

論文 / 著書情報
Article / Book Information

題目(和文)	接触熱分解とCO2ガス化プロセスによる電気電子機器廃棄物からの燃料油と有用資源の同時回収
Title(English)	Integrated Recovery of Valuable Resource and Fuel Oil from E-wastes by Catalytic Pyrolysis and CO2 Gasification Process
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

専攻： 環境理工学創造 専攻
Department of
学生氏名： 武 虎 (Wu Hu)
Student's Name

申請学位 (専攻分野)： 博士 (工学)
Academic Degree Requested Doctor of
指導教員 (主)： 吉川 邦夫
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Academic Advisor(sub)

要旨 (英文 800 語程度)
Thesis Summary (approx.800 English Words)

The thesis has been divided into 5 chapters. The summary of each chapter is shown as following:

Chapter 1. Introduction

Firstly, the characteristics, the environmental hazards and the recycle methods of waste electrical and electronic equipments (WEEE) were introduced, respectively. Additionally, special attention was paid to the catalytic pyrolysis and gasification technology for the recycling of WEEE plastics. Finally, the objective and originality of this thesis were presented.

Chapter 2. Catalytic pyrolysis of brominated high impact polystyrene over red mud, limestone and natural zeolite additives

The thermal degradation of high impact polystyrene containing brominated flame retardants and antimony trioxide (Br-HIPS) was conducted at different temperatures and in the presence of three additives (red mud, limestone and natural zeolite) in a fixed-bed reactor, respectively. The effect of the pyrolysis temperature on the product yield and the Br content in the oil product was investigated. It was found that the maximum oil yield was obtained at the pyrolysis temperature of 500 °C. The pyrolysis temperature had no significant impact on the bromine reduction in the oils. The Br in the flame retardant was mainly transferred into the oil product. With the aim of removing Br and Sb from the oils, three additives were used to investigate their influence on the product yield and composition, especially on the bromine removal from the oils. It was found that all of the additives could significantly lower the bromine contents in the oils and the red mud was the most effective. Additionally, the distributions of Br and Sb in the residues were also studied by the SEM-EDX and XRD analysis. There were lots of metal bromides existing in the pyrolysis residues, which indicated that bromine removal from the oil products was mainly attributed to the formation of metal bromides.

Chapter 3. Fuel oil production from pyrolysis-catalytic reforming of Br-HIPS using zeolite and Fe₂O₃ loaded zeolite catalysts

The experiments of two-stage pyrolysis and catalytic reforming of Br-HIPS were conducted in the presence of four zeolite catalysts in order to remove the Br content from the oil products. The four catalysts were natural zeolite (NZ), iron oxide loaded natural zeolite (Fe-NZ), HY zeolite (YZ) and iron oxide loaded HY zeolite (Fe-NZ). The effect of catalyst types on the product yield, product composition and the debromination efficiency of the oil products were evaluated in detail. The results showed that regardless of the presence of catalysts, the single-ring aromatic compounds were the main components of the oil products, such as ethylbenzene, toluene and styrene. Meanwhile, when YZ and Fe-YZ were used, the two-ring and multi-ring aromatic compounds in the oils and gas product yield significantly increased at the expense of valuable single-ring aromatic compounds. Furthermore, as for the debromination performance of the oil products, Fe-NZ and Fe-YZ were better than NZ and YZ, duo to the loading of iron oxide, which could react with the derived HBr and then remove more bromine from the oil products. Finally, the deactivation and regeneration of catalysts were also evaluated in this chapter. It was found that the deactivation of the catalysts was attributed to the coking and the reduction of Fe₂O₃. In addition, the regenerated catalyst almost have the comparable activity and effect for the catalytic

decomposition of Br-HIPS.

Chapter 4. The CO₂ gasification kinetic of WEEE plastic char derived from medium temperature pyrolysis by TGA

In order to effectively utilize the char without oxidizing the metal contents, the CO₂ gasification of WEEE plastics chars were firstly studied by TGA within the temperature range of 850–1050 °C. Phenolic board (PB), brominated high impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS) were employed as model WEEE plastics for the char production. The effect of the gasification temperature on the WEEE plastic char conversion, the reactivity indexes and the gasification rate were investigated in detail. The random pore model (RPM), the extended random pore model (eRPM) and the shifted extended random pore model (s-eRPM) have been employed to fit with the CO₂ gasification rate of chars. It was found that the CO₂ gasification reactivity of PB char was the highest, followed by that of HIPS char and then that of ABS char. Additionally, it was found that RMP could fit well with the gasification reaction rate of HIPS char whose maximum gasification rate appeared at the char conversion of approximate 0.4. Nevertheless, as for PB and ABS chars, their maximum gasification rate presented at char conversion of around 0.8 and 0.2, respectively. And eRMP and s-eRPM could predict their gasification rate very well, respectively. Finally, the addition of carbonate catalysts could obviously increase the gasification rate and the reactivity index of char samples. At 850 °C, the addition of 10wt.%K₂CO₃, 5wt.%K₂CO₃ 5wt.%Na₂CO₃, 10wt.%Na₂CO₃ into HIPS char could increase the reactivity index 10, 2.8 and 6.7 times, respectively, which also could reduce the activation energy of HIPS char from 145.94 KJ/mol to 78.50, 125.00, 98.23 KJ/mol, respectively.

Chapter 5. Conclusions and recommendations

The principal results achieved in this research are summarized. The proposals and comments for the future study were also discussed.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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