mL of 30 % NaOH and 4.5 g of NaMCA at 55 ºC for 3.5 h reaction time.

The DP of cellulose was successfully controlled by ozone pretreatment. By the longer ozone treatment time, the DP of cellulose was reduced and was resulted in difference of its CMC characterizations. Higher DP of cellulose caused the higher viscosity of CMC. While, the lower DP of cellulose caused the higher solubility. Therefore, the viscosity of CMC was reduced by longer reaction time of ozone pretreatment and then, the viscosity could be controlled by the ozone treatment.

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