（第３号様式）(Form No. 3)

学 位 論 文 要 旨
Dissertation Abstract

氏名：
Name　Agustu Sholeh Pujokaroni

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）

学位論文要旨：
Dissertation Abstract

The palm plant, which is an abundant agricultural product with high economic value, is widely distributed in tropical and sub-tropical countries.

Firstly, we attempted to extract cellulose from waste fiber from oil palm processing for preparation of useful and valuable materials, such as carboxymethyl cellulose. We studied two methods for extraction of cellulose from palm fiber: the American Society for Testing and Materials (ASTM) international method, which is a maceration and delignification method, combined with hypochlorite treatment using sodium hypochlorite; 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 hypochlorite treatment gave the product with α-cellulose recovery rate of 82.5%. The dissolving method with a phosphoric acid mass fraction of 3% in the pre-hydrolysis process and 11% sulfidity (mass fraction) in the kraft process gave the product with the highest α-cellulose recovery rate (89.0%).

Secondly, the effects of ozone treatment on solubility of cellulose and chemical composition in cellulose extracted from palm fiber was studied. 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 DP.

Next, carboxymethyl cellulose (CMC) with high degree of substitution (DS), high solubility and high purity was studied. The concentrations of NaOH and monochloroacetic acid (NaMCA) were investigated. In addition, the control of viscosity from degree of polymerization (DP) by ozone pretreatment was studied. Ozone pretreatment, NaOH concentration and the additional amounts of NaMCA had the significant factors on characterization of CMC such as DS, purity and solubility. The solubility increased with increasing the DS of CMC. The optimum conditions were the ozone treatment for 3 h, the addition of 10 mL of 30 % NaOH and 4.5 g of NaMCA at 55 ^{o}C for 3.5 h reaction time. In their conditions, the DS, purity and solubility were 1.05, 79.6 %, and 94.6 %, respectively. The DP decreased with increasing the ozone treatment time. Higher DP of cellulose caused the higher viscosity of CMC. While, the lower DP of cellulose caused the higher viscosity and 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.