論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Adsorbent fabrication from shrimp shell waste for sustainable shrimp cultivation through nutrient cycles
著者(和文)	YamsomphongKANOKWAN
Author(English)	Kanokwan Yamsomphong
出典(和文)	学位:博士(工学), 学位授与機関:東京科学大学, 報告番号:甲第342号, 授与年月日:2025年3月26日, 学位の種別:課程博士, 審査員:高橋 史武,CROSS JEFFREY SCOTT,吉村 千洋,江頭 竜一,中村 隆志
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Institute of Science Tokyo, Report number:甲第342号, Conferred date:2025/3/26, 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

（博士課程）
Doctoral Program

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	（ 工学 ）
学生氏名： Student's Name	KANOKWAN Yamsomphong		審査員主査： Chief Examiner	高橋 史武	

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

This thesis aims to efficiently utilize shrimp shell waste for the removal of anionic water contaminants by converting it into biochar-derived adsorbents. The adsorbents obtained from shrimp shells (SSs) were synthesized from shrimp shell waste via pyrolysis and alkali activation employing calcium hydroxide ($Ca(OH)_2$) and potassium hydroxide (KOH). Four formulations were developed and designated as SSsN (pyrolysis at 700 °C), SSsH (pyrolysis at 800 °C), SSsCA ($Ca(OH)_2$ + pyrolysis at 700 °C), and SSsK (KOH + pyrolysis at 700 °C). All SS samples were characterized to examine their physicochemical properties, as described in Chapter 2. The adsorbents were subsequently applied for wastewater treatment for removing phosphate (PO_4^{3-}) and methyl orange dye (MO) as representative anionic contaminants, as detailed in Chapters 3 and 4, respectively.

In Chapter 2: Fabrication and characterization of the shrimp shell derived-adsorbent, shrimp shell-derived adsorbent (SSs) were fabricated from shrimp shell waste through a pyrolysis process and alkali activation using calcium hydroxide (Ca(OH)2) and potassium hydroxide (KOH). SSs demonstrated significant improvements in both physical and chemical characteristics, compared to raw shrimp shell. All samples exhibited enhanced surface area (SBET) and pore volume (Vpore), with higher pyrolysis temperatures (800 °C) resulting in more significant enhancements than differing alkali activators. Shrimp shells are rich in Ca, which is distributed throughout the surface, as confirmed by EDS analysis, resulting in the formation of hydroxylellestadite (HDL), calcium carbonate ($CaCO_3$), calcium hydroxide ($Ca(OH)_2$), and potassium sodium calcium chloride carbonate hydrate (KSC). Samples after pyrolysis at 700 °C (SSsN and SSsCA) exhibited HDL and $CaCO_3$, whereas KOH-activated sample (SSsK) generated KSC. At 800 °C (SSsH), $CaCO_3$ converted into $Ca(OH)_2$. The formations, validated by XRD, FTIR, and XPS, may affect the adsorption of PO_4^{3-} and MO, as elaborated in the following chapter.

In Chapter 3: Phosphate Removal and Recovery, SSs were investigated their removal performance for PO43− removal and recovery from solution. All SSs samples (SSsN, SSsCA, and SSsK) demonstrated significant effectiveness in PO_4^{3-} adsorption, with SSsCA exhibiting the greatest adsorption selectivity. The adsorption mechanism for PO43− removal was dominated by chemical precipitation between Ca and P, forming stable Ca-P groups in the adsorbent. Ca2+ could be released from HDL, Ca(OH)2, and Ca(CO)3. Ligand 70 exchange and anion–π interactions also contributed to the PO_4^{3-} adsorption. The recovery ratio of PO_4^{3-} was determined through a case study in Southern Thailand, indicating a recovery efficiency (R%) of 69.54%, which corresponds to approximately 40,479 kg of PO_4^{3-} retrieved from pond water. This substantial decrease in an excess PO_4^{3-} represents a sustainable strategy for managing shrimp shell waste while offering an effective way of PO_4^{3-} recovery, thereby promoting the development of a circular system in shrimp aquaculture.

In Chapter 4: Methyl orange removal, SSsN, SSsCA, and SSsK were selected to remove methyl orange (MO) dye. As a results, SSsCA (qmax= 4033 mg/g) exhibited the best performance in terms of MO removal performance. The outstanding MO adsorption performance was attributed to the presence of HDL within SSs and the inherent characteristics of MO molecules. HDL facilitated a high adsorption capacity by releasing Ca^{2+} ions and providing silanol-like surface properties, which effectively captured the anionic MO through the formation of Si–N linkages and Ca^{2+}–SO_3^- complexes. This chapter also highlights the concentration-dependent nature of MO adsorption, which also influences its adsorption performance. The adsorption was reversible at low MO concentration (≤ 100 mg/L) because MO monomer (disconnecting MO). In contrast, at higher concentrations (>100 mg/L), the adsorption was irreversible due to the connectivity between polymeric complexes. The interactions between MO molecules continued agglomerate that ultimately increases the overall adsorption capacity. Due to the excellent MO adsorption performance of SSs, they could potentially be used to remove other anionic pollutants from shrimp aquaculture wastewater.

In conclusion, the SSs derived from shrimp shell waste has high potential to be used as an effective adsorbent for removing anionic water pollutants. The results demonstrated efficient PO_4^{3-} adsorption and significant MO removal, emphasizing its dual role in nutrient recovery and water purification. This "waste-to-wealth" approach, which transforms waste into valuable products, supports sustainability and a circular system in shrimp aquaculture.

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、東京科学大学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 Science Tokyo Research Repository Website (T2R2).