

論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Clean Solid Biofuel Production from Empty Fruit Bunch Employing Hydrothermal Treatment and Water Washing for Co-combustion with Coal
著者(和文)	RuksathamcharoenSirawasith
Author(English)	Sirawasith Ruksathamcharoen
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第11169号, 授与年月日:2019年3月26日, 学位の種別:課程博士, 審査員:吉川 邦夫,竹下 健二,中崎 清彦,高橋 史武,時松 宏治,梶谷 史朗
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第11169号, Conferred date:2019/3/26, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

論文要旨

THESIS SUMMARY

系・コース : Department of, Graduate major in	融合理工学 地球環境共創	系 コース	申請学位 (専攻分野) : Academic Degree Requested	博士 Doctor of Engineering
学生氏名 : Student's Name	Ruksathamcharoen Sirawasith		指導教員 (主) : Academic Supervisor(main)	吉川 邦夫
			指導教員 (副) : Academic Supervisor(sub)	

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

This research proposes integration of the washed hydrochar derived from empty fruit bunch (EFB) into the coal-fired power generator. To realize the aim of the thesis, various aspects essential in EFB treatment, transportation and energy conversion were investigated in this study.

In Chapter 2, effects of HT temperature (180 - 220° C) and water washing on the fuel properties, structure, combustion characteristics and kinetics of EFB combustion was carried out. The mentioned properties of HTW-EFB from lab-scale were compared with that of commercial-scale to investigate the scaling effects. For the lab-scale samples, EFB was hydrothermally (HT) treated at the temperature of 180, 200 and 220° C for 30 mins and washed using water at 60° C for 15 mins for removing alkaline metals. For the commercial-scale sample, EFB was HT treated at 2 MPA for 30 mins and washed with room temperature water using the centrifugal machine for 30 mins. Results indicated that combination of the hydrothermal and the washing treatments (HTW) improved the fuel properties of EFB significantly with an increase in the calorific value up to 23.3 MJ/kg. The alkaline contents of HTW-EFB were reduced when compared with that of untreated EFB. In addition, an increase in the porosity of EFB was observed after the HTW process. Significant changes in the combustion behavior were observed when EFB underwent HTW. The ignition temperature of the hydrochars was

between 290 to 296° C with the burnout temperature from 438 to 485° C. From the kinetic study, the activation energy of HTW-EFBs were between 99.96 to 138.26 kJ/mol in the devolatilization stage and 10.97 to 27.56 kJ/mol in the char combustion stage. HTW-EFB from commercial-scale showed better fuel properties than that of lab-scale despite the low treatment temperature ranging between 150 and 180 ° C during the holding time.

Chapter 3 examined the effects of the hydrothermal treatment and the pelletizing temperature on the physical characteristics of EFB pellets. RAW-EFB was blended to the size below 2 mm, while HTW-EFB was directly pelletized. The samples were pelletized using the single pellet making device at a pressure of 60 MPa and the temperature of 100, 150 and 200° C. Results indicated that combination of the hydrothermal treatment and the water washing significantly reduced the hemicellulose content of EFB from 23.55% to 1.24% causing the lignin content of HTW-EFB to increase due to the concentration effect. Moreover, the particle size of HTW-EFB was significantly reduced compared with that of RAW-EFB. The changes in the biological composition and the particle size of HTW-EFB significantly improved the pelletization performance of EFB especially when it was pelletized at 100° C. At the pelletizing temperature of 100° C, the pellet durability index (PDI) and the compressive strength of EFB increased from 78.1% and 18.8 N/mm to 98.7% and 51.4 N/mm, respectively, when it was treated. Notable increase in the pellet properties of untreated EFB were also observed as the pelletizing temperature increased. At the pelletizing temperature of 200° C, PDI and the compressive strength increased to 92.8% and 46.1 N/mm, respectively. However, only slight improvement in the characteristics of the washed hydrochar pellets were observed as the pelletizing temperature

increased.

Chapter 4 studied the effects of HT and the water washing on co-combustion of EFB with coal. The thermogravimetric analysis (TGA) was employed to study the thermal behaviors and kinetics of the blended fuel. HTW-EFB from the was mixed with sub-bituminous coal at the ratio of 10, 20, 30, 40 and 50% on the mass basis. The sample was heated at the rate of $5^{\circ}\text{C min}^{-1}$ under the air flow rate of 150 ml min^{-1} from the room temperature to 800°C . Results showed that treated EFB showed two combustion steps: from 290°C to 350°C and from 370°C to 445°C . However, only one combustion step was observed for coal, from 330°C to 462°C . The HTW-EFB/coal blend showed only two combustion steps indicating the synergistic effect. The increase in the blend ratio reduced the ignition temperature and the burnout temperature of the blended fuel.

For the NO emission test, HTW-EFB was co-fired with coal in a fixed bed reactor. The mixture of Ar and O₂ was used as a carrier gas to avoid any thermal NO generation from the co-combustion. For all the tests, 0.2g of the blended fuel was mixed with 5 g of silica sand to prevent the ash agglomeration. The carrier gas was injected to the combustor at 2L/min and the combustion temperature was 900°C . The results showed that the NO emission and NO conversion of HTW-EFB was lower than that of coal. In addition, the increase in the blending ratio resulted in a gradual reduction of NO emission as well as NO conversion. From the results of both TGA and NO emission test, the blending ratio of 30% was recommended for the co-combustion.

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).

注意：論文要旨は、東工大リサーチリポジトリ(T2R2)にてインターネット公表されますので、公表可能な範囲の内容で作成してください。

Attention: Thesis Summary will be published on Tokyo Tech Research Repository Website (T2R2).

(博士課程)

Doctoral Program

東京工業大学

Tokyo Institute of Technology

