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種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨
THESIS SUMMARY

系・コース： Department of, Graduate major in	Department of Transdisciplinary science and Engineering, School of Environment and Society 系コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of (Philosophy, Ph.D.)
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Recently, the hydrothermal carbonization (HTC) has been emerged as a promising thermo-chemical wet biomass conversion technology to address simultaneously the proper disposal method of biomass waste and its valorization by conversion into value-added products. This main purpose of this research is to investigate the effects of operating condition of the HTC on physico-chemical properties of its solid carbonaceous product, so called hydrochar (HC). The second aim of this study is to explore the feasibility of utilizing typical HC and modified/activated hydrochar as cost-effective carbon-based adsorbents to remove the organic and inorganic pollutant from aqueous solution. This study includes three main parts.

In the first part of this research, high moisture wastewater sludge (WS, 88.9% moisture) was selected as a biomass waste to produce typical sludge-based hydrochars (SHCs) at different condition of HTC (170, 200, 230 and 260 °C) and high surface area sludge-based activated hydrochars (SACs) via activation processes. For this purpose, SHCs and SACs were prepared from WS without pre-drying via HTC followed by physical (P-SAC) and chemical (C-SAC) activation with CO2 at 900 °C and KOH at 700 °C, respectively.Moreover, the prepared SHC, the P-SAC and the C-SAC was selected to evaluate their adsorption performance of the removal of methylene blue (MB) from aqueous solution. The elemental analysis and FTIR results provided the evidence that the processes of dehydration and decarboxylation were dominating the reaction pathway during HTC. The results indicate that even though CO2 -activation improve the pore structure and the specific surface area of HCs (from below 7 to 260 m2/g), KOH-activation of HCs could significantly enhance the specific surface area (up to 1614 m2/g). Therefore, the chemically activation was much more effective than the physically activation for the development of HCs porosity. Prepared HCs and SACs were applied for the removal of methylene blue from aqueous solution. Based on Langmuir isotherm model (R2>99.4%), the maximum monolayer MB adsorption capacity of hydrochar, P-SAC and C-SAC were 63.3, 122.4, and 588.2 mg/g, respectively at pH > 8.0. The MB adsorption on C-SACs followed the pseudo-second order kinetic model and a spontaneous endothermic reaction from 298 to 328 K. The commercial ACs also was compared with our materials and found that produced C-SACs showed superior results for MB removal. Therefore, HTC is the best potential carbonization method for wet biomass conversion.

The objectives of the second part are to investigate the effect of operating conditions of hydrothermal process on physicochemical properties of prepare typical HCs and modified HCs using in-situ acid-assisted HTC and to assess their performance of Cd (II) removal from aqueous solution. For the purposes, acid-assisted HTC was performed at different operating conditions (200 to 260 °C and 0.5 to 3h) using HNO3 (0.0 to 5.0%) to prepare the HCs and mHCs from timed tree branches as lignocellulose biowaste. The mass yield of HCs and modified HCs decreased with increased HTC temperature and retention time. Based on XPS results, the highest value of surface polarity (O+N) was obtained at low operating condition(200°C, 0.5h) and 5%acid concentration, which its Cd adsorption capacity was 48.1% more than that at the same condition without the presence of acid. The reaction time of HTC was no significant influence on physicochemical properties of mHC. Although the OFG values were generally raised with increasing the acid concentration, the trend of Cd adsorption capacity did not follow completely the increase of surface Oxygen functional groups (OFGs). The results indicated that correlation coefficient (R2) of data fitting between exchangeable cations concentration (CEC) and OFG vs. Cd adsorption capacity was 0.90% and 0.48%, respectively. Therefore, CECs play considerable role in the Cd adsorption due to the surface complexation reaction with mHC.

As shown in the second part, the CECs is the predominant Cd adsorption mechanism as shown by good consistency of trend of the CEC with Cd uptake capacity. Therefore, the main purposes of third part of research were to prepare

mHCs via in-situ alkaline-assisted HTC, to prepare mHCs using ex-situ modification with several alkaline reagents and finally to assess the Cd removal. Ex-situ modification of hydrochars was performed at 50 °C for 2h with 0.3 N of each alkaline solutions (KOH, NaOH, CaCO3 and K2CO3). The results showed that the Cd uptake capacity of mHCs capacity (9.11 to 19.98 mg/g) prepared via in-situ KOH-assisted HTC was much higher compared to mHCs obtained from in-situ acid modification (~ 4.3 mg/g).The commercial activated carbons (CAC) were also compared with our materials and found that produced KOH-mHCs showed superior results (more than 4 times) for Cd removal. In conclusion, mHC obtained from in-site HTC with alkaline additive has the potential application to produce effective alternative adsorbents to current CACs in removal of heavy metal from wastewater streams.