Effective treatment of palm oil mill effluent using FeSO4 center dot 7H(2)O waste from titanium oxide industry: Coagulation adsorption isotherm and kinetics studies

By: Hossain, MS (Hossain, Md. Sohrab)[1]; Omar, F (Omar, Fatehah)[2]; Asis, AJ (Asis, Ahmad Jaril)[3]; Bachmann, RT (Bachmann, Robert Thomas)[4]; Sarker, MZI (Sarker, Md. Zaidul Islam)[5]; Ab Kadir, MO (Ab Kadir, Mohd Omar)[1]

View Web of Science ResearcherID and ORCID

JOURNAL OF CLEANER PRODUCTION
Volume: 219 **Pages:** 86-98
DOI: 10.1016/j.jclepro.2019.02.069
Published: MAY 10 2019
Document Type: Article
View Journal Impact

Abstract

Palm oil mill effluent (POME) is a highly polluted industrial wastewater that may cause detrimental environmental pollution if discharged directly due to its biochemical oxygen demand (BOD) and chemical oxygen demand (COD) concentrations. In the present study, the performance of FeSO4 center dot 7H(2)O waste from titanium oxide industry was investigated in removing BOD, COD, and total suspended solids (TSS) from POME. Jar tests were conducted with varying coagulant doses (1-5 g L-1), pH (2-10), and temperature (40-80 degrees C) as a function of treatment time ranging from 5 to 90 min. Results show that the FeSO4 center dot 7H(2)O waste can remove about 70% COD, over 80% BOD, and over 85% TSS in a single stage coagulation treatment. The coagulation adsorption mechanisms for the removal of COD, BOD, and TSS from POME were investigated based on Brunauer-Emmett-Teller (BET), Freundlich, and Langmuir isotherm models. The removal of COD, BOD, and TSS from POME was best described by the Freundlich isotherm model, indicating that coagulation adsorption occurred in a multilayer formation with non-uniform distribution of adsorbed particles. The coagulation adsorption kinetics studies revealed that the removal of COD, BOD, and TSS from POME using FeSO4 center dot 7H(2)O waste followed the second-orderkinetics modeling. Our findings suggest that the FeSO4 center dot 7H(2)O waste has the potential to be utilized as a coagulant for treating POME in compliance with the standard discharge limits. (C) 2019 Elsevier Ltd. All rights reserved.

Keywords

Author Keywords: Agro-industrial wastewater; Isotherm model; Coagulation kinetics; Ferrous sulfate; POME; Wastewater treatment
KeyWords Plus: FERROUS SULFATE; REMOVAL; WATER; BIOGAS; FLOCCULATION; TECHNOLOGIES; CHLORIDE

Author Information

Reprint Address: Hossain, MS (reprint author)

Univ Sains Malaysia, Sch Ind Technol, Environm Technol Div, George Town 11800, Malaysia.

Addresses:

[1] Univ Sains Malaysia, Sch Ind Technol, Environm Technol Div, George Town 11800, Malaysia

[2] Univ Sains Malaysia, Sch Civil Engn, Nibong Tebal 14300, Penang, Malaysia

[3] Sime Darby Res Sdn Bhd, Carey Isl 42900, Selangor, Malaysia

[4] Univ Kuala Lumpur, Branch Campus Malaysian Inst Chem & Bioengn Techn, Alor Gajah 78000, Melaka, Malaysia

[5] Int Islamic Univ Malaysia, Fac Pharm, Kuantan Campus, Kuantan 25200, Pahang, Malaysia

E-mail Addresses: sohrab@usm.my

Funding

Funding Agency	Grant Number
Ministry of Education, Malaysia	FRGS- 203/PTEKIND/6711438

View funding text

Publisher

ELSEVIER SCI LTD, THE BOULEVARD, LANGFORD LANE, KIDLINGTON, OXFORD OX5 1GB, OXON, ENGLAND

Journal Information

Impact Factor: Journal Citation Reports

Categories / Classification

Research Areas: Science & Technology - Other Topics; Engineering; Environmental Sciences & Ecology
Web of Science Categories: Green & Sustainable Science & Technology; Engineering, Environmental; Environmental Sciences

See more data fields

Cited References: 33

Showing 30 of 33 **View All in Cited References page** *(from Web of Science Core Collection)*

1. **Progress in the biological and chemical treatment technologies for emerging contaminant removal from wastewater: A critical review** — Times Cited: 226
   By: Ahmed, Mohammad Boshir; Zhou, John L.; Huu Hao Ngo; et al.
   JOURNAL OF HAZARDOUS MATERIALS Volume: 323 Special Issue: SI Pages: 274-298 Part: A Published: FEB 5 2017

2. **Production of biogas and performance evaluation of existing treatment processes in palm oil mill effluent (POME)** — Times Cited: 62
   By: Ahmed, Yunus; Yaakob, Zahira; Akhtar, Parul; et al.
   RENEWABLE & SUSTAINABLE ENERGY REVIEWS Volume: 42 Pages: 1260-1278 Published: FEB 2015

3. **An evaluation of the major factors influencing the removal of copper ions using the egg shell (Dromaius novaehollandiae): chitosan (Agaricus bisporus) composite** — Times Cited: 6
   By: Anantha, R. K.; Kota, S.
   3 BIOTECH Volume: 6 Article Number: 83 Published: FEB 23 2016

4. Title: [not available] — Times Cited: 2,360
   Group Author(s): APHA-American Public Health Association
   Standard Methods for the Examination of Water and Wastewater Published: 2012

5. **Post treatment of palm oil mill effluent using electro-coagulation-peroxidation (ECP) technique** — Times Cited: 4
   By: Bashir, Mohammed J. K.; Lim, Jun Hong; Abu Amr, Salem S.; et al.
   JOURNAL OF CLEANER PRODUCTION Volume: 208 Pages: 716-727 Published: JAN 20 2019

6. **Palm Oil Mill Effluent (POME) Treatment-Current Technologies, Biogas Capture and Challenges** — Times Cited: 2
   By: Chan, Yi Jing; Chong, Mei Fong
   GREEN TECHNOLOGIES FOR THE OIL PALM INDUSTRY Book Series: Green Energy and Technology Pages: 71-92 Published: 2019

7. **Simultaneous adsorption of methyl red and methylene blue onto biochar and an equilibrium modeling at high concentration** — Times Cited: 10
   By: Ding, Guanyu; Wang, Buyun; Chen, Lingyu; et al.
   CHEMOSPHERE Volume: 163 Pages: 283-289 Published: NOV 2016

8. **Malaysia's requirement on industrial effluent treatment systems** — Times Cited: 2
   Group Author(s): DOE
   WEPA WORKSH ANN M 18 Published: 2013

9. **Coagulation by hydrolysing metal salts** — Times Cited: 922
   By: Duan, JM; Gregory, J
   ADVANCES IN COLLOID AND INTERFACE SCIENCE Volume: 100 Special Issue: SI Pages: 475-502 Article Number: PII S0001-8686(02)00067-2 Published: FEB 28 2003

10. **A review of the production cycle of titanium dioxide pigment** — Times Cited: 70
    By: Gazquez, M.J.; Bolivar, J.P.; Garcia-Tenorio, R.; et al.
    Mater. Sci. Appl. Volume: 5 Pages: 441-458 Published: 2014
    [Show additional data]

11. **Pollutant in palm oil production process** — Times Cited: 13
    By: Hosseini, Seyed Ehsan; Wahid, Mazlan Abdul
    JOURNAL OF THE AIR & WASTE MANAGEMENT ASSOCIATION Volume: 65 Issue: 7 Pages: 773-781 Published: 2015

12. **A sustainable process to utilize ferrous sulfate waste from titanium oxide industry by reductive decomposition reaction with pyrite** — Times Cited: 14
    By: Huang, Penghui; Deng, Shaogang; Zhang, Zhiye; et al.
    THERMOCHIMICA ACTA Volume: 620 Pages: 18-27 Published: NOV 20 2015

13. **Removal of organic contaminants from river and reservoir waters by three different aluminum-based metal salts: Coagulation adsorption and kinetics studies** — Times Cited: 59
    By: Hussain, Sabir; van Leeuwen, John; Chow, Christopher; et al.
    CHEMICAL ENGINEERING JOURNAL Volume: 225 Pages: 394-405 Published: JUN 1 2013

14. **Production and Characterization of the Defatted Oil Palm Shell Nanoparticles** — Times Cited: 2
    By: Khalil, Abdul H. P. S.; Hossain, Md Sohrab; Amiranajwa, Nur A. S.; et al.
    SAINS MALAYSIANA Volume: 45 Issue: 5 Pages: 833-839 Published: MAY 2016

15. **Synthesizing slow-release fertilizers via mechanochemical processing for potentially recycling the waste ferrous sulfate from titanium dioxide production** — Times Cited: 15
    By: Li, Xuewei; Lei, Zhiwu; Qu, Jun; et al.
    JOURNAL OF ENVIRONMENTAL MANAGEMENT Volume: 186 Pages: 120-126 Part: 1 Published: JAN 15 2017

16. **Conventional methods and emerging wastewater polishing technologies for palm oil mill effluent treatment: A review** — Times Cited: 55

By: Liew, Wai Loan; Kassim, Mohd Azraai; Muda, Khalida; et al.
JOURNAL OF ENVIRONMENTAL MANAGEMENT Volume: 149 Pages: 222-235 Published: FEB 1 2015

17. **Adsorption characteristics of copper (II) ions from aqueous solution onto humic acid-immobilized surfactant-modified zeolite** Times Cited: 85
By: Lin, Jianwei; Zhan, Yanhui; Zhu, Zhiliang
COLLOIDS AND SURFACES A-PHYSICOCHEMICAL AND ENGINEERING ASPECTS Volume: 384 Issue: 1-3 Pages: 9-16 Published: JUL 5 2011

18. **Removal of phosphate anions using the modified chitosan beads: Adsorption kinetic, isotherm and mechanism studies** Times Cited: 150
By: Liu, Xin; Zhang, Lingfan
POWDER TECHNOLOGY Volume: 277 Pages: 112-119 Published: JUN 2015

19. **Study of the coagulation process in wastewater treatment of dairy industries** Times Cited: 6
By: Loloei, M.; Alidadi, H.; Nekonam, G.; et al.
International Journal of Environmental Health Engineering Volume: 3 Pages: 12 Published: 2014
[Show additional data]

20. **Modelling the kinetics of coagulation process for tannery industry effluent treatment using Moringa oleifera seeds protein** Times Cited: 12
By: Mageshkumar, Marichamy; Karthikeyan, Ramasamy
DESALINATION AND WATER TREATMENT Volume: 57 Issue: 32 Pages: 14954-14964 Published: JUL 8 2016

21. **Treatment of palm oil mill effluent by electrocoagulation with presence of hydrogen peroxide as oxidizing agent and polialuminum chloride as coagulant-aid** Times Cited: 17
By: Nasrullah, Mohd; Singh, Lakhveer; Mohamad, Zahari; et al.
WATER RESOURCES AND INDUSTRY Volume: 17 Pages: 7-10 Published: JUN 2017

22. **Treatment of palm oil mill effluent by a microbial consortium developed from compost soils** Times Cited: 2
By: Nwuche, CO.; Aoyagi, H.; Ogbonna, J.C.
Int. Sch. Res. Notices Volume: 2014 Article Number: 762070 Published: 2014

23. **A review of biogas production from palm oil mill effluents using different configurations of bioreactors** Times Cited: 30
By: Ohimain, Elijah Ige; Izah, Sylvester Chibueze
RENEWABLE & SUSTAINABLE ENERGY REVIEWS Volume: 70 Pages: 242-253 Published: APR 2017

24. **Implementation of the supercritical carbon dioxide technology in oil palm fresh fruits bunch sterilization: A review** Times Cited: 5
By: Omar, A. K. Mohd; Norsalwani, T. L. Tengku; Asmah, M. S.; et al.
JOURNAL OF CO2 UTILIZATION Volume: 25 Pages: 205-215 Published: MAY 2018

25. **A Recent Overview of Palm Oil Mill Effluent Management via Bioreactor Configurations** Times Cited: 9
By: Rana, Supriyanka; Singh, Lakhveer; Wahid, Zularisam; et al.
CURRENT POLLUTION REPORTS Volume: 3 Issue: 4 Pages: 254-267 Published: DEC 2017

26. **Optimized use of alum together with unmodified Cassia obtusifolia seed gum as a coagulant aid in treatment of palm oil mill effluent under natural pH of wastewater** Times Cited: 55
By: Shak, Katrina Pui Yee; Wu, Ta Yeong
INDUSTRIAL CROPS AND PRODUCTS Volume: 76 Pages: 1169-1178 Published: DEC 15 2015

27. **Treatment of hexavalent chromium in chromite ore processing solid waste using a mixed reductant solution of ferrous sulfate and sodium dithionite** Times Cited: 67
By: Su, CM; Ludwig, RD
ENVIRONMENTAL SCIENCE & TECHNOLOGY Volume: 39 Issue: 16 Pages: 6208-6216 Published: AUG 15 2005

28. **Recent Advancement of Coagulation-Flocculation and Its Application in Wastewater Treatment** Times Cited: 192
By: Teh, Chee Yang; Budiman, Pretty Mori; Shak, Katrina Pui Yee; et al.
INDUSTRIAL & ENGINEERING CHEMISTRY RESEARCH Volume: 55 Issue: 16 Pages: 4363-4389 Published: APR 27 2016

29. **Enhanced coagulation with polyaluminum chlorides: Role of pH/Alkalinity and speciation** Times Cited: 121
By: Yan, Mingquan; Wang, Dongsheng; Yu, Jianfeng; et al.
CHEMOSPHERE Volume: 71 Issue: 9 Pages: 1665-1673 Published: APR 2008

30. **Mechanism of natural organic matter removal by polyaluminum chloride: Effect of coagulant particle size and hydrolysis kinetics** Times Cited: 140
By: Yan, Mingquan; Wang, Dongsheng; Ni, Jinren; et al.
WATER RESEARCH Volume: 42 Issue: 13 Pages: 3361-3370 Published: JUL 2008

Showing 30 of 33 **View All in Cited References page**