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Adsorption of anionic and cationic dyes from aqueous solutions on fly ash-based porous geopolymer

Purbasari A.*, Ariyanti D. and Fitriani E.

Department of Chemical Engineering, Faculty of Engineering, Universitas Diponegoro, Semarang, Indonesia
Received: 06/06/2022, Accepted: 02/01/2023, Available online: 05/01/2023
*to whom all correspondence should be addressed: e-mail: aprilina.purbasari@che.undip.ac.id
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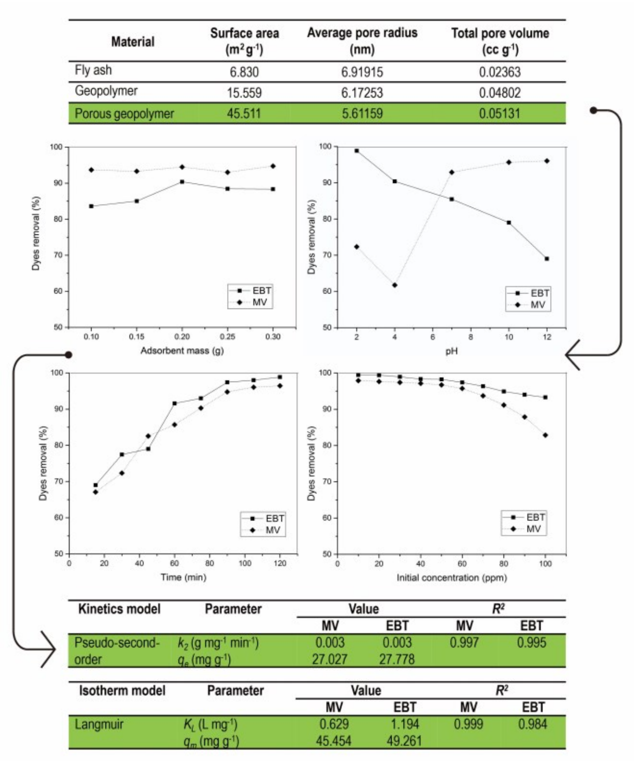

Abstract

Fly ash, solid waste from coal-fired power plant, had been utilized as raw material for porous geopolymer by alkaline activation and addition of hydrogen peroxide (H_2O_2) blowing agent. Porous geopolymer had higher surface area and total pore volume compared to fly ash and geopolymer without blowing agent, namely 45.511 $m^2\,g^{-1}$ and 0.05131 cc g^{-1}, respectively. Porous geopolymer was applied as adsorbent for anionic dyes Eriochrome Black T (EBT) and cationic dyes Methyl Violet (MV) from aqueous solutions. In this paper, factors affecting adsorption process such as adsorbent dosage, pH, time, and initial concentration were studied, in addition to adsorption kinetics and isotherm studies. Adsorbent dosage, time, and initial concentration factors had the same effect on the adsorption process for both EBT and MV dyes. The optimum removal efficiency was obtained at adsorbent dosage of 2 g L^{-1} and adsorption time of 90 minutes. The increase of the initial concentration of dyes would decrease the removal efficiency. For pH factor, adsorption of EBT dyes was better at pH of 2, while adsorption of MV dyes was better at pH of 10. Both adsorption of EBT and MV dyes by porous geopolymer followed pseudo-second-order kinetics model and Langmuir isotherm model with maximum adsorption capacity of 49.261 and 45.454 mg g^{-1}, respectively.

Keywords: Adsorption, fly ash, Eriochrome Black T, Methyl Violet, porous geopolymer

1. Introduction

Waste water containing dyes apart from causing aesthetic problems also causes health problems for living organisms. Dyes can act as allergic, mutagenic, carcinogenic, and toxic agents (Berradi *et al*. 2019; Lellis *et al*. 2019). In general, dyes can be classified as cationic, anionic, and nonionic dyes. Cationic dyes include azo basic, anthraquinone disperse, reactive dyes and are widely used in acrylic, nylon, silk, and wool dyeing. Anionic dyes include acid, direct, reactive dyes and are used in modified acrylic, polyamide, and polypropylene fibers dyeing; whereas nonionic dyes include disperse dyes for cellulose acetate, nylon, polyester, and acrylic fibers dyeing (Saini. 2017; Salleh *et al*. 2011).

The removal of dye pollutants in waste water can be done by physical, chemical, and biological methods. The physical methods consist of adsorption, filtration (microfiltration, nanofiltration, ultrafiltration, reverse osmosis), and irradiation. Meanwhile, examples of chemical methods are coagulation-flocculation, electrochemical treatment, oxidation, and photochemical treatment. For biological methods, there are aerobic and anaerobic treatments. Among those methods, adsorption is widely used because the process is simple, flexible, and effective with low cost (Kushwaha *et al*. 2013; Gita *et al*. 2017; Gherbia *et al*. 2019; Dutta *et al*. 2021). The common adsorbents for dyes removal are activated carbon, zeolite, and fly ash. Application of activated carbon from bamboo as adsorbent for wastewater from textile industry had showed efficiency of 91.84% (Salleh *et al*. 2011). Meanwhile, application of zeolite and fly ash adsorbents on textile wastewater had

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Recovery of bioethanol from food waste using *Saccharomyces cerevisiae*

Murugan S. and Sujithaadevi S.
Department of Environmental Engineering, Government College of Technology, Coimbatore, Tamil Nadu, India.
Received: 23/09/2022, Accepted: 05/01/2023, Available online: 05/01/2023
*to whom all correspondence should be addressed: e-mail: smurugan02@gmail.com
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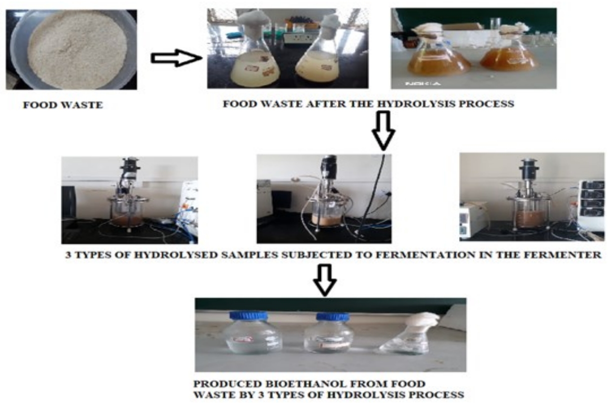
Graphical abstract



Abstract

Excessive use of fossil fuels results in the rapid depletion of non-renewable fossil energy resources, a rise in fuel cost, and an uncontrolled emission of greenhouse gases which causes a severe threat to the environment. Bio-fuels are being scrutinized as substitutes for current high-pollutant fuels obtained from conventional sources. To meet the global demands, it becomes necessary to find an alternate source of fuel which is bioethanol. In this work, a strategy to promote ethanol production from Leftover Cooked Rice (LCR) by comparing the different types of hydrolysis was proposed. Process integration comprised of mechanical pretreatment of the leftover cooked rice followed by hydrolysis which was then followed by fermentation. The food wastes of weight 50g taken in each of the 3 fermenters were subjected to acid hydrolysis, enzyme hydrolysis, and combined hydrolysis respectively. Commercially available Baker's yeast (*Saccharomyces cerevisiae*) was used for the fermentation process. The fermented samples were subjected to distillation to separate the bioethanol from them. The amount of bioethanol obtained from combined hydrolysis, acid hydrolysis, and enzyme hydrolysis was 400ml, 150ml, and 350ml respectively. Qualitative analysis of ethanol was done by using the Jones reagent. Hence, bioethanol can be produced from leftover cooked rice using the yeast *Saccharomyces cerevisiae*.

Keywords: Bioethanol, leftover cooked rice, hydrolysis, *Saccharomyces cerevisiae*, qualitative analysis

1. Introduction

Bio-fuel has been an energy source for human beings since ancient times. Excessive utilization of fossil fuels results in the rapid depletion of non-renewable fossil energy resources, a rise in fuel cost, and an uncontrolled emission of greenhouse gases, which causes a severe threat to the environment. This critical state has made it necessary to explore the substitutes for the high-pollutant fuels obtained from conventional sources. To meet the global energy demands, it becomes necessary to find an alternate source of fuel which is bioethanol.

The bioethanol that is produced from agricultural residues and forest residues is termed second-generation (2G) ethanol whereas the first-generation ethanol is produced from sucrose which is the juice extracted from sugarcane, sugarbeet, or sorghum (Dionisio S.R *et al*., 2021). Since the demand for food is not yet satisfied, second-generation ethanol production has gained more interest since these biofuels are produced from agricultural residues and waste biomass. The bioethanol produced from the waste emits a low amount of greenhouse gases when compared to conventional fuels (Senkevich S *et al*., 2012). The processes that are involved in bioethanol production are: pretreatment, hydrolysis, fermentation, and distillation

In Asia, rice is considered one of the important staple foods. Rice is wasted more than any other food and it accounts for 34% of the total wasted food (Abdullah Bilal Ozturk *et al*., 2021). The leftover cooked rice is rich in carbohydrates and therefore, it is considered a good feedstock for bioethanol production (Xikai Chen *et al*., 2021). Starch in cooked rice is formed of glucose called amylase and amylopectin.

The main objective of the pretreatment is to rupture the lignin structure to enhance the ease of access of enzyme to the cellulose during the hydrolysis (Kretzschmar J *et al*., 2012). (Roni Maryana *et al*., 2014). (Li-Qun Jiang *et al*., 2013).,and (Amrita Verma *et al*., 2011). The natural structure of the lignocellulosic material cannot be affected efficiently by enzymatic hydrolysis. Therefore, the pretreatment step is essential for efficient hydrolysis of

Global NEST Journal, Vol 25, No 3, pp 91-102

The physico-chemical and bacteriological effects of UV-treated wastewater irrigation on soil and turfgrass quality: A case study in a coastal golf course

Hajji S.[1,*], Ben-Haddad M.[1], Abelouah M.R.[1], Nourredine S.[1], Moukrim A.[2], and Alla A.A.[1]
[1]Laboratory of Aquatic Systems: Marine and Continental Environments, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco
[2]Faculty of Sciences, Abdelamalek Essadi University, Tetouan, Morocco
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*to whom all correspondence should be addressed: e-mail: sarahajji5@gmail.com
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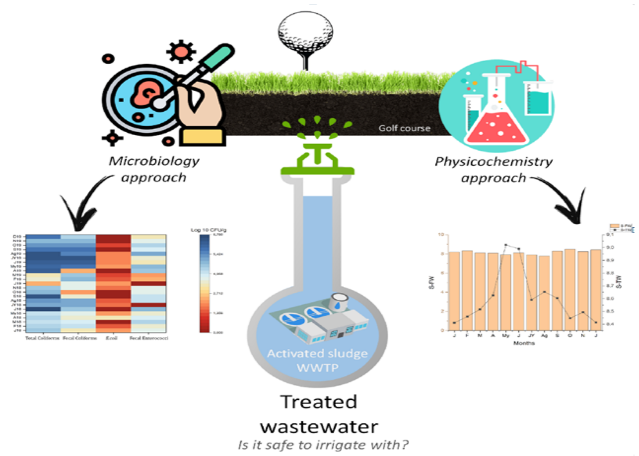

Abstract

This research describes the bacteriological and physicochemical impact of two types of irrigation water on soil and turfgrass quality during 2018 and 2019. Wastewater treated by an activated sludge process coupled with UV disinfection UV-TW was compared to fresh water FW. The first cycle (2018) was devoted to monitoring soil and turfgrass irrigated by FW, and the second cycle (2019) for UV-TW. Our results showed that the mean concentration of fecal indicators of treated wastewater UV-TW is about 2.17, 1.74, 1.77, and 1.52 log10 CFU/100ml for total coliforms, fecal coliforms, *E. coli* and fecal enterococci, respectively. The physicochemical characteristics showed no significant difference between soil irrigated with UV-TW and soil irrigated with FW except for pH and electrical conductivity. No significant difference was recorded comparing the fecal contamination of soil and turfgrass between the two irrigation cycles, except for fecal coliforms. Overall, the outputs of this work reported that the irrigation with UV-TW presents advantages not only on the quality of the soil and the vegetation, but also on the management of water scarcity. Thus, a highly controlled process of treatment and irrigation must be conducted to assure a safe hydric resource and to avoid any potential risk to human health.

Key words: Fecal contamination, irrigation, risk, safety, sustainable resource, wastewater

1. Introduction

Wastewater reuse has been considered a common procedure in many countries around the world and an Amount of research have recognized its efficiency (Mujeriego & Sala, 1991; Mcheik *et al*., 2017; Bihadassen *et al*., 2020; Ofori *et al*., 2021). Wastewater recovery and reuse has been an attractive alternative source of water destined to irrigation (Candela *et al*., 2007). Treated sewage is used exponentially for agriculture in areas suffering from water scarcity (Ofori *et al*., 2021). This could be an economical way to reduce surface water pollution and allow groundwater recharge for other agricultural areas (Asano, 2006; Yuan *et al*., 2016; Ventura *et al*., 2019). The reuse of water for irrigation is widely applied in agriculture because of the benefits of nutrient recovery possibilities, socio-economic implications, reduction of fertilizer application, and effluent disposal (Candela *et al*., 2007; Alsubih *et al*., 2017; Ibekwe *et al*., 2018). Even though the irrigation with treated wastewater (TWW) offers many advantages, its use can however affect the physicochemical properties of the soil and consequently crop production (Feigin *et al*., 2012; Chen *et al*., 2004). These effects depend on several parameters such as the quality and the quantity of irrigation water, soil type, duration of irrigation, and local climate (Tarchouna *et al*., 2010).

However, the applications of TWW are several in different domains (industry, urban and recreational uses, aquaculture, and groundwater recharge). Indeed, the scarcity of conventional water resources constitutes a social, agricultural, and economic problem in most of the countries located in the southern Mediterranean basin (Laraus, 2004). Additionally, water shortage results from climatic conditions and population growth contributing to