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Preparation and application of fly ash-based geopolymer for heavy metal removal

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Abstract

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Abstract

Geopolymer is anorganic polymer which can be used to heavy metal removal through adsorption process. Geopolymer can be produced from raw material containing alumino-silicate oxide such as fly ash which is solid waste from coal combustion. In this study, geopolymer was prepared from fly ash with alkali activation process using mixture of 10 N NaOH solution and Na-Silicate solution. Fly ash-based geopolymer was then applied as adsorbent for different heavy metals removal, i.e. Cu^{2+}, Fe^{2+}, Mn^{2+}, Zn^{2+}, in aqueous solutions. Removal efficiencies were calculated from changes of heavy metal concentration determined by Atomic Absorption Spectroscopy (AAS) analysis. Characterization of fly ash- based geopolymer covered Brunauer-Emmett-Teller (BET) surface area analysis and Scanning

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MODELLING, SIMULATION, CONTROL AND ANALYSIS OF MANUFACTURING PROCESSES

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Preparation and Application of Fly Ash-Based Geopolymer for Heavy Metal Removal

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Abstract. Geopolymer is anorganic polymer which can be used to heavy metal removal through adsorption process. Geopolymer can be produced from raw material containing alumino-silicate oxide such as fly ash which is solid waste from coal combustion. In this study, geopolymer was prepared from fly ash with alkali activation process using mixture of 10 N NaOH solution and Na-Silicate solution. Fly ash-based geopolymer was then applied as adsorbent for different heavy metals removal, i.e. Cu^{2+}, Fe^{2+}, Mn^{2+}, Zn^{2+}, in aqueous solutions. Removal efficiencies were calculated from changes of heavy metal concentration determined by Atomic Absorption Spectroscopy (AAS) analysis. Characterization of fly ash-based geopolymer covered Brunauer-Emmett-Teller (BET) surface area analysis and Scanning Electron Microscope-Energy Dispersive X-Ray (SEM-EDX) analysis. The results showed that fly ash-based geopolymer could adsorb heavy metals with better removal efficiency compared to the raw fly ash.

INTRODUCTION

Heavy metal pollution has become one of the serious environmental problems. Heavy metals are materials that cannot be decomposed and in certain levels can endanger the health of humans and other living things. The presence of heavy metals in the environment can naturally occur through the process of weathering minerals, erosion, or volcanic activity; as well as from human activities such as mining, metal processing, use of pesticides and fertilizers [1]. Treatment of heavy metal wastewater can be carried out by physical methods (adsorption, membrane filtration, coagulation and flocculation, flotation), chemical methods (precipitation, ion exchange, electrochemical), and biological methods (bio-adsorbent, use of microorganisms) [2]. Among these methods, adsorption is widely used because the process is simple, effective, and low cost. Heavy metal adsorbents that have been widely used are activated carbon, zeolite, resin, fly ash, chitosan, etc. [3].

Geopolymer, inorganic polymer with Si-O-Al polymeric bonds having amorphous to semi-crystalline structure, can also be used as heavy metal adsorbents. Geopolymer can be made from materials containing alumino-silicate oxides with alkaline activators at temperatures below 100 ^{o}C [4]. Fly ash, a solid waste from coal combustion, contains silica and alumina which can be utilized as raw material for geopolymer. Several studies have shown that geopolymer with fly ash as raw material has been used as heavy metal adsorbent, such as copper [5], cadmium [6], chromium [7], and lead [8].

This paper studied the preparation of geopolymer from fly ash and application of geopolymer as adsorbent for heavy metal removal, namely Cu^{2+}, Fe^{2+}, Mn^{2+}, Zn^{2+}, in aqueous solutions. Changes of heavy metal concentration were determined by Atomic Absorption Spectroscopy (AAS) analysis, meanwhile fly ash-based geopolymer was characterized by Brunauer-Emmett-Teller (BET) surface area analysis and Scanning Electron Microscope-Energy Dispersive X-Ray (SEM-EDX) analysis. As comparison, the heavy metal adsorption process was also carried out with fly ash adsorbent.

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Green Technology in Treating Aquaculture Wastewater

Ahmad Jusoh[1,3,a)], Nurfarahana Mohd Nasir[1,b)], Fareza Hanis Mohd Yunos[1,c)], Hajjar Hartini Wan Jusoh[1,d)] and Su Shiung Lam[2,3,e)]

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Abstract. Aquaculture contributes a large number of world food supplies which increases rapidly over these few years. Similarly, there is a huge development of aquaculture in Malaysia over the years. However, aquaculture activities generate wastewater with high in nutrients where developing a proper treatment system is crucial. An appropriate wastewater treatment is needed to reduce uncontrolled pollution and environmental impacts while sustaining the development of aquaculture industry. Hence, this study focuses on the implementation of green technology method namely physical and biological in treating aquaculture wastewater. Major effect of releasing wastewater that is rich in nutrients is mainly eutrophication. This problem could be mitigated utilizing microalgae whereby the nutrients used as feed for microalgae growth. However, excess nutrients will cause undesirable consequences such as algal blooms due to the rapid growth of microalgae. Therefore, harvesting microalgae after treating the wastewater helps in the prevention of this problem. Current microalgae harvesting technology depends on sophisticated and complex approaches such as hollow fiber filtration, chemical flocculants and centrifugation, which are deemed feasible if high value products were obtained. The potentiality of *Moringa oleifera*, filamentous fungus (*Aspergillus niger*), microalgae (*Ankistrodesmus* sp.), Biofloc Technology (BFT) and chitosan as bio-flocculant were investigated in harvesting microalgae, *Chlorella* sp.. This type of development in phytoremediation and phycoremediation with continuous bio-harvesting could promote the use of sustainable green technology for effective aquaculture wastewater treatment.

AQUACULTURE

Aquaculture is known as the growing of aquatic animal and plant. It ranges from cultivation of fish in simple naturally occurring pond in rural areas to a complex intensive culture of commercial fish in fiberglass tanks. Aquaculture globally has undergone a rapid growth from a production of less than a million tons in the early 1950s to over than 50 million tons in the present. World aquaculture production is growing about 8 to 14% annually as compared to 1.5% for capture fisheries [1]. Besides, aquaculture in Malaysia has developed tremendously from a small-scale family pond to a large commercial scale. However, about 90% of the contribution came from capture fisheries sector and only 10% is produced from aquaculture [1]. Malaysia normally exports most of its high value fish to foreign market includes United States, Singapore, Japan, Italy and China. The main commodities produced include shrimp, high grade fish and mollusk. The most commonly practiced aquaculture system is aquaculture pond, cage aquaculture, raceway aquaculture system and recirculating aquaculture system. On top of that, the combination of hydroponic vegetable production and fish aquaculture production which is known as aquaponic is also gained popularity in Malaysia.

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Synthesis of free standing TiO_2 nanostructures (FSTNS) via hydrothermal process for organic photocatalytic degradation

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Abstract. The superiority of TiO_2 nanoparticle for photocatalytic degradation of organic pollutant has been acknowledged in many researches. However, the powder form of TiO_2 face new challenge related to its recovery after photocatalytic process. In this paper the synthesis of free standing TiO_2 nanostructures (FSTNS) via hydrothermal process were reported. The effect of hydrothermal processing time at temperature 180°C to the FSTNS properties were observed. The optimum FSTNS was synthesized at 180°C in 18 hours by using acetone as oxidation agent. The synthesized FSTNS was effectively able to degrade the organic pollutant (Bromothymol blue) via photocatalysis under black light illumination.

INTRODUCTION

Almost 80% of wastewater is simply discharged into the environment without further treatment, including domestic waste and 300-400 cubic tons of industrial waste [1, 2]. In Indonesia, industrial wastewater, domestic wastewater and commercial wastewater are the largest contributors of the total wastewater. According to the Indonesian Agency for the Assessment and Application of Technology (BPPT), domestic and industrial wastewater have a high pollution potential due to the lack of affordable technology to be applied in the wastewater treatment system [3].

Wastewater contains various components such as colloidal particles, pathogenic microorganisms, inorganic pollutants and organic pollutants. Domestic and industrial wastewater both small and medium contain more organic components with a COD value of 7000-10,000 ppm [3]. Organic components include dyes, pesticides, fertilizers, hydrocarbons, phenols, plasticizers, biphenyl, detergents, oils, fats, pharmaceutical ingredients, proteins and polysaccharides [4-6].

At present, organic wastewater treatment still relies on biological methods such as aerobic and anaerobic processes. This process can degrade organic pollutants, but the time required is very long and this process is very vulnerable to environmental changes [5, 6]. Advanced oxidation processes (AOPs) are relatively new destructive technologies and can be used as an alternative for wastewater treatment processes that contained organic components. The basic principle of this process is the formation of hydroxyl radicals (• OH) which can degrade organic pollutants to form minerals. One of the technologies categorized as AOP is photocatalysis with semiconductor material TiO_2. In photocatalytic oxidation process UV / TiO_2 hydroxyl radicals (• OH) are generated by the illumination of ultraviolet light into the surface of TiO_2 [7, 8]. TiO_2 has high photoreactive properties and chemical stability compared to other materials [9].

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Computation and Numerical Modeling of Fuel Concentration Distribution and Current Density on Performance of The Microfluidic Fuel Cell

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Abstract. This study numerically investigates current density and fuel concentration on the performance of microfluidic fuel cells that breathe air as an oxidant. The microfluidic fuel cells having a microchannel width of 1.0 mm and 50 µm in-depth with an electrode spacing of 0.3 mm. The concentration formic acid of 0.3 M, 0.5 M, and 1.0 M mixed with 0.5 M sulfuric acid (supporting electrolyte) in aqueous solution was used as fuel and another inlet a stream of 0.5 M sulfuric acid as an electrolyte which were varied at an inlet flow rate of 0.3, 0.5, and 0.7 mL/min. First, a three-dimensional microfluidic fuel cell model was established using COMSOL Multiphysics 5.1 to simulate the fuel cell performance. Subsequently, both V-I curves obtained from simulation and published experimental data under similar operating condition were compared to assure the validity of the simulation. The transport phenomena in the microfluidic fuel cells were formulated with continuity equation, momentum equation, species transport equation, and charge equation. The porous media flow in the gas diffusion layer was described by Brinkman equation. The Butler-Volmer equations were applied to get the V-I curves. The maximum power density of the fuel cell at 0.7 mL/min fed with 0.3 M, 0.5 M, and 1.0 M formic acid for the measured was approximately 27 mW/cm^2, 30 mW/cm^2, and 36 mW/cm^2, respectively, while for the simulation was approximately 21.64, 29.82, and 36.57 mW/cm^2, respectively.

Keywords: air-breathing; microfluidic, fuel cells; formic acid; fuel utilization

INTRODUCTION

The development of novel miniaturized fuel cell based on MEMS (micro electro mechanical systems) are considered as promising candidate of alternative power sources for future generation due to its potentially wide range applications in portable devices [1-5], such as cell phones, laptop, clinical diagnostics, small stationary power etc. Microfluidic cells have some significant intrinsic advantages than conventional Li-battery [6-8], i.e. fuel cell ability to continuously generate power as long as both fuel and oxidant are supplied into the cell, higher energy density, longer lifetimes without replaced and recharged periodically, more reliable related in diverse power input, no emissions and no pollutions, and no interrupts if integrated into the system. Power sources are corresponding for fuel cell applications is batteries in which the use of a longer operating time without needed frequent recharging power.

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