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（要　旨）

Feedstock recycling which involves pyrolysis of waste plastics is an alternative method not only to produce fuels but also to reduce the waste plastics. In this thesis, the fuel productions from waste plastics by the sequential pyrolysis and catalytic reforming (SPCR) method developed at Tokyo Institute of Technology have been investigated. The main product of this system is liquid fuel with some additional products such as gaseous and solid fuels. This system consists of two reactors for pyrolysis and the catalytic reforming processes. The gaseous fuel can be used either as a single fuel for gas engines or used together with diesel fuel in dual fuel diesel engines. The solid residues still have high calorific value which can be used as solid fuel for co-combustion with coal or biomass. This study focuses on the liquid fuel production to be prepared for running in a diesel engine.

The utilization of a commercial Y-Zeolite catalyst has been investigated to study the effect of the reforming temperature and the weight hourly space velocity (WHSV) on the product yields, the liquid characteristics, the gaseous composition and residue characteristics for both high density polyethylene (HDPE) and polystyrene (PS) samples. Increasing the reforming temperature and decreasing WHSV have resulted in an increase of gaseous and solid products while the liquid product decreased. The maximum oil production for HDPE (70.0wt%) and PS (88.1wt%) were obtained at the pyrolysis temperature of 450°C and 400°C, respectively, with the same reforming temperature of 450°C and WHSV of 4. The gaseous fraction of C_2, C_3 and C_{4+} (>75 mol %) are the main components of the gaseous products from HDPE, while C_2 and C_3 gases (>65 mol %) are the main components of the gaseous products from PS. The residues produced in the pyrolysis reactor also produced solid products with high calorific values which can be utilized as fuels as well.

However, the use of commercial catalysts is the main obstacle for recycling of waste plastics since it is very costly. Therefore, the utilization of natural zeolite (NZ) catalyst has also been investigated. Some pretreatments of NZ have been done such as the calcination, the acid treatment and the metal impregnation. The results show that the mordenite-type natural zeolites, either with the calcination pertreatment or the HCl pretreatment or the nickel impregnation could be used as efficient catalysts for the conversion of polypropylene (PP) and PS into liquid and gaseous fuels. The maximum oil production from PP and PS are 86.4% and 97.4% respectively after the calcination pretreatment of NZ. The maximum diesel yield can be obtained utilizing calcinated NZ

catalyst for PP and natural zeolite catalyst after the calcination and the acid pretreatments for PS. Natural zeolite catalysts produced higher diesel fraction due to the lower activity of natural zeolite than Y-Zeolite catalyst. The gaseous product was dominated by propene for PP and by propane and propene for PS.

In order to study the performance of the SPCR method using real waste plastics, the experimental study has also been conducted utilizing municipal plastic wastes (MPW) obtained from the final disposal site in Yogyakarta city, Indonesia. The results show that HDPE waste produced the highest liquid fraction. However, the heavy oil fraction was still high in the oil from HDPE waste. The highest diesel fraction has been produced using polyethylene bag after crushing and washing. The catalyst presence reduced the liquid fraction and increased the gaseous fraction. Pyrolysis with natural zeolite catalyst produced higher liquid products compared with Y-Zeolite catalyst. However, the presence of catalysts have slight effect on the product yields. This might be due to the presence of impurities in MPW. The quality of waste plastics oil (WPO) was still lower than those of commercial diesel fuels according to the oil properties. Blending of WPO and diesel fuels will produce better quality oil.

Finally, the diesel engine tests have been done using blends of WPO with diesel fuel under different loads to investigate the impact of WPO on the performance and emission characteristics of the engine. The brake thermal efficiencies were slightly higher as compared to that of diesel. However, the difference was not significant since the calorific value of WPO was found to be similar with that of diesel. The NO_x emission is found to be lower by blending diesel with WPO. The decreased NO_x emission is due to the decrease of the in-cylinder temperature as the effect of non-homogeneity of WPO. The emissions of HC and CO of WPO blends were higher than those of diesel. The higher HC emission in WPO-diesel blends compared to diesel may be attributed to the reason that the fuel spray does not propagate deeper into the combustion chamber. The increased CO emission is due to incomplete combustion as the effect of reducing the in-cylinder temperature, poor mixture preparation and local rich regions.