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Guest Editorial

Special issue of 2013 6th International Conference on Challenges in Environmental Science and Engineering

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"Challenges in Environmental Science & Engineering", CESE International Conference Series is an annual event initiated by Professor Jega V. Jegatheesan and Dr. Li Shu both of whom are currently associated with Deakin University, Australia. Researchers, policy-makers, academics, students and the broader community active in contributing solutions to the myriad of environmental issues facing environmental sustainability are the consistent participants of CESE series.

CESE-2013, the Sixth Annual International Conference on CESE Conference was held from the 29th of October to the 2nd of November at EXCO in Daegu, South Korea. There were two hundred and five oral presentations and 165 poster presentations on 13 themes covering water, wastewater, solid waste, energy and applications of membranes in various treatment processes.

This special issue has been dedicated to a wide range of themes that are related to better catchment management. Six research articles and one technical note covering detection of forest disturbances, responses of runoff and sediment yield in a river basin in China, nitrogen transport and transformation in artificial groundwater recharge, determination of historical and projected methane gas emission in Malaysia, enhancement of biogas production from anaerobic digestion, reuse of sediment from catfish pond through composting and the effect of palm oil fuel ash content on strength development and porosity of blended cement mortar have been included in this special issue.

The Guest Editors of this special issue are thankful to the Editor-in-Chief of *Sustainable Environment Research*, Professor H. Paul Wang for providing an opportunity to publish the above peer reviewed papers that were presented at CESE-2013. Thanks are also due to the Journal Manager and the entire production team of the journal for their valuable support in bringing out this special issue. Last but not least, our sincere appreciation to all the reviewers for their invaluable and critical review comments on manuscripts that were submitted for this special issue.

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Nitrogen transport and transformation in artificial groundwater recharge with treated reclaimed municipal wastewater through river utilization

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Key Words: Nitrogen transformation and transport, artificial groundwater recharge, wastewater reclamation and reuse, soil aquifer treatment, semi-arid

ABSTRACT

Nitrogen pollution in river-based artificial groundwater recharge using reclaimed municipal wastewater poses a major threat to groundwater drinking water supplies in Beijing, China. Laboratory leaching column experiments simulating recharge were conducted to study nitrogen transformation, transport and leaching. Representative soil vadose zone media from three parts of the ChaoBai River were used as filler for the three columns. The media consisted mainly of water-permeable gravel sand, fine sand and less-permeable silty clay, which are the typical streambed in the Huabei plain. The results showed that the attenuation of total nitrogen (TN) was in the order of silty clay column > fine sand column > gravel sand column, which followed the first-order kinetics. The TN attenuation mass was 6.36, 2.05 and 1.33 mg 100 g^{-1}, respectively. The TN decay rate constants were 2.1, 1.7 and 1.6 m^{-1}, respectively. The NO_3^--N attenuation mass was 7.68, 1.76 and 1.17 mg 100 g^{-1}, respectively. The denitrification rate constants were 6.5, 3.5 and 2.6 m^{-1}, respectively. The inflection points of TN concentration at different depths were 0.4, 0.5 and 0.8 m, respectively. The same trend was observed in NO_3^-. The content of NH_4^+-N was in the range of 0-4 mg L^{-1} in the early experimental period, while NH_4^+ was not detected after 15 d. Nitrogen transformation was affected by water temperature; when the temperature was below 5 °C, the conversion of nitrogen did not change significantly with depth and time. Groundwater nitrogen pollution was related to the adsorption and degradation capacity of the soil vadose zone media. To avoid or minimize possible nitrogen contamination of groundwater in artificial groundwater recharge areas, the amount of TN in treated reclaimed municipal wastewater has to be determined and minimized by optimizing reclaimed water treatments and enhancing the ecological purification function of rivers.

INTRODUCTION

China is severely suffering from water shortages, especially in northern arid areas. Artificial groundwater recharge with reclaimed water provides many advantages, such as groundwater supplementation, mitigation of declining groundwater levels, and storage of reclaimed water for later usage [1]. The artificial recharge of several aquifers was successfully accomplished at many locations around the world [2-5].

In most of the arid regions in northern China, river surface runoff comes from secondary wastewater treatment plant effluents, which can impact groundwater quality [6]. The concentration of total nitrogen (TN) in the secondary wastewater treatment plant effluent was between 15 and 20 mg L^{-1} [7], and even tertiary-treated reclaimed municipal wastewater contains an appreciable concentration of nitrogen, approximately 5-15 mg L^{-1}, which might cause nitrogen pollution in artificially river-recharged aquifers in this area. High nitrogen

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Enhancement of biogas production from anaerobic digestion of *Chlorella vulgaris* biomass with ultrasonic pretreatment

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Key Words: *Chlorella vulgaris*, microalgae, biogas production, anaerobic digestion, ultrasonic pretreatment, disintegration

ABSTRACT

High growth rate makes *Chlorella vulgaris* a promising source of biomass for biogas production; however, its thick cell wall hinders the degradation process. In this study, *C. vulgaris* cells were subjected to ultrasonic treatment prior to anaerobic digestion for biogas production. Ultrasonic pretreatment helped release the intracellular organic substances from the cells, increased the soluble chemical oxygen demand (COD) and released proteins, facilitating further digestion of the biomass by anaerobic bacteria for enhanced biogas production. The highest methane production was obtained by pretreatment at 5,000 J mL^{-1} dose. The first-order equation showed a better fit in terms of R^2 value as compared to the modified Gompertz equation in describing biogas production.

INTRODUCTION

Availability of energy sources has become a global issue due to the rapid depletion of fossil fuels [1]. Several countries have therefore initiated the use of alternative energy sources, especially clean energy sources, such as geothermal power, wind power, small-scale hydropower, solar energy, biomass energy, tidal power, and wave power. Clean energy is comparatively less polluting than fossil fuels and therefore has lesser impact on the environment. Biogas produced by anaerobic digestion is an interesting alternative clean energy [2].

Anaerobic digestion is an effective as well as an environment-friendly energy production technology for the production of sustainable energy. It not only generates energy but also reduces the amount of organic waste and area used for land filling [3]. Biogas is a mixture of methane gas and carbon dioxide gas [4]. Natural gas contains approximately 90-95% methane, but biogas contains approximately 50-65% methane. Therefore, biogas is a low-grade natural gas. Biogas is produced via organic matter decomposition by anaerobic bacteria, leading to methane gas production. Biogas production requires addition of bacteria to accumulated organic feed under anaerobic conditions and suitable temperature for the growth and proliferation of methanogenic bacteria (mesophilic temperature 30-35 °C and thermophilic temperature 50-60 °C).

Microalgae grow in sunlight and use carbon dioxide for photosynthesis; therefore, microalgae can be used as potential feedstock for biogas production. The doubling time of microalgae is 3.5-24 h in the exponential growth phase [5]. The production rate of microalgae is more than 100 t ha^{-1} yr^{-1} when grown in photo-bioreactors or in high-rate raceway ponds [6]. The high growth rate of microalgae is advantageous in providing greater biomass in less time. However, the tough cell wall of the microalgal cells is a major drawback in anaerobic digestion. Therefore, it is necessary to pretreat the microalgal cells to an extent that the intracellular organic matter of the cells becomes accessible to anaerobic bacteria in the anaerobic digestion process [7].

Various methods of pretreatment have been studied to improve the hydrolysis rate [8,9]. The order of pretreatment efficiency that enhance methane gas production is as follows: ultrasonic lysis (20 W, 9 Hz, 30 min) > thermal pretreatment by autoclaving (120 °C, 30 min) > thermal pretreatment with hot water (60 °C, 30 min) > freezing (-10 °C, 15 h) [10,11]. Thus, ultrasonic treatment is one of the most promising technologies for microalgae cell disruption. Ultrasonic pretreatment has several advantages, in-

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Forest disturbances detection with MODIS data and a bootstrapping SVM

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Key Words: Forest disturbances, MODIS, bootstrapping SVM

ABSTRACT

Forest disturbances play significant roles in carbon balance and global climate changes. Due to its advantages of macro-scale and cost-effectiveness, time-series Moderate Resolution Imaging Spectrometer (MODIS) data are a striking data source for monitoring forest coverage and forest loss. With MODIS data from 2001 to 2010, this study used Support Vector Machine (SVM) algorithm with bootstrapping iteration method to identify annual forest disturbances in the Great Khingan, the largest forest area in China. Ten-year metrics capturing the salient features of phonological variations to reveal the forest disturbances were produced. Training pixels of forest "change" and "no-change" were interactively selected with additional Landsat TM/ETM images. After stratified sampling, training metrics data were input to build and calibrate a SVM model by bootstrapping iteration, and the rest metrics data were used to test the model. The tested SVM model was then used to produce annual forest disturbance map for the study area. The results showed that the overall accuracy and Kappa coefficient are 99.6% and 0.74 respectively which suggested that the boot-strapping SVM model can be used as an effective tool for monitoring forest disturbances. The forest disturbance mainly and frequently occurred on the northeast and southeast parts of the Great Khingan, and forest disturbances in 2003, 2005 and 2006 are much larger in than those the other years.

INTRODUCTION

Forest disturbances play important roles in carbon cycle and climate change. Forest vegetation absorbs carbon dioxide, stores it in the organisms, and releases it to the atmosphere. To understand carbon dynamics, it is essential to quantify the forest vegetation at various spatial and temporal scales [1]. Forest disturbances represent forest vegetation change, suffered from fire, clear-cuts, plague of insects, and windstorms, and also have significant roles in canopy biomass and forest structure [2]. Thus, precise mapping of forest disturbances especially accurate identification of burned areas can substantially reduce uncertainties in estimating the carbon balance.

Recent studies of delineating forest disturbances with remote sensing imagery have been mainly focused at regional [3,4] and global scales [5,6], particularly with moderate-scale resolution like Moderate Resolution Imaging Spectrometer (MODIS) and fine-scale resolution like Landsat Thematic Mapper (TM) or Enhanced TM Plus (ETM+). However, temporal MODIS data cannot supply accurate changes because of their coarse resolution and sub-MODIS pixel heterogeneity while Landsat TM/ETM data are of high cost and frequently degraded by cloud cover [7,8]. Also, employing an appropriate method to extend the geographic range and the tempo-

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Responses of runoff and sediment yield to LUCC with SWAT model: A case study in the Xichuan River Basin, China

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Key Words: LUCC, SWAT, Xichuan River, runoff, sediment yield

ABSTRACT

With the support of geographic information system, Soil and Water Assessment Tool (SWAT) was calibrated and validated based on sensitive analysis in the Xichuan River basin, a typical loess gullied area in the Loess Plateau, China. The runoff and sediment yield were estimated with the model under different land use/cover change (LUCC) scenarios, and the responses of runoff and sediment yield to LUCC were quantitatively analysed. The results showed that the localized SWAT model can simulate the runoff and sediment yield with good performance; LUCC had a significant effect on runoff and sediment yield in the basin: the runoff, sediment yield decreased with the increase of forest and grass land covering area; the runoff increased and the sediment yield decreased with grass land being changed into forest land. The results would provide local decision makers with scientific references for land use planning and soil and water conservation in the basin.

INTRODUCTION

As an important factor of altering the hydrological processes [1], land use/cover change (LUCC) can significantly influence the hydrological cycle by affecting ground surface runoff and evaporation, soil moisture and interception rate [2] and hence affecting catchment water balance. And a broken balance tends to result in ecological environment problems such as land degradation and serious soil erosion [3]. Therefore, the study of hydrological response to LUCC is important for developing management strategies for ecological preservation and sustainable utilization of water resources in basins.

With the development of GIS (Geographic Information System) and RS (Remote Sensing), the hydrological model is being used more and more to study the effects of LUCC on the hydrological cycle and non-point source pollution [4]. In recent years, Soil and Water Assessment Tool (SWAT) [5] has been used to study runoff and sediment transport in small and large catchments worldwide and turns out to be an effective tool to predict the impacts of LUCC. For examples, investigators [6,7] have applied SWAT in the Aar watershed located in central Germany to examine the hydrological effects of land use changes, predicted by ProLand model. The peak flow rate was especially affected by land use change. Miller et al. [8] used SWAT to simulate runoff and sediment yield of the upper San Pedro River in Sonora, under significant land cover changes. The simulation results indicated that the increasing of urban and agricultural areas and invasion of woody plants and decline of grasslands resulted in dramatic increases in runoff volume, runoff rate and sediment yield. In China, Lu et al. [9] applied SWAT in Ruihe watershed on the Loess Plateau where five different landscapes were simulated and the results showed that SWAT can describe the soil water loss reasonably.

The Xichuan River basin, one of the tributaries of the Yellow River basin, is a typical loess gullied area in the Loess Plateau, China. The soil type there is dominated by loessal soil, which is easy to suffer from soil loosening resulting in serious soil erosion [10]. In this area, industry, agriculture and social economy development rely mainly on local water resources. In

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Historical and projected methane emission determination in Malaysia (1980-2020)

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Key Words: Climate change, global warming, methane, inventories, emissions

ABSTRACT

The threat of global warming and climate change has reached alarming levels due to increased emissions of greenhouse gases. Chief among these gases are carbon dioxide, methane and nitrous oxide. The inventory of methane emission sources in Malaysia was traced from 1980 to 2011 and was used as basis for computing the resultant methane emissions. The results showed that annual methane emission from rice production has been relatively constant at about 51 Gg. Emission from cattle production is rising and might double by 2015 from the 1980 level if the government achieves its aim of increasing livestock level to 1.5 million by 2015. Emission from the oil sector is the highest but it is being harnessed in the form of liquefied natural gas for export and domestic consumption to generate electricity and as fuel substitutes in some vehicles. Methane emission during the time (1980-2020) from anaerobic treatment of wastewater (particularly palm oil mill effluent) is between 98-761 Gg and is being captured for possible electricity generation. The municipal solid waste sector also generated between 71-147 Gg of methane in the time interval and the methane was captured for electricity generation through the upgrading of some landfills to sanitary types that use clay liners to separate the trash from the environment.

INTRODUCTION

The rising trend in the temperature of the earth has become a global threat. This is as a result of global warming. Global warming is caused by the emission of greenhouse gases (GHGs) into the atmosphere and it has had a significant impact on the world's climate [1,2]. There is increase in global surface temperature by 0.74 ± 0.18 °C between the start and the end of the 20th century and is expected to increase by 1.1 to 6.4 °C in the 21st century [3]. Another evidence of global warming is the increasing heat content of the oceans and sea level rise [4]. The planet is said to be heating at a faster rate than at any time in the last 10,000 yr. Moreover, eleven of the hottest year on record have occurred since 1983 with the decade of the 1990s being the hottest in the 20th century. The global mean surface temperature in 1998 is the highest on record since 1860 and is followed by 2005 [5].

Climate change is largely a result of human activities, especially the combustion of fossil fuels, which has led to increase in the atmospheric concentrations of GHGs - carbon dioxide, methane, nitrous oxide, and other gases [2,6]. These concentrations continue to increase yearly [7]. It has been shown that the concentrations of CO_2 in the atmosphere have gone up by about 30% since the preindustrial era, and those of CH_4 concentrations have more than doubled. It is a global concern and its continuation is significantly impacting on people, environment, and economic conditions globally [8-11].

Many studies have been carried out on the negative effect of CO_2 emissions in Malaysia [12,13]. The emissions of methane from the other sources have not been adequately investigated, hence, there is scarcity of literature on CH_4 emissions in Malaysia. The recorded study on methane emissions in Malaysia are from municipal solid waste (MSW) landfills [14,15]

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Strength development and porosity of blended cement mortar: Effect of palm oil fuel ash content

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Key Words: Mathematical model, compressive strength, porosity, palm oil fuel ash, cement, mortar

ABSTRACT

Generation of large amount of biofuel ash from Malaysian palm oil industry and its eventual disposal in landfills pose a serious problem of sustainability of natural environment. The efforts to utilise the ash as supplementary cementitious material in construction industry will be a milestone towards promoting industrial ecology and curbing CO_2 emission to the atmosphere from cement industry. This paper presents the quadratic polynomial mathematical models for estimating the compressive strength and porosity of cement mortar blended with palm oil fuel ash (POFA). The effect of POFA content up to 30 wt% of binder on the strengths and porosities of mortar at 7, 28 and 90 d was evaluated. The accuracy of the models was statistically measured and found to be acceptable for the estimate. Furthermore, a strong quantitative relationship between the compressive strength and porosity of POFA cement mortar was obtained and the relationship follows the same trend (Powers model) with that of ordinary Portland cement mortar.

INTRODUCTION

The generation of palm oil fuel ash (POFA) as waste from palm oil industry in the palm oil producing countries such as Malaysia and Thailand has become a source of concern to the relevant government agencies and environmental conservation organizations due to its potential harmful effect on the environment [1]. In 2009, about 3 Mt of POFA were produced in Malaysia [2] and it was projected to be increasing annually. Owing to the minimal utilization of the ash at present, it is disposed of in landfills and this could eventually trigger land, water and air contaminations. Additionally, cement production which leads to the enormous consumption of energy and natural resources (limestone and clay), and also emission of about 0.85 t CO_2 t^{-1} cement to the atmosphere [3] contributes to the degradation of our natural environment. Hence, the utilization of industrial wastes as partial cement replacement material would be a viable option for sustaining the natural environment.

POFA, a by-product from biomass thermal power plant where palm oil fibers, shells and empty fruit bunches are incinerated to produce energy, has recently been recognized as pozzolanic material [4]. Partial substitution of cement with POFA modifies the fresh and hardened properties of cement based materials [5-7]. The modifications are mainly due to the physical and chemical impacts of POFA on the cement hydration [8,9]. The POFA particles which are usually finer than that of ordinary Portland cement (OPC) densely fill up the voids and capillaries between cement grains and fine aggregates, resulting in a decrease in porosity. In addition to the filler effect, the chemical reaction between the active phase (amorphous silica) of POFA and the calcium hydroxide liberated during cement hydration reaction which generates secondary calcium silicate hydrates (C-S-H) also leads to the enhancement of the inherent property of cement paste and, hence, the properties of concrete [5].

However, the strength and pore structures development patterns of blended cement system containing POFA broadly vary from that of unblended one depending on the length of curing and the cement/POFA ratio [8,10]. Due to the low pozzolanic activity of POFA, the rate of strength development of POFA con-

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Isothermal mathematical modeling for decolorizing water - A comparative approach

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Key Words: Adsorption, bottom ash, Metanil Yellow, Methyl Orange, dye

ABSTRACT

A power plant waste material, bottom ash, has been used for the adsorptive removal of hazardous Azo dyes, Methyl Orange and Metanil Yellow from wastewater. In the present research the adsorption characteristics determined from the primary studies help in developing an efficient dye removal methodology. Theoretical aspects of isothermal models, calculation of operational parameters along with a comparative account of the behavior of dyes under study on isothermal data have been presented in this paper. On the basis of the value of adsorption intensity of the adsorbate - adsorbent system it is evident that the adsorption intensity over bottom ash varies in the order Methyl Orange > Metanil Yellow. It is observed that Langmuir isotherm is more favorable as compared to the Freundlich for both the systems. The D-R isothermal evaluation of both the dye indicates that chemisorption is followed in Methyl Orange- Bottom Ash system while physisorption is operative for Metanil Yellow adsorptive removal.

INTRODUCTION

Textile industries are one of the highest consumers of water. Textile wastewater is released from spent dye bath and dye rinse operations that contain unfixed dyes and are often extremely colored. Effluents from dye production and dyeing mills are highly offensive if discharged into water-bodies without pre-treatment. The non-biodegradable nature of the spent dyes poses serious environmental problems [1,2]. Textile wastewater compositions are very complex solutions of dye in water, and include materials like particulates, processing additives, salts, surfactants, acids and alkalis [3]. Increasing environmental water pollution caused by toxic dyes due to their hazardous nature and complex composition is a matter of great concern. There are a number of methods for dye removal which include chemical coagulation, flocculation, chemical oxidation, photochemical degradation, membrane filtration, aerobic and anaerobic biological degradation [4-10], but all of these methods suffer from one or other restrictions. This includes inefficient removal of organic matter with low molecular mass and intermediate molecular mass and also, slow kinetics and high costs restrict the utility of the processes [11]. Among several chemical and physical methods, the adsorption has been found to be superior compared to other techniques for wastewater treatment in terms of its capability to efficiently remove a broad range of pollutants and its simplicity of design [12]. Adsorption is a process by which certain components of a fluid phase are attracted to the surface of a solid adsorbent via physical or chemical bonds, thus removing the component from the fluid phase. Adsorption processes may be classified as physical or chemical depending on the nature of forces involved. Many physico-chemical factors influence the adsorption process including adsorbate/adsorbent interaction, adsorbent surface area and pore structure, chemistry of the surface, nature of the adsorbate, effect of other ions, particle size, pH, temperature, contact time, etc. Adsorption processes provide a feasible waste water

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Technical Note

Reuse of sediment from catfish pond through composting with water hyacinth and rice straw

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Key Words: Compost, *Pangasius hypopthalamus*, catfish pond sludge, water hyacinth, straw

ABSTRACT

In this study, sediment collected from the bottom of catfish (*Pangasius hypopthalamus*) ponds in An Giang province, Mekong Delta in Vietnam was used to produce different compost compositions and test its suitability as substrates for vegetable farming. The total organic carbon (TOC) and total nitrogen (TN) in the bottom sludge were 6.65 and 0.44% with a C/N ratio of 16. Water hyacinth and straw, which were available in the region, were added to the sludge to achieve the C/N ratio of 20, 25 and 30. Water hyacinth contained 49.7% TOC and 1.46% TN (C/N = 34). Straw contained 51.7% TOC and 0.84% TN (C/N = 61). The composting products were used to test the growth of the common vegetables, *Brassica Juncea* and *Ipomoea aquatica*. The highest growth of the vegetables was achieved at a C/N ratio of 30 for sediment-straw composts, and at a C/N ratio of 25 for the sediment-hyacinth composts. Overall the results indicate that sludge from catfish ponds has a potential to be reused as compost material when mixed with either water hyacinth or rice straw.

INTRODUCTION

Aquaculture has always been a special strength of Vietnam, and will most likely continue to develop and increase in the future. However, an increased production is often followed by an increased pressure on the external environment, and there is a need to identify methods that limit the release of waste to the environment and instead increase the recycling of organic matter (OM) and nutrients for an enhanced and sustainable production [1]. *Pangasisus* pond-farming, for example, produces a large amount of waste sludge that needs to be treated to improve the sustainability of the *Pangasisus* aquaculture operations [2].

Composting can provide a simple and cost effective method to treat the sediments and at the same time reuse excessive OM and nutrients for enhanced production of different crops [3]. The combination of waste sludge and water hyacinth or rice straw, which are easily accessible in the Mekong Delta can help enhance the quality of the composting process, and the finished compost from this waste has been shown to improve the long-term soil fertility [4,5]. The application of composts to agro-industries wastes has also shown to have other positive effects, such as suppressing the Fusarium wilt of cucumber and carnation

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Production of active intermediates and decomposition behaviors of organic compounds in the ultraviolet ray/supersonic wave reactions with TiO_2 photocatalyst

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Key Words: Ultraviolet ray irradiation, supersonic wave irradiation, TiO_2 photocatalyst sprayed at low temperature, active intermediates, organic compounds

ABSTRACT

The production and behaviors of active intermediates formed during ultraviolet ray (UVR)/ supersonic wave (SSW) reactions in water were investigated using a nano-reaction field separation TiO_2 photocatalyst sprayed at low temperature. The oxidizing substances were radicals, which were detected during SSW application, because they could exist for several minutes via a micro- or nano-bubble effect. However, they were not detected during UVR irradiation alone because they immediately disappeared under these conditions. A large amount of the radicals were produced and acted as strong oxidative decomposition agents. The amount of the oxidizing substances increased with the photocatalyst.

For methanol (CH_3OH), about 4.1% was converted to CO_2 after 4-h reaction. Five intermediates containing formic acid were detected. For dimethylsulfoxide (DMSO), an 18.7 mol% reduction occurred after 4-h reaction and methanesulfinic acid and methanesulfonic acid were detected. DMSO was not converted to volatile C-containing compounds.

INTRODUCTION

Removal [1,2] of contaminating particles, metals, oil, fat, plasticizers and other organic and inorganic substances on the surface of integrated circuit (IC) wafers is a challenge that needs to be addressed for ultra-minute and highly integrated semiconductors [3,4]. Washing generally is done with an acid, base, or O_3 because physical methods, such as supersonic wave (SSW) application, damages semiconductor chips. However, an effective, low-cost washing method, which does not require treatment of the waste solvent, is needed.

Decomposition of chemical substances using ultraviolet ray (UVR) radiation along with a TiO_2 photocatalyst has been investigated [5-7]. Several studies on decomposition caused by SSW application also have been reported and show a synergistic effect by combining UVR and SSW irradiation [8-10]. The nano-reaction field separation TiO_2 photocatalyst is more effective because the oxidation and reduction portions are separated. The nano-reaction field separation TiO_2 photocatalyst could be coated on the carrier using a low-temperature spraying method, protecting it against strong physical forces as SSW. Then, the wash water containing radicals, produced by the combined UVR/ SSW treatment catalyzed by the TiO_2 photocatalyst,

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Batch and fixed bed studies: Removal of copper(II) using chitosan-coated kaolinite beads from aqueous solution

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Key Words: Breakthrough curve, chitosan, fixed bed, groundwater, kaolinite

ABSTRACT

In this study, Cu(II) removal under batch and fixed-bed conditions using chitosan-coated kaolinite (CCK) was investigated. The surface morphology of CCK was characterized using scanning electron microscopy. Batch experiments showed that 1:20 chitosan to kaolinite ratio can provide satisfactory Cu(II) removal. Kinetics study revealed that adsorption is best described by pseudo-second order equation ($R^2 > 0.99$). The isotherm data of Cu(II) adsorption using different ratios of CCK fitted well with Langmuir model ($R^2 > 0.98$). The Langmuir constant, q_{mL} has the following values of 11.2, 9.4 and 8.9 mg g^{-1} for 1:5, 1:10 and 1:20 chitosan to kaolinite ratio. In fixed bed studies, Cu(II) uptake increases and longer breakthrough time are attained as pH becomes more acidic. In addition, about 93% of Cu(II) removal from real groundwater system was attained using 2 g CCK.

INTRODUCTION

Copper, an essential mineral needed by the human body, is generated by several anthropogenic sources such as cooling water systems, mining, fungicide manufacturing, metal electroplating and finishing [1]. An increase in Cu(II) intake can cause health problems like Wilson's disease, gastrointestinal disturbance, vomiting, and lesions in the central nervous system [2,3]. In addition, heavy metal contamination in surface water and groundwater will further prevent any beneficial use of the water bodies.

Among the physicochemical treatment for heavy metal removal, adsorption has the ability to remove contaminants in wastewater with high solute loading and even at dilute concentrations [4]. However, using commercialized adsorbent such as activated carbon is considered to be expensive, which leads to high operational costs [5]. On the other hand, chitosan has been proven to have the highest metal chelating capacity among natural adsorbents [6]. Chitosan, poly$\beta(1\rightarrow4)$-2-amino-2-deoxy-□-glucose, is produced through deacetylation of chitin using a strong alkaline solution [7]. Due to its hydrophilicity, it becomes soft and gel-like in aqueous media [4]. In addition, it easily swells and crumbles and has a low specific surface area [1,8]. Modification could be applied to chitosan in order to improve its chemical and mechanical properties. Physical modification such as coating chitosan on a support material would enhance the accessibility of

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Lead(II) adsorption using allspice-alginate gel biocomposite beads

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Key Words: Alginate, allspice, biocomposite, lead, sorption

ABSTRACT

Adsorption of aqueous lead ions onto allspice-alginate biocomposite beads was evaluated in both batch and column operations. The experimental data were fitted to Langmuir and Freundlich isotherm models. According to Langmuir model, the maximum adsorption capacity of Pb(II) was found to be 6.6 mg g^{-1} wet mass, equivalent to 132 mg g^{-1} dry mass. Batch kinetic data fitted a pseudo second-order rate, indicating a chemisorption process. Experimental breakthrough curves for continuous flow column studies for two different bed heights were analyzed. The response curves were modeled and fitted using Aquasim software with an advection-dispersion model. The simulation results were extrapolated and synthesized with the Adams-Bohart equation for design and scale-up, generating a continuous-flow column capacity of 6 mg g^{-1} wet mass or 120 mg g^{-1} dry mass and a service time of 369 h. The use of allspice residue in combination with alginate in the form of beads lowers the amount of alginate necessary for adsorption beads by 43%, resulting in lower cost.

INTRODUCTION

Despite well-known health and environmental issues, lead continues to be used in many industrial processes, notably in the manufacture of battery components, pigments, fuels, photographic materials, and explosives, as well as in printing processes. Since Pb(II) is a potent neurotoxin, its pollution is of major concern. The presence of lead in drinking water, even in low concentrations, causes many human health problems such as renal disturbances, hepatitis, encephalopathy, anemia, lung inefficiency, bone lesions, hypertension, as well as cancer [1-5].

Conventional methods for removing metal ions from aqueous solutions include chemical precipitation, ion exchange, membrane technologies, and adsorption onto activated carbon. However, these processes can be quite expensive and somewhat ineffective for treating high volume wastewater streams with low metal ion concentrations below 100 mg L^{-1}. Additionally, some techniques generate large quantities of sludge or other solid waste which requires additional treatment or hazardous waste disposal. There is clearly an opportunity for alternative techniques to address these concerns [6-8].

Biosorption is a passive sequestration process for organic or inorganic substances by non-living biomass. Unlike bioaccumulation in living systems, biosorption does not depend on metabolism. The sorption of metals by agricultural waste, natural material, and industrial byproducts is commonly attributed to the presence of polar functional groups of lignin, proteins, carbohydrates, and phenolic compounds that have carboxyl, hydroxyl, sulfate, phosphate, and amino

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Factors affecting voluntary participation in food residue recycling: A case study in Da Nang, Viet Nam

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Key Words: Food residue, recycling, voluntary participation, microeconomic factors

ABSTRACT

This study investigated the factors affecting participation in food residue recycling in Da Nang City, Viet Nam. Since involvement of citizens in food residue recycling in developed countries usually requires government interventions such as sanctions for non-participants, this study is unique in that it seeks to identify factors influencing voluntary participation in this activity, as no government intervention exists regarding food residue recycling in Da Nang City. We considered microeconomic, psychological, and traditional factors. Some of the microeconomic factors consistently explained our results using a social survey of 142 randomly selected households. Psychological factors affected participation in some model specifications. None of the variables in the tradition category were found to be statistically significant.

INTRODUCTION

Involvement of households in recycling of municipal solid waste is one of the central issues in creating an environmentally sustainable community. In order to promote recycling among households, we need to identify factors influencing household participation in recycling activities. Major research on household solid waste management has focused on citizens' motivations from psychological perspectives [1-3]. Recently, comprehensive microeconomic perspectives have been introduced into research in this area [4,5]. We explore microeconomic factors in detail and some psychological factors related to voluntary participation in a unique example of food residue recycling in Da Nang city, Viet Nam.

Da Nang city, one of the major port cities in Viet Nam, is the country's fourth largest city. Located in central Viet Nam, it is one of the commercial and educational centers of the country. Its population in 2011 was 951,070 [6]. In 2008, the People's Committee of Da Nang publicized a plan for Da Nang to be known as "The Environmental City" by 2020 [7].

Kato et al. [8] illustrate the extensive network involved in food residue recycling; it includes households, food-related businesses, and piggeries in Da Nang city. They estimated that 4.1% of solid waste generated in Da Nang city, which amounted to 600 t d^{-1} [9], was recovered by piggery workers and used for breeding swine. This network provides a unique opportunity for investigating this topic because the network is operated by citizens without government intervention or rule of law. Table 1 shows food residue recycling policies in major East and Southeast Asian countries. Among developed countries such as Japan, South Korea, and Taiwan, it seems difficult to involve many households in food residue recycling without strong government intervention. These government interventions often enact powerful sanctions for non-participants and make it difficult to observe the true impact of various factors on household participation.

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Hydrograph separation for evaluating streamflow recession characteristics in Taiwan

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Key Words: Hydrograph separation, streamflow recession, Taiwan

ABSTRACT

Understanding streamflow recession characteristics is critical for water resource management. Two important streamflow recession characteristics are the recession index, defined as the hydrographic slope of a streamflow on the recession curve, and the critical time, defined as the time required for streamflow to achieve stable discharge from peak flow. These parameters control the variation of the base flow hydrograph. This study analyzes the recession indices and critical times of 57 gauging stations in Taiwan. Based on the recession index spatial distribution diagram of Taiwan, the recession indices of the alluvial fan of Chuosui River, Chianan Plain, Pingtung Plain, Lanyang Plain, Hualien Plain, and Taitung Plain gradually decrease from the coastal areas towards inland. The magnitude of this reduction is highest for Pingtung Plain. The analysis results show that the recession indices are all within a specific numerical range, which gradually decreases (converges) with increasing basin area. The elevation of the gauging stations affects the distribution of critical times, where a lower elevation decreases the distribution and convergence was achieved following a gradual incline in elevation.

INTRODUCTION

Water resource management requires a firm understanding of streamflow recession processes. Streamflow recession characteristics are influenced by natural factors such as climate, geology, topography, and soil characteristics [1-4]. Two important streamflow recession characteristics are the recession index (K), defined as the hydrographic slope of a streamflow on the recession curve, and the critical time (T_c), defined as the time required for streamflow to achieve stable discharge from peak flow [5]. These parameters control the variation of the base flow hydrograph. Several regression-based regionalization studies have established models for assessing K and T_c from the flow and physiographic characteristics of a basin [6-10]. Streamflow recession has been investigated using various methods, such as the recession curve displacement method, the curve-fitting method, and the water-table fluctuation method [11]. However, there is no standard method for estimating streamflow recession characteristics due to the use of different management objectives and the various lengths of available streamflow records [3]. Several methods have been used to assess groundwater discharge from streamflow records, with the most commonly used being the recession curve displacement method [12,13]. This procedure, often referring as the Rorabaugh method, consists of a set of calculations for estimating the total recharge for each streamflow peak [14-16]. Although this method has been manually conducted by several researchers [17], it has a heavy calculation burden, as the recharge must be calculated for each recharge event. For increasing the speed of analysis and reducing the subjectivity inherent in manual analysis, Rutledge [18] proposed several computer programs, namely RECESS, RORA, and PART; newer versions have also been proposed [19,20].

In streamflow recession studies that employ the Rorabaugh method to analyze streamflow, the K

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Technical Note

Chemical scrubbing of odorous fumes emitted from hot-melted asphalt plants

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Key Words: Hot-melted asphalt odors, chemical scrubbing, odor removal, VOCs, sodium hypochlorite

ABSTRACT

Hot-melted asphalt (HMA) plants use sized gravels, asphalt and/or recycled asphalt as raw materials. In the plants, the materials are heated to certain preset temperatures and blended at fixed ratios at around 170 °C to prepare the required HMA for road paving. In the asphalt-melting, hot-blending and dumping operations, fumes and particulates are emitted from the process equipments and chimneys. The emitted gases contain various volatile organic compounds and poly aromatic hydrocarbons which are harmful to the health of the plant workers and nearby residents. Complaints from the residents also come with the fume and odorous emissions. In this study, an oxidation-reduction-in-series scrubbing process was tested to remove odorous compounds in waste gases emitted from HMA plants. Waste gas samples for test were collected from the vent hole of an oven which contains heated samples of asphalt or recycled asphalt concrete. NaOCl solution was used to scrub and oxidize the compounds and H_2O_2 to reduce the chlorine emitted from the oxidative scrubber. A gas chromatography with a mass spectrophotometric detector (GC-MSD) was used for the identification of the odorous species and their concentrations in the waste gases.

GC-MSD indicate that alkanes, arenes, alkenes, halides, esters, and carbonyl compounds are detected in the test gas. Scrubbing test results indicate that with oxidative solution of 60-120 mg L^{-1} residual chlorine at pH 7.0-7.5 and reductive solution of 35 mg L^{-1} H_2O_2 peroxide at pH > 12, over 90% of the non-methane hydrocarbon in the tested gas could be removed. Odor intensities could be reduced from 3,090 (expressed as dilutions to threshold) to 73. Pungent asphalt odor in the test gas was turned into slight sulfur smell after the scrubbing.

For removing the odors from 500 Nm^3 min^{-1} of the flue gas vented from a HMA plant, a cost analysis indicates the required total cost for chemicals (NaOCl, H_2O_2 and NaOH) added to the scrubbers is around USD 94 d^{-1} for a daily operation time of 7.5 h. The cost is far lower than that by the traditional thermal incineration one (USD 836 d^{-1}) or by the regenerative thermal oxidation one (USD 478 d^{-1}). This study has successfully developed a cost effective chemical scrubbing technology for the removal of odorous compounds in gases emitted from HMA plants.

INTRODUCTION

Malodor might be thought of as the single or composite of chemical compounds which causes ill feelings by smelling through the sensory organ. It is often classified as sensory pollution resulting in damaging more mentally or psychologically than physically [1]. Many of sources causing malodors are found to include chemical plants, oil refineries, sewage treatment plants, landfills, livestock facilities, etc. [2-5]. It is in fact known that some of these compounds, when accumulated beyond certain concentration ranges, can exert toxic effects on human beings [6].

Hot-melted asphalt (HMA) plants use sized

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Technical Note

Biological effect of magnetic field on the production of polyhydroxyalkanoates

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Key Words: Municipal wastewater, excess activated sludge, polyhydroxyalkanoates, magnetic field

ABSTRACT

This study reports on the effect of magnetic field at 0 to 50 mT on polyhydroxyalkanoate (PHA) production in activated sludge. Tests were performed for excess carbon addition and PHA content and some other parameters determined. In summary, this research indicated that higher PHA contents of 0.75 g L^{-1} were produced at magnetic field intensities of 5 and 20 mT, whereas the lowest PHA content was recorded at 50 mT (0.55 g L^{-1}). In addition, magnetic field influenced the type and amount of monomer produced of the copolymer PHA. Higher amounts of butyrate and valerate monomer were observed at magnetic field of 5 and 50 mT, respectively. Finally, in the present work, the magnetic field intensity of 5 mT was determined as the optimum magnetic field by considering the ratio of PHA produced to the amount of suspended solids in the activated sludge together with other economic factors (such as costs related to the production of PHA, reduction of sludge volume and production of magnetic field).

INTRODUCTION

Biodegradable plastics are mainly constituted of chemically or biologically produced polyesters. Polyhydroxyalkanoates (PHAs) are natural macro molecules of polyesters produced by a variety of microorganisms and are currently considered as an alternative to conventional plastics. PHAs are formed from 3-hydroxy fatty acid monomers and accumulated as a carbon/energy reserve source in microorganisms [1-3].

More than 300 types of microorganism are able to produce and store PHA under conditions of limited nutrients and excess carbon source [1]. Bacteria can synthesize a wide range of PHAs and approximately 150 different constituents of PHAs have been identified. Currently polyhydroxybutyrate (PHB) and copolymer P (HB/HV) are the only PHAs produced on a commercial scale [4-6].

Over the past decades, the intrinsic resistance of plastic materials to degradation has been increasingly regarded as a source of environmental and waste management problems. Converting biodegradable components in municipal sludge under thermophilic conditions to volatile acids and further into PHAs has its merits for sustainable development and waste management such as less and safer sludge to be handled, less methane produced in landfill sites, lower cost for sludge disposal, if it can be partially utilized as raw materials to produce valuable products, and production of true biodegradable thermoplastics. Based on previous studies, excess sludge volume can be reduced to less than 30% by extracting of PHA from activated sludge [7]. The idea of PHA production using mixed culture arose from recognition of the PHA's role as a metabolic intermediate in microbial processes for wastewater treatment (WWT). In most cases, a mixed culture generates PHA from organic acids in wastewater or organic acids that have been added from other sources of industrial waste [8-10].

Magnetic field application is a new technique in WWT for various objectives and its key advantages are those of protein recovery, treatment of cells, simulation

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Investigation of the environmental indicators at the main library of Sultan Qaboos University (SQU) in the Sultanate of Oman

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Key Words: Sick building syndrome, indoor air quality, thermal environment, library building, Oman

ABSTRACT

An investigation of the status of the indoor air quality and thermal environment of the new library building at Sultan Qaboos University was the primary objective of the current study. The secondary objective was to discover the extent to which users of the library suffered from symptoms of sick building syndrome (SBS) due to a poor indoor environment. In order to fulfill these objectives, the concentrations of indoor air pollutants and ranges of thermal comfort parameters were recorded at five different locations in the building. The results of the study indicated that the occupants of the library were being affected by SBS due to raised levels of carbon dioxide, total volatile organic compounds, and relative humidity (RH) along with an overly cool indoor environment. Increased levels of RH and CO_2 indicated inadequate ventilation in the building. Short-term exposure to the polluted indoor environment of the library impacts the productivity, comfort level, and health of its library patrons. It is hoped that this study will contribute to the literature associated with quality of life in public indoor environments.

INTRODUCTION

Many studies have been conducted in recent years to investigate indicators of sick building syndrome (SBS) in various types of buildings, but SBS in libraries has garnered the attention of only a few researchers [1-19]. Furthermore, researchers who have conducted their work on libraries have focused their attention primarily on describing their architectural elements and the developments and improvements made to libraries over time. Most studies on libraries have dealt with the implications of these developments on libraries and the services they offer. Some researchers have focused upon the stages of development that library buildings go through over time and studying the impact of modern technical developments on their functions. Other researchers have described libraries' safety and security systems, while yet others have focused upon the architectural design of libraries [15]. At the same time, only a very limited number of studies focus on the environmental dimension of libraries and the effect on SBS, despite its importance to and impact on the quality of the performance of libraries' information specialists. Hence, the relevant studies published internationally remain limited; further, Arab studies related to the topic are a rarity. The researchers of this study did not find any studies focusing adequately on this topic. No light was shed on the extent to which indoor air quality (IAQ) impacts the health of librarians and the extent to which this is reflected in their performance.

This is what drew the attention of Abdul-Wahab and Salem [15] to the IAQ inside libraries and the necessity of determining the extent to which the occupants develop SBS. This determination was achieved by focusing on the main library of Sultan

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Performance evaluation of sedimentation followed by constructed wetlands for drainage water treatment

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Key Words: Constructed wetlands, modeling, nutrient transformation, polluted drain water, removal efficiency

ABSTRACT

Performance of a constructed wetland utilized to improve the water quality in "Bahr El-Baqar" drain was evaluated. The drain is located on the north-eastern edge of the Nile Delta, which receives a mixture of domestic and agricultural discharges. The treatment system consists of two sedimentation units followed by ten constructed wetlands operated as free water surface flow basins. The drain discharges its water into "El-Manzala" Lake, which has fishing activities and connects to the Mediterranean Sea. Results showed that, at an organic loading of 2,800 kg BOD (biological oxygen demand) d^{-1}, treatment facilities achieved overall removals: 75 ± 3% (BOD), 57 ± 5% (chemical oxygen demand, COD), 78 ± 2% (suspended solids), 50 ± 5% (NH_4) and 44 ± 8% (total P). Profiles of basins revealed that, due to natural aeration at the water surface (shallowness) and from the roots of the plants, dissolved oxygen (DO) levels gradually increased from 1.0 ± 0.1 to 6.5 ± 0.7 mg L^{-1}. At a hydraulic retention time (HRT) of 60 h, the wetlands were able to reach the allowable limits in the Law 48/1982 for DO (> 4 mg L^{-1}), BOD (< 40 mg L^{-1}) and COD (< 80 mg L^{-1}) after 60% of their longitudinal length. Ordinary differential equations were implemented to model the biological process occurring in the wetlands. It was observed that the simulated results tracked the measured data well, and the stoichiometric parameters were: Y_H = 0.45 mg VSS mg^{-1} BOD, Y_A = 0.26 mg COD mg^{-1} N, and Y_N = 0.06 mg N mg^{-1} COD. The model predicted that operating the basins at HRT of 73 h, removal of NH_4 will be enhanced by 24%. At this condition, the effluent NH_4 is allowable for adequate discharge according to Law 48/1982 (NH_4-N < 3.0 mg L^{-1}).

INTRODUCTION

In Egypt, the high population growth rate along with the limitation of water supplies has caused severe problems in the water quality and quantity. As a result, Egypt has been reported as one of the most water-stressed ten countries in the world [1]. The annual share of fresh water resources per-capita in Egypt is now about 800 m^3, and it is expected to drop to about 600 m^3 per person-year by 2025 [2]. Additionally, limited amount of rainfall makes the country highly dependent on the Nile River and underground aquifers, which are also subjected to unpredicted seasonal fluctuations. In this context, there is a crucial need to explore all viable options for conserving current water resources, as well as finding new alternatives to cope with the projected water scarcity problem [3].

Great efforts have been directed towards reutilization of drainage water in the agricultural production process [4]. This is due to agriculture being the primary consumer of water in Egypt, which requires up to 85% of total water resources. Unfortunately, Egyptian drains receive large quantities of partially treated or untreated domestic and industrial wastewater.

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Sequential treatments of oil sand tailings from green extraction by settling, ozonation, and sand filtration

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Key Words: Bitumen, oil, sand, water, tailings

ABSTRACT

Extraction of bitumen from oil sands as a source of heavy oil is increasingly attractive as crude oil reserve depletes. The current hot water extraction process creates a large volume of difficult tailings imposing a tremendous environmental burden. We developed an environmentally friendly extraction technique that involved compression and decompression with a gas during extraction, eliminating the need of chemical additives and the concomitant problematic tailings. In this study, we demonstrated the treatment of the resultant solids and water through a treatment train that involves settling, sand filtration, pressure cycles-assisted ozonation, and sand filtration, and successfully removed the suspended solids and organics. The unique pressure cycles-assisted extraction process supplied ozone for treatment of the process water via compression and decompression cycles, resulting in expanding ozone bubbles during the decompression stage achieving good treatment outcomes. The green extraction technique resulted in a process-end slurry with total solids (TS) > 15000 mg L^{-1} and turbidity > 4000 NTU; it was treated to an effluent TS of 600 mg L^{-1} and turbidity of < 30 mg L^{-1}, with significant removal of organics. The demonstrated extraction technique and accompanying treatments provide a more sustainable alternative to the current extraction practice and tailings management, alleviating the huge environmental cost.

INTRODUCTION

Although hot-water extraction of bitumen from oil sand proves very effective in commercial application, its enormously environmental impact looms. The process uses a large amount of water during operation and generates as much contaminated water. For every m^3 of oil produced, 3 m^3 of fresh water are withdrawn from surface sources [1]. Fresh water withdrawal is only a small portion of the total water used in the hot-water process. A major Canadian oil sand company reported that for every m^3 of bitumen produced, 2.3 m^3 of fresh water were used that represented only 13% of the total water usage [2], which signified a total of 17.4 m^3 of water use per m^3 of bitumen produced. The report showed a significant effort in recycling the tailings water and a very large volume of tailings being handled.

The tailings from hot-water extraction was not treated to remove contaminants before recycling for extraction, it was used directly after the solids were removed; nevertheless, the separation of sands from water was challenging. The added chemicals to improve extraction efficiency also make it difficult to treat or dispose of. One of the major difficulties in tailings arises from its constituent fine particles that settle extremely slowly, typically requiring 10 yr to progress from 30-35 wt% solids to 44 wt% [1]. As the process water was recycled for extraction without treatment other than removal of spent sands from it [3,4], extraction efficiency suffered as the water quality declined in repeated uses. The effort in oil sand tailings treatment has turned to removal of soluble compounds via ion exchange, acidification, and sorbent activated carbon [3]. Research had also been conducted on detoxification of oil sand tailings by acidification

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Characterization of solid and liquid products obtained from thermal processing of Khoot coal and evaluation of char-made activated carbon adsorption

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Key Words: Coal, petrographic analysis, pyrolysis, thermal dissolution, tar, activated carbon

ABSTRACT

Raw coal of Khoot deposit and pyrolyzed coal samples were analyzed for ash content and composition, surface area and porosity, as well as thermal conversion characteristics in air atmospheres. The results confirm that the Khoot coal is a middle-rank sub-bituminous B-D mark coal. The porosity of raw coal, char of pyrolyzed coal or after thermolysis (thermal dissolution) was determined by scanning electron microscopes. The liquid tar product of thermolysis of Khoot coal was investigated by Fourier transform infrared spectroscopy, ^{13}C and ^{1}H nuclear magnetic resonance spectrometric analysis. The results of thermal dissolution of Khoot coal in tetralin with constant mass ratio between coal and tetralin (1:1.8) at 450 °C show that 61% of liquid product can be obtained after thermal decomposition of the coal organic mass. The char after pyrolysis was activated by heated water steam (called char-made activated carbon). The inherent physiochemical characteristics of sub-bituminous coal largely influence the development of micro-and meso-structure within the activated carbon. Activated carbon from sub-bituminous coal was the most effective in removing Methylene Blue from an aqueous solution.

INTRODUCTION

Coal is one of the most important energy sources, especially for power generation and the global coal demand is projected to grow further in the next years [1]. Apart from coal as primary energy fuel, different products such as metallurgical coke, coal tar, synthetic gases can be derived and manufactured from coal, which represent an important feedstock for chemical industry. Converting coal into oil and gas allows coal to be utilised as an alternative to fuel, which will affect the national safety and the economic sustainable development. Among the operating factors for coal pyrolysis, the temperature, pressure, and type of catalysts used play important roles on the product composition. Typical pyrolysis products of raw coal are generated primarily through the decomposition of aliphatic side chains, oxygen functional groups, and low-molecular-weight compounds [2].

Compared to oil and natural gas, coal resources are more evenly distributed worldwide and often readily accessible, e.g., by surface mining [1]. Mongolia is a country which lacks large oil resources but is relative rich in coal resources. Mongolia is estimated to have potential coal reserves of more than 160 billion tons. Most of Mongolia's coal resources are undeveloped

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Technical Note

Catalytic oxidation of VOCs over the structured bimetallic catalyst 0.1% Pt-0.75% CeO_2/SSWM

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Key Words: Porous anodic membrane, stainless steel wire mesh, catalytic oxidation

ABSTRACT

A structured bimetallic catalyst, 0.1% Pt-0.75% CeO_2/stainless steel wire mesh was successfully synthesized by impregnating 0.75% CeO_2 and 0.1% Pt on the stainless steel wire mesh, which was modified by anodic oxidation method. The Scanning Electron Microscopy images showed that the anodic oxidation membrane formed on the surface of stainless steel wire mesh is a porous structure. This typical structure played an important role to ensure the active phase anchored on the support. The catalyst exhibited high catalytic activity and the total oxidation of toluene, acetone and ethyl acetate over the catalyst can be achieved at 240, 320 and 300 °C, respectively. Furthermore, the bimetallic catalyst still keeps stable even it was used up to 400 h at 10000 h^{-1}, which is essential for industrial applications. It is proposed that the highly dispersed active species and the unique advantages of stainless steel material are conducive to the high activity and excellent stability of the catalyst.

INTRODUCTION

Volatile organic compounds (VOCs) are one of the major contributors to air pollution, which are involved in the formation of photochemical smog and toxic to human health [1-3]. Therefore, it is necessary to develop efficient method for VOC elimination. Among the technologies for VOC abatement, catalytic oxidation is considered as the most prospective method [4]. Catalysts supported by noble metals, such as Pt and Pd, have been found to be the most effective catalysts for VOC oxidation [5]. However, they are costly and sensitive to sulphur poisoning. Recently, more researchers pay attention to new catalysts containing rare earth metals. Rare earth metal oxides exhibit good catalytic performance in oxidation reactions for their excellent oxygen storage capacity, strong interaction with the supported metal and high oxygen mobility [6,7]. Meanwhile, the application of ceria-based catalysts appears the most excellent promoter among the rare-earth oxide catalysts [8]. Hence, ceria-based catalysts are the promising alternative to noble metals as catalysts for VOC oxidation. From another perspective, using cheap CeO_2 as active components to partly replace the noble metal in the catalysts is desirable for industrial process.

In addition to the catalyst type, the catalyst support is another important factor. Alumina/cordierite honeycomb has been widely used as catalyst support in VOC oxidation [9,10]. However, in most cases, VOC combustion catalysts are required to cover a wide temperature range from 300-1000 °C. These supported Pd or Pt catalysts using alumina/cordierite honeycomb as support show their shortages in stability, because the alumina/cordierite honeycombs are easily fragmented and the species on the support are likely to sinter and lose their activity at high temperature. Hence, it is necessary to find a novel support which shows more stability and temperature resistance.

Compared with other supports, stainless steel material displays much better stability, which is essential for industrial application. On the other hand,

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Technical Note

Preconcentration and determination of copper(II) and silver(I) onto polyurethane foam functionalized with salycilate

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Key Words: Polyurethane foam, salicylate, sorbent, functionalized, preconcentration

ABSTRACT

Polyurethane foam was chemically functionalized with salicylate through -N=N- group generating a stable chelating sorbent (PUFS) to adsorb copper(II) and silver(I). The synthesized sorbent was characterized by Infrared Spectrometry measurement. Good stability towards various solvents was noticed. The effect of pH and equilibration shaking time was studied for metal adsorption onto functionalized foam. Extraction of copper and silver were accomplished in 25 and 19 min, respectively. Cu and Ag at ppm level were absorbed as the salicylate complex on powered PUFS at pH about 7.0 and 8.0. Copper and silver extraction efficiency could be achieved at 86 and 82% from 500 mL Cu and Ag solutions (1.72 and 0.65 mol mg^{-1}, respectively) which shows the suitability of salycilate foam for preconcentration analysis.

INTRODUCTION

Polyurethane foam (PUF) is one of the most important synthetic polymers, and it is synthesized through a polyaddition reaction between a polyisocyanate (a polymeric molecule with two or more isocyanate groups, such as toluene diisocyanate and methylene diphenyl diisocyanate) and a polyol (a polymer with two or more reactive hydroxyl groups, such as polyethylene adipate and poly(tetramethylene ether)glycol). Both the polyisocyanates and the polyols are currently derived from petroleum oil [1].

Polyurethane is a material with excellent hydrodynamic characteristics and has been widely exploited as a solid phase for extraction and preconcentration of inorganic and organic species from different media by conventional methods. It can be used either without pretreatment (unloaded PUF) or as a solid support for organic reagents (loaded PUF). While unloaded PUF can be used for the sorption of more than 50 metals, with some restriction loaded PUF with organic reagents provides the possibility of modifying it to improve their selectivity and sorption proprieties [2,3]. Although the excellent proprieties for preconcentration and separation of loaded PUF for metal ions, the leaching of the loaded chelating reagent during the extraction, limits the application and will influence the extraction yield concerning the reutilization and reproducibility, affecting the final results [2]. The preparation of PUF using the chelating reagent is a good alternative to avoid leaching. Polyurethanes present terminal toluidine groups in its structure, which make possible diazotization and azo coupling reactions [4]. In the work described in this paper PUF was functionalized with salicylate through an -N=N- group in order to eliminate the problem of ligand leaching. The sorption behavior of copper and silver on to PUFSalicylate was studied to optimize the best conditions for its removal and preconcentration from water.

MATERIALS AND METHODS

1. Reagents and Materials

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Technical Note

Citizen participation in carbon offsetting: Potential of collaboration with local government

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Key Words: Carbon offset, international development, local government, subsidies

ABSTRACT

This study examines whether a local government authority could promote international environmental cooperation through carbon offsetting by individual citizens. It proposes matching funds by the local government. The study examines the motivation crowding effect of local government subsidies, apart from the price effect. The survey was conducted among adult citizens in Kitakyushu city, Japan, who drive privately owned vehicles. They were asked if they would offset carbon dioxide emissions from driving via contributions towards a hypothetical climate change mitigation project in a developing country, Vietnam. We apply randomized split sample allocation regarding offset price and subsidies. The survey suggests matching funds are effective to increase the demand for voluntary individual carbon offsetting. In addition, the study also confirms that subsidies have both effects of motivation crowding in and crowding out for individuals who have specific interests or experiences in developing countries.

INTRODUCTION

Carbon offsetting by individual citizens in developed countries has the potential to promote low carbon development in developing countries so that a climate change mitigation project has direct benefits to local communities [1]. Untapped demand for such voluntary carbon offsetting is suggested by an experimental survey in Japan [2]. However, there is also evidence that citizens who support international environmental cooperation at local levels may not support the use of carbon offsetting because of their sense of environmental responsibility [3]. Therefore, the current study examines the potential for collaboration between local government and citizens to promote individual voluntary carbon offsetting by citizens for the sake of international environmental cooperation. In particular, it investigates the possibility of matching funds or subsidies by local government for individual carbon offsetting to support a climate change mitigation project in a partner city in a developing country.

Moreover, government subsidies as matching funds might have a 'motivation crowding' effect. According to motivation crowding theory [4-9], external interventions such as subsidies 'crowd out' intrinsic motivation when the concerned individuals perceive them to be controlling, while external interventions 'crowd in' intrinsic motivation when the individuals perceive them as supportive. That is, under a certain reward or external intervention, work effort for doing good decreases when motivation is crowded out, while work effort increases when motivation is crowded in. A field experiment on grocery choices (cola, milk, meat, and butter/margarine) in a supermarket reveals that subsidies crowd out intrinsic motivation

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Effluent water and river water purification by the installation of decentralized water treatment facilities in Surabaya City, Indonesia

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Key Words: Surabaya City, river water purification, environmental survey, investigation of pollution sources, decentralized water treatment facility

ABSTRACT

The river water in Surabaya City was heavily polluted with organic matter and heavy metals. Household well water was not good for drinking water because it contained organic matter and heavy metals. Consequently, we proposed 3 decentralized water treatment facilities for the direct river water purification and the measure against the pollution source of the river water. About 16 m^3 d^{-1} of the combined-type treatment facility for 20 households of sewerage was proposed in the park in Jambangan and the treated water BOD (biological oxygen demand) 50 mg L^{-1} and SS (suspended solids) 50 mg L^{-1} are expected. About 150 m^3 d^{-1} of the biological contact aeration facility having a settling tank and a flow regulating tank for the treatment of effluents of fish-washing, toilet and miscellaneous household at fish market was proposed in Pabean. The gravel biological contact aeration facility for about 50% of the river water in Tenggilis was proposed and the treated river water treatment should be BOD 25-28 mg L^{-1} and SS 8-9 mg L^{-1}.

INTRODUCTION

In the developing country, the urban environment is becoming worse because of rapid industrialization, increase in population or car, among others [1-3]. In Surabaya City, the composting of domestic raw refuse and the city greening are promoted by cooperating with the university and the non-governmental organization (NGO) and the city was received the "UN Local Government Honours" and the "Indonesia Environmentally Advanced City Honours" [4]. Further, the measure for water pollution is a top-priority issue and the master plan is revised to serve with sewage works together with strengthening the regulation on industrial effluent and the fulfilment of the monitoring on water quality. It will cost a considerable amount of money to serve with sewage works and will take a lot of time. If the maintenance and the fee system are not established, its function cannot be fulfilled [5,6]. At present, many household effluents flow into a channel and then directly discharged into a river. A human waste is collected in the septic tank, the effluent without sufficient treatment then penetrates into underground and pollutes groundwater and river water [7,8]. Therefore, there are fears about health damage [9]. The WHO reported that the infant mortality rates (about 1-yr-old baby) were 27 (Indonesia), 2 (Japan) and 40 persons (worldwide average) in 2010 [10].

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Treatment by advanced oxidation processes for an effluent of an anaerobic digester from a slaughterhouse

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Key Words: Fenton, electro-Fenton, photo-Fenton, slaughterhouse, chemical oxidation

ABSTRACT

Different advanced oxidation processes (AOPs) were evaluated to treat the effluent of an anaerobic biological digester. For Fenton-like processes, the most important operating parameters were studied, such as the initial concentrations of hydrogen peroxide $[H_2O_2]_0$ and ferrous ion $[Fe^{2+}]_0$ and the current density to determine the best operating conditions. AOPs achieved high dissolved chemical oxygen demand (COD) removal: 83, 85 and 70% for Fenton, photo-Fenton and electro-Fenton processes, respectively, through coagulation and chemical oxidation. Coagulation was significant in Fenton and photo-Fenton processes because it contributed 68 and 87% of the total removal of COD, respectively, whereas in the electro-Fenton process, chemical oxidation was the principal mechanism and contributed 75% of the total removal of COD. However, according to legal regulations and because of lower costs, the studied AOPs are suitable at lower concentrations of $[Fe^{2+}]_0$ and $[H_2O_2]_0$, different to the optimal conditions for this effluent such as: Fenton process with a $[Fe^{2+}]_0$ of 56 mg L^{-1} and $[H_2O_2]_0$ of 200 mg L^{-1}.

INTRODUCTION

The steady growth of the population has increased the demand for water, which requires appropriate care by optimizing its consumption, treating wastewater, reusing treated wastewater and using other water sources. Advanced oxidation processes (AOPs) have been widely used in wastewater treatment to remove different organic pollutants in synthetic or real effluents [1-4] and they have been used alone or in combination with other processes as pretreatment or post-treatment [5-7]. The number of publications on AOPs related to their applications, principles and design of new treatments is increasing [8]. However, the reaction mechanisms, reaction kinetics, costs, removal efficiencies, and usage of alternative energy sources, such as solar energy, must be examined. AOPs use a strong oxidant specie to chemically oxidize organic pollutants in wastewater, hydroxyl radical ($^{\bullet}OH$) which may be produced in an aqueous solution [9] by different chemical, photochemical or electrochemical methods. Fenton oxidation process is a chemical method, which offers the advantages of coagulation and oxidation [10-12], using hydroxyl radicals generated by Fenton reaction (reaction 1):

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + {}^{\bullet}OH + OH^- \quad (1)$$

In the solution, hydroxyl radicals can oxidize ferrous ions or the organic matter according to the following reactions (reactions 2 and 3).

$$^{\bullet}OH + Fe^{2+} \rightarrow Fe^{3+} + OH^- \quad (2)$$

$$^{\bullet}OH + \text{organic matter} \rightarrow \text{final products} \quad (3)$$

There are also parallel reactions, such the production of hydroperoxyl radicals ($HO_2^{\bullet}$) (reaction 4), or the production of hydrogen peroxide (reaction 5):

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Human health risk management of a mercury, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, and pentachlorophenol contaminated site: Remediation action

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Key Words: Multi-pollutant, mercury, dioxin, groundwater, risk assessment

ABSTRACT

The An-Shun plant soil contaminated site of China Petrochemical Development Corporation polluted by multi-pollutants, including mercury, polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs), and pentachlorophenol (PCP), is a unique and complex soil contamination case. During the remediation period environmental monitoring of groundwater, river water, and air were conducted to evaluate the health risk of the residents near the site to understand the effect of secondary pollution. Multiple exposure pathways were considered including ingestion and inhalation. Monitoring results showing contaminants level with notable health risk only occurred inside the site. The concentration of mercury, PCDD/Fs and PCP in the river water around the site was low with only one monitoring result showing hazard index contributed by PCDD/Fs of 1.11. The results suggested that the health risk from mercury, PCDD/Fs, and PCP were retained in the site, while the health risk to the residents around the site was negligible. Solid phase and gas phase mercury and PCDD/Fs in the air were monitored in this study. Mercury in the air was mainly presented in the gas phase with concentration three orders of magnitude higher than in solid phase. Both mercury, gas and solid phase, and PCDD/Fs concentrations were lower in summer (May to September). The correlation of PCDD/Fs and particulate matter (PM_{10} and $PM_{2.5}$) suggested the effect of the Asian dust storm episodes and the Southeast Asia biomass burning events on increasing of PCDD/Fs concentration in fall, winter, and spring. However, the secondary pollution control strategies applied in this site effectively restrained the inhalation health risk to the residents near the site in acceptable range.

INTRODUCTION

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs), are a class of structurally related toxic chemicals. The chemicals are persistent in environment, arousing a great concerns for human health [1]. The toxicity of PCDD/Fs among the congeners are different. In general, 2,3,7,8-chlorine substituted PCDD/Fs congeners are more toxic than the others, while 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) is the most toxic one [2]. The major sources of PCDD/Fs in environment include a variety of combustion processes and the impurity from the manufacture of industrial chlorinated production, such as chlorophenols [3]. The main exposure pathway of human to dioxins is through food, especially seafood, and then inhalation [4].

Mercury in environments are mainly in three

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Three dimensional modelling of propagation of hydraulic fractures in shale at different injection pressures

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Key Words: 3D modelling, hydraulic fractures, shale, COMSOL Multiphysics

ABSTRACT

The modeling of conjugate development of fractures and fluid flow remains a significant subject in a diversity of rock engineering. Continuum numerical methods are paramount in the modeling of rock engineering practice problems, merely with restrained capacities in modeling the problem of fracture development coupled by fluid flow. There exists a demand for them to be understood in details. Driven by this, we demonstrated an approach based on a three-dimensional development of fracture of an abstract model condensed to two-dimensional analysis comprising rocks with fractures. In the framework of a continuum method of modeling, the contact between the fracture development and deformation was paired with fluid flow. A 3-D model was established in this case for a shale reservoir and fluid was injected at multiple pressures to understand the initiation and propagation of fractures, as applied to the field of hydraulic fracturing. The stress, strain, displacement in the reservoir were monitored at multiple injection pressures. Linear relations of injection pressures were observed with these parameters. A detailed insight with quantification of the values is given into the subject based on the findings of this study.

INTRODUCTION

With a rapid rise in energy demands and with continuous development in industry, exploration and generation of new sources of energy has gathered momentum in the recent years. Traditionally, coal has been one of the main resources of energy of the world. However, oil and gas reservoirs have become very popular over last few decades. More recently, tight sands and shale gas reservoirs also gained the attention of industry for power generation as they exhibit tremendous potential resource for future development, and analysis of these systems is proceeding briskly. With a fast pace decline in conventional petroleum reserves, unconventional resources have gained a progressively significant role in the energy industry over past few years and turning to be an important element in years to come.

Gases in shale are stored as the free gas in both fracture and matrix pores and as absorbed gas on the surface of micro-pores [1,2]. Modeling and simulation of shale gas reservoir presents an unusual problem. These reservoirs have trenchant properties, such as [3]:

- In some of the reservoirs, nearly 50% of the gas content is absorbed gas from organic materials.
- The flow is not easy to comprehend due to the extremely low matrix permeability of nano-Darcy levels.
- Due to the presence of both natural and induced fractures, complex fracture network distribution

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Technical Note

Response of vehicular emissions to air pollution and radiation - A case study during public strike in Hyderabad, India

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Key Words: Aerosols, erythemal UV, public strike, global solar radiation

ABSTRACT

The scope of the present study is to analyse the variations in aerosol optical properties due to absence of vehicle emissions alone and its influence on global solar and the erythemal UV ($UV_{erythemal}$) radiation over the urban region of Hyderabad, India. In this context, systematic measurements on the atmospheric aerosols, global solar radiation and $UV_{erythemal}$ were carried out using ground based instruments. The analysis was performed during public strikes and the results compared with normal days. A decrease in AOD_{550} (49 to 73%) and increase in the global solar reaition (17%) and $UV_{erythemal}$ (5 to 21%) radiation were observed on strike days compared to normal days. The present study highlightes the contribution of vehicular pollution to the aerosol optical properties and its influence on the ground reaching solar radiation and also the $UV_{erythemal}$ radiation, associated with the public strike in the metropolitan cities.

INTRODUCTION

Aerosols play a major role in balancing the Earth's radiaton budget by both absorbing and scattering the radiation, In turn, they affect the climate directly as well as indirectly. Urban areas were considered to be the major source of atmospheric pollution due to anthropogenic sources from industries and vehicles [1]. The physical and chemical properties of aerosols in urban and remote rural areas are different from each other.

Ground measurements are needed for better understanding of the urban particle sources. The fuel combustion (e.g., gasoline, LPG and diesel) in vehicle engines produces various substances and gases. Majority of them are carbon monoxide (CO), CO_2, oxides of nitrogen (NO_x), particulate matter (PM) and black carbon (BC) [2]. The development of models to assess human exposure to air pollution within cities and to assign related health effects has been identified as a priority field for future research [3]. Further, the air pollutants are also trapped under certain meteorological conditions like low wind speed and low ventilation coefficient [4]. BC and PM concentrations exhibited two peaks during the morning and evening associated with peak traffic hours [2]. Further, studies during the absence of potential sources of atmospheric pollution from urban environment have indicated a drastic decrease in BC [5,6] and also reduction in boundary layer height [2,4]. Large vertical extent of aerosols was observed due to vehicular emissions [7]. In addition to the present study, the authors had also carried out contribution of vehicular emission on urban air quality using BC, PM and CO measurements [8].

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Technical Note

Is sodium in anaerobically digested food waste a potential risk to soils?

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Key Words: Anaerobic digestate, SAR, sodicity, sodium, food waste

ABSTRACT

Digestate produced by the anaerobic digestion of food waste contains a substantial amount of plant nutrients and so is applied to land as an organic fertiliser. Food waste in developed countries typically contains high concentration of sodium, which is then applied to soil in the digestate fertiliser. This extra sodium is a potential risk to soil structural stability and plant growth. We assessed the risk to soil through identifying effects of soil sodicity in relation to digestate application using two paired field experiments on grassland sites in UK. Results showed a significant increase in soil sodicity, which increased with digestate application rate. This indicates a potential risk for land that continually receives digestate application and particularly for soil with already high levels of sodicity. The susceptibility of soils to sodicity related problems can be predicted, and risk mapping of soils likely to receive long-term applications of digestate is recommended.

INTRODUCTION

Digestate, the slurry remnants of anaerobic digestion (AD), is a source of plant nutrients often applied to land as an alternative to mineral fertilisers. In Britain, 16 Mt of food waste was produced per year [1]. This large feedstock has led to an increase of AD installations in the UK from 17 in 2009 to 140 in 2014, of which 53 predominantly use food-sourced materials [2]. Quality assurance systems across Europe have been implemented to reduce the risk for the end-user, but currently no upper limit has been specified for sodium. Consequently the salt content of digestate may cause imbalances in the soil to which it has been applied.

Food products can have high concentrations of Na, reaching 14 g kg^{-1} for pork and cured ham, and 5.7 g kg^{-1} in prawns [3]. The daily adult consumption of salt in England was reported at 8.1 g, or 3.2 g Na [4]. As the nutrient profile of digestate is dependent on feed-stock composition [5], salt within food products will remain within the digestate that is subsequently applied to soil. The Na concentration in digestate is variable, where reported values include 524 [6], 2000 and 3100 [7] and 1842 mg kg^{-1} [8].

Soil degradation by salts is a major threat to sustainable crop production globally, with more than 831 million ha being salinized [9]. Soils with a predominance of Na can become alkaline and sodic as the Na replaces calcium and magnesium. This is described by the Sodium Absorption Ratio (SAR), which is a ratio of the contribution of Na to that of Ca and Mg in the soil. The USDA classifies soils with an SAR of > 13, and an Electrical Conductivity of > 4 dS m^{-1}, as saline sodic [10]. In Australia, soils with SAR > 3 are termed sodic [11], as Na can cause soil structural deterioration and infiltration problems at < 13. Adverse effects of salinity on crop yields [12,13], soil chemistry [14,15], and microbial status [14,16,17] have been extensively reported. The degree of soil structural deterioration and infiltration problems depends on soil texture [18], drainage conditions and irrigation water quality.

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Emission of ozone precursors and particulate matter at signalized intersection of developing town

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Key Words: Vehicle emissions, level of service, delay time, ozone precursors

ABSTRACT

This study aims to analyze and develop strategies on how to reduce the vehicle emissions at six signalized intersections during non-peak hours during construction period at Parit Buntar, Perak, by using Sidra Intersection 5.1. Vehicle emissions include pollutants such as CO, nitrogen oxide (NO_x), hydrocarbon, and particulate matters. Both objectives are accomplished by analyzing the effect of signal phasing, cycle time, level of service, lane addition, provision of Left Turn On Red, and new approach at signalized intersections. The effects of vehicle emission on the environment were overlooked by traffic engineers because of their focus on the development of traffic signalized intersections. The more pressing issue is the rate of NO_x converted to ground level ozone in the presence of sunlight (NO_x = NO + NO_2), with the main emitters of NO_2 being traffic and industries. Junction 4 is a congested and polluted signalized intersection with a released NO_x of 80.7 kg h^{-1}, whereas Junction 3 recorded 14.5 kg h^{-1} NO_x. The congestion factor, which is due to the rapid development of new construction work (flyover and double track), is influenced by the increasing total volume of vehicles from the three nearest towns within a 3-km radius between Parit Buntar, Nibong Tebal, and Bandar Baharu. A comparison of traffic congestion between 2011 (non-peak hours) and 2010 (peak hours) showed 100% increase in vehicle volume in five out of six signalized intersections.

INTRODUCTION

Pollution from motor vehicles has become an important issue because of the increasing number of vehicles in use, distance travelled by vehicles, and signal delay time at intersections. Similar to population, the number of motor vehicles in Malaysia has been increasing rapidly since 2011, with a total of 21.4 million motor vehicles of all types in 2011. According to the Ministry of Transport Malaysia [1], motorcycles comprise the highest number of motor vehicles at close to 10 million, followed by motorcars at around 9.7 million.

At an optimum speed in excess of 60 km h^{-1}, the emissions of CO_2 and oxides of sulfur (SO_x) vary directly with fuel consumption. Chen et al. [2] concluded the tailpipe emissions of CO, nitrogen oxide (NO_x), particulate matter, and hydrocarbons (HC) vary with engine design, air-to-fuel ratio, and vehicle operating characteristics. With increasing engine temperature (or increasing vehicle speed), NO_x emissions increase, whereas CO, particulate, and HC emissions decrease [3].

This paper focus on understanding vehicle emission at signalized intersections according to the effect of cycle time, level of service (LOS), and signal phasing on vehicle emissions. Hence, after analyzing the selected intersections in terms of changing signal phasing, cycle time, and LOS, mitigation was selected to overcome problematic traffic emissions. Reduction in traffic gaseous emission of NO_x will reduce the production of ozone in ambient air [4].

A four-mode elemental model for estimating fuel consumption, operating cost, and pollutant emissions was generated by Sidra Intersection 5.1. For each lane of traffic, the program constructs drive cycles consisting

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Performance evaluation of electro-Fenton process for pretreatment and biodegradability improvement of a pesticide manufacturing plant effluent

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Key Words: Electro-Fenton process, pesticide manufacturing plant, advance oxidation process, biodegradability

ABSTRACT

This paper presents the experimental results on COD removal from a pesticide formulation and production plant effluent by electro-Fenton process (EFP) in the bench scale reactor. The concentration of COD in the raw wastewater was 6040 mg L^{-1} with the BOD/COD ratio close to zero. Effect of main parameters including pH, amount of H_2O_2, current density, and reaction time on COD removal efficiency was determined, and then the biodegradability improvement of the wastewater was evaluated under the optimum conditions. COD removal efficiency of 96% was obtained in the EFP under optimum operation conditions (pH = 6, H_2O_2 concentration = 1.5 mM, current density = 6 mA cm^{-2} and reaction time = 40 min). At these conditions the BOD/COD ratio increased from 0 to 0.37. It was confirmed that EFP is an efficient technology for pre-treatment and biodegradability improvement of the wastewater generated in the pesticide formulation and production plants.

INTRODUCTION

Pesticides and herbicides are wildly used in agricultural activities. They are major pollutants of water bodies, wastewater and soil. Moreover, these compounds are mostly toxic in nature and carcinogenic even at low concentrations, with reported field half-lives from 20 to 300 d [1]. Their photodegradation is significant only on soil surface and volatilization is practically low. The pesticides and herbicides may be aerobically biodegraded depending on application rates and environmental conditions. These pesticides are poorly bound to the soil particles, and the presence of organic matter increases their adsorption. One of the recent progresses in the treatment of effluents containing toxic compounds is advanced oxidation processes (AOPs). These processes involve chemical, photochemical or electro-chemical techniques to bring about chemical degradation of organic pollutants. The principal agent generated in AOPs is the hydroxyl radical ($^{\bullet}OH$), a highly active specie for oxidizing organic contaminants. The $^{\bullet}OH$ reacts with organic pollutants and lead to their degradation through various mechanisms including hydrogen abstraction, red/ox reaction or electron addition to the system [2]. One of the most commonly used AOPs for the removal of persistent organic pollutants from water and wastewater is the electro-Fenton process (EFP). Among the different Fenton-like reactions, indirect EFP is efficient in eliminating organic pollutants from aqueous media [3]. This technology uses the Fenton reaction as the source of $^{\bullet}OH$ (Eqs. 1-3), in which H_2O_2 is manually added and Fe^{2+} is electro-chemically produced [4]. This process is an environmental friendly option for wastewater treatment and seems to be promising for the purification of water streams contaminated by toxic organic contaminants [5].

$$O_2 + 2H^+ + 2e^- \rightarrow H_2O_2 \quad (1)$$

$$Fe^{2+} + H_2O_2 \rightarrow Fe(OH)^{2+} + {}^{\bullet}OH \quad (2)$$

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Comparison of the sorption behavior of mercury (II) on inorganic, organic and biomass substrates in the presence of different counter-ions

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Key Words: Mercury, inorganic, biomass, coal, activated carbon

ABSTRACT

This research compares the sorption behavior of mercury on inorganic, organic and biomass substrates in the presence of three different counter-ions. Parameters such as sorption efficiency, rate, pH dependence of sorption and effect of complexing agents such as: Cl^-, SCN^- ions and ethylenediaminetetraacetic acid (EDTA) were investigated. Organics, including biomasses, peats, different rank coals and activated carbons seems to be more efficient at mercury sorption than inorganics. Inorganics show less sensitivity from the speciation of mercury; however $HgCl_2$ is generally less efficiently sorbed due to the formation of chloro complexes. The Hg sorption on biomass, peat and coals has the smallest pH effect, and it was found that activated carbons were found to recharged to positive at low pH and become efficient for negatively charged complexes. Among the studied ligands, EDTA limited the sorption due to the strong complexes formed.

INTRODUCTION

Soil is a complex matrix that has three phases: solid, which consists of inorganic and organic substances, and solution and gas phases. Each of these phases interacts with the others. Living organisms are present in all of these three phases [1,2]. A significant problem in soil is heavy metal pollution since it can be transferred to plants and eventually to the food chain of humans, or even toward water sources. The origin of heavy metal contamination of soils may be anthropogenic as well as natural. Unlike organic contaminants, most metals do not undergo microbial or chemical degradation, and they thereby accumulate in soils [3].

Metal ions can exist in soils and sediments in various fractions in different chemical forms: adsorptive-exchangeable, carbonate-bound, oxide-bound, organic matter-bound and detrital or crystal lattice metals. Among the most important phases involved in heavy metal sorption in soils are inorganic colloids such as clays, metal oxides and hydroxides, metal carbonates and phosphates. Furthermore organic colloidal matter of detrital origin and living organisms such as algae and bacteria provide interfaces for heavy metal adsorption. The sorption of heavy metals onto these soil surfaces regulates their solution concentration, which is also influenced by inorganic and organic ligands. Those ligands can be of biological origin such as humic and fulvic acids [4,5]. These geochemically formed ligands can fix the heavy metals in soils affecting their solubility, which directly influence their mobility, the risk of ground water pollution, and bioavailability. The soluble forms of toxic ions strongly depend on the relative sorption contribution of solid soil components such as silicates, carbonates, oxides and organic matter [6].

The most important parameters controlling heavy metal sorption and their distribution between soil and water are the soil type (composition and structure),

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Pyrolysis of biomass in a laboratory pyrolysis unit with a screw type reactor and a secondary decomposition reactor

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Key Words: Pyrolysis, wood biomass, secondary decomposition, catalyst, dolomite, RC

ABSTRACT

The current paper deals with experimental pyrolysis of wood biomass in a laboratory pyrolysis system with two reactors (a primary pyrolysis reactor and a secondary catalytic reactor). The effect of temperature (500-800 °C) and the addition of two mineral catalysts on the product yields, gas composition and tar reduction were investigated. In the second catalytic reactor, calcined dolomite and a red clay mineral material (marked as RC) were used as catalysts.

Solid residue was collected at the outlet of the first reactor and the liquid product was obtained after the condensation of vapors in a series of coolers. Total organic carbon in the liquid product was estimated by elemental analysis. Instantaneous concentrations of gaseous products were obtained under the experimental conditions and analyzed by gas chromatography. The main gaseous products were: carbon monoxide, methane, hydrogen, carbon dioxide and light hydrocarbons. In addition, gravimetric tar analysis of the product gas was performed to determine the heavy tar content in the outgoing gas.

The use of catalysts in the secondary reactor had a significant effect on the gas and tar yields. The results showed an increase in the total gas yield at higher temperatures, accompanied by a drop in the tar yield. RC demonstrated good effectiveness of tar reduction at low temperatures. However, at 700 °C, the tar content obtained using RC was 4.8 mg g^{-1} of the raw sample compared to 3.2 mg g^{-1} when using dolomite. This was significantly different to that obtained in the non-catalyst run, with 11.2 mg g^{-1} of the tar remaining.

INTRODUCTION

Currently, biomass is the fourth most used energy source worldwide representing more than 10% of the world's energy supply [1]. Despite the growing popularity of wood biomass for energy production, its utilization is still considerably lower than the existing resource potential. Hence, the Directive of the European Parliament and of the Council No. 2009/28/EC (on the promotion of the use of energy from renewable sources) establish the objective of reaching at least 20% of the EU's energy consumption through renewable sources by 2020 [2].

Pyrolysis and gasification are thermochemical methods for energy production from wood waste. Pyrolysis (thermal degradation in the absence of oxygen) can be used to produce liquid and gas fuel from biomass, which can be utilized in various spheres of industry. Pyrolysis has lower efficiency of gas fuel production when compared to gasification (sub-stoichiometric conditions of air), but the higher heating value of produced gas is a significant advantage. Moreover, the pyrolysis process requires smaller capacity of downstream gas cleaning and a lower amount of carrier gas. When the pyrolysis process is designed for gas application, the liquid product and the tar content should be converted to gas or minimized in order to prevent the blockage and corrosion of downstream process equipment and to improve the gas production efficiency [3].

The pyrolysis gas typically consists of hydrogen, carbon monoxide, carbon dioxide, methane, carrier

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Optimization of culture conditions for bioethanol fermentation in oil palm fronds juice concentrates via Box-Behnken design

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Key Words: Oil palm fronds juice, response surface methodology, Box-Behnken design, bioethanol, *Kluyveromyces marxianus*

ABSTRACT

Response surface methodology via Box-Behnken design was used to evaluate the effect of culture conditions on bioethanol production by *Kluveromyces marxianus* in oil palm frond juice concentrate. In this study, the tested parameters were agitation speed, incubation temperature, inoculum size, pH, and initial glucose concentration; the responses were bioethanol yield and biomass. The optimum culture conditions obtained from the response surface analysis were agitation speed 117 rpm, incubation temperature 35 °C, inoculum size 4.0% (v/v), pH 6.59, and initial glucose concentration 44 g L^{-1}, respectively. Under these conditions, the experimental data for bioethanol yield (0.47 g g^{-1}) and biomass (5.61 g L^{-1}) were close to the predicted values.

INTRODUCTION

Bioethanol, a fossil fuel substitute has drawn much attention as an alternative transportation fuel [1]. It has very good combustion properties and can be applied to the existing car engines without major modification when blended at low concentration [2]. In fact, this biofuel has gained worldwide acceptance especially to overcome severe energy crisis, fossil fuels depletion and environmental pollution. Hence, development of biofuel production from readily available feedstock from agro-based industries is urgently needed.

Oil palm (*Elaeis guineensis* Jacq.) fronds (OPF) are the most abundant agricultural wastes generated in oil palm plantations in Malaysia [3], which are obtained daily while pruning and harvesting fresh fruit bunches. However, these wastes are improperly disposed off without considering their benefits to mankind. The disposal of OPF is currently by direct decaying in natural environment or by burning on sites. These practices have created environmental pollution to industries and public. The OPF can be utilized and converted to value added products (bioethanol) [4,5]. But the problem of this OPF is to remove lignin from the lignocellulosic materials, and this has impeded the commercialization potential of this renewable resource [6]. Besides, the costs to recover sugar from the lignocellulosic materials and the pre-treatment processes are crucially high [7]. Hence, an alternative approach of producing renewable sugars from OPF is urgently needed.

Bioconversion of sugar presence in OPF juice to bioethanol via fermentation is believed to be a promising method since it is a simplified route to gain products, also reducing the operating and chemicals cost. Zahari et al. [8] reported that OPF juice consisted of higher glucose concentrations (54.0 ± 2.9 g L^{-1}), which accounted 70% of the total free sugar. Glucose was found to be a dominant sugar component in OPF juice, followed by sucrose and fructose. In fact, the amount of sugar was relatively similar to the sugar composition in oil palm trunk sap [9]. Moreover, the OPF juice is enriched with natural nutrients such amino acids and contains a higher percentage of organic carbon. It is also suitable to be used as a renewable carbon source for bioethanol production [7].

Previous study has shown that *Kluveromyces marxianus* was able to produce ethanol, enzymes,

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Life cycle assessment of asphalt pavement product

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Key Words: Life Cycle Assessment (LCA), asphalt production, CO_2 emissions

ABSTRACT

Life Cycle Assessment (LCA) can be used to quantify the environmental impacts of materials, processes, products or systems during their entire lifetime from creation to disposal. The objective of the present study was to examine and compare the environmental impacts of different asphalt products by means of LCA. The functional unit selected was one ton asphalt production. The comparative LCA was performed using LCA software SimaPro® with Impact2002+ database. The guidelines from ISO 14040:2006 was used throughout the analyses. Results from the software underline the estimated environmental performance of asphalt production in terms of a number of choices such as carbon footprint, resource and energy consumptions and various environmental impacts. According to the comparisons, between three different types of asphalt products, it was found that average 10% decrease of environmental effects can be achieved when the less bitumen was used in the asphalt production. At the same time carbon emission was also 5% higher in the binder type asphalt production where bitumen needs to keep warm. Therefore it can be said that LCA can provide a useful comparison between products and helpful in decision making.

INTRODUCTION

Life-cycle assessment (LCA) is a methodical tool to evaluate all potential environmental impacts over the entire life cycle of product, materials and processes [1-3]. LCA quantifies all environmental impacts from raw material extraction, manufacturing and use to ultimate disposal. This is a useful tool if one needs to evaluate or find an alternative product, process or activity. Therefore it can be a valuable decision-support tool for both policy makers and industry. LCA results are also used in marketing or environmental labelling as well as getting information on environmental performance. The term of system boundaries can usually be used to define types of LCA. All relevant stages of the life of a product and LCA boundaries are given in Fig. 1.

International Organization for Standardization (ISO) produced series of LCA standards in 1997 which were then revised in 2006. ISO 14040:2006 provides a description of principles and framework whereas ISO 14044:2006 outlines requirements and guidelines for LCA [4,5].

The LCA process can be divided into four phases according to ISO 14001; Goal and Scope Definition, Life Cycle Inventory Analysis (LCI), Life Cycle Impact Assessment (LCIA) and Interpretation (Fig. 2).

Asphalt is mainly used for paving all kinds of roads as well as for other applications such as airports, playing and sporting areas, agricultural and industrial constructions [6,7]. Asphalt can be defined as a cement-like material that contains a mixture of aggregates, binder and filler. Crushed rocks, sand and gravel are used as aggregates. A binder, most commonly bitumen, is used to bind these materials into asphalt mixture. There are hot, warm and cold types asphalt production due to different requirements of sectors. Pollutant gases and global warming problems arise from hot and warm asphalt production due to higher energy requirements. Therefore the energy use is the key for calculating emissions of asphalt production [6,7].

There are several researches dealing with environmental effects of asphalt pavement production, recycling and in use [8-10]. These studies usually identify the environmental effects of asphalt pavement

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Study of SO_2 dispersion from a proposed refinery in Newfoundland and Labrador, Canada

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Key Words: Sulfur dioxide, dispersion, CALPUFF, MM5, refinery, Canada

ABSTRACT

Breathing air-containing sulfur dioxide (SO_2) by human being could cause severe health problems. Therefore, modeling SO_2 dispersion is essentially important to make sure that concentrations do not exceed threshold limit, especially for commercial and residential buildings which are located close to the penetration sources. The main objective of this paper is to examine the dispersion effects of SO_2 from a new oil refinery proposed by Newfoundland and Labrador Refining Corporation to be constructed in Newfoundland and Labrador, Canada. The study, done in 2012 to analyze the dispersion effects of SO_2, attempts to decide if the oil refinery requires retrofitting within five years of this study (2012-2017) considering the government policy on reducing emission from industrial sectors to meet limit of civilians' exposure. For this purpose, CALPUFF dispersion modelling software was used to simulate the dispersion effects of SO_2. Results indicate that the highest hourly SO_2 concentration (582 μg m^{-3}, at a location 2.5 km east and 3.5 km north of the refinery) and second highest 3-h average (199 μg m^{-3}) both occurred on October 19, 2012. The simulation indicates that the highest daily average concentration (63 μg m^{-3}, at a location 5.5 km east and 0.5 km north of the source) and monthly average concentration (12 μg m^{-3}, same location as highest hourly concentration) were on 13th December and July, respectively. Besides, the hourly, 3-h and monthly SO_2 limits set by the province of Newfoundland and Labrador are 900, 600 and 300 μg m^{-3} respectively. These limits are all significantly higher than the highest hourly, 3-h and daily average SO_2 concentrations of 582, 200 and 63 μg m^{-3} respectively. To conclude, out of all months in 2012, the highest hourly, 3-h, daily and monthly average SO_2 concentrations are simulated to be the lowest in March, November, May and April respectively. The maximum hourly, 3-h and daily simulated SO_2 concentrations are all well below the SO_2 limits set for the province of Newfoundland and Labrador. Likewise, the maximum 3-h simulated SO_2 concentration is also well below the National Ambient Air Quality Standards 3-h SO_2 limit. However, the maximum hourly SO_2 concentration is found to be significantly higher than the NAAQS hourly SO_2 limit by 196%.

INTRODUCTION

Sulfur dioxide (SO_2) is a toxic and colourless gas [1]. Due to its highly reactive nature [2], it is found to be a byproduct emitted from many industrial and transportation processes, especially from those that require the combustion of fossil fuels. The three main sources that contribute to the emission of SO_2 are ore smelters, power generators fuelled by coal and natural gas processors [1]. SO_2 has been associated as a cause for many adverse respiratory illnesses [3]. Short-term SO_2 exposure can lead to increased hospitalization rates, bronchoconstriction and worsening asthma symptoms. The people most sensitive to SO_2 emissions

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Relationship between ozone with nitrogen dioxide and climatic impacts over major cities in India

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Key Words: TCO, NO_2, AURA/OMI, meteorological data, correlation

ABSTRACT

Total column ozone (TCO) and NO_2 levels along with meteorological parameters over five Indian regions using satellite data for a period from 2005 to 2013 have been studied in this investigation. Annual variations show that TCO was high in Delhi (278 DU) and low in Madurai (254 DU). Concentrations of NO_2 were also high in Delhi (9.8×10^{15} molecules) and low in Madurai (3.7×10^{15} molecules). A systematic monthly variation of TCO was maximum in May and minimum in December whereas NO_2 level is maximum in March-May and minimum in June-September. Compared to all studied sites the rainfall was maximum in monsoon and minimum in winter season. Five major sites were statistically analyzed using Pearson correlation method. Correlation between ozone and NO_2 shows the positive correlation (0.6) in Chennai and Madurai and negative correlation in Delhi (-0.1), Kolkata (-0.1) and Mumbai (-0.3). Correlation results for the relationship between ozone and nitrogen dioxide and with meteorological parameters have been discussed in this study. Delhi shows the maximum level of ozone and NO_2 due to the climatic conditions, industrial activities, heavy vehicular flow and lack of rainfall observed in this study.

INTRODUCTION

Nowadays climate change and global warming cause many worldwide environmental problems. Both ozone (O_3) and nitrogen dioxide (NO_2) are major the air pollutants in urban atmosphere. Ozone is one of the greenhouse gases and it plays an important role in the climate system. It absorbs solar ultraviolet radiation and thereby warming stratosphere and troposphere. By the photolysis of molecular oxygen at shorter UV wavelength, the stratospheric ozone is produced and destroyed by catalytic cycles involving nitrogen, hydrogen and halogen radicals [1]. Change in ozone abundance could have an impact on climate, and changes in climate could also affect ozone in a number of different ways. As a result, the ozone distribution in the future will depend on the emission and impact of other greenhouse gases. Combustion of air leads to the formation of oxides of nitrogen. Nitrogen dioxide is toxic to the biospheric species. It converts into nitric acid (HNO_3) and contributes to acid rain, which is harmful to the entire (terrestrial + aquatic) ecosystem [2]. NO_2 is a major catalyst in the tropospheric ozone production. Stratospheric ozone have been depleted in recent decades, following emission into the atmosphere of various ozone-depleting substances, most of which are also greenhouse gases. Human activities alternate the atmospheric gaseous concentrations such as tropospheric ozone, OH, NO, ClO, and BrO [3]. Ozone can be transported over long distance from their sources [4]. Many studies have suggested that formation of ozone and its transportation depend on the meteorological factors [5,6]. The present paper therefore studied the relationship between ozone and nitrogen dioxide and climatic impacts over five major cities in India.

METHODOLOGY

1. Sampling Sites Description

For the present study five sites were selected (Fig.

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Applying hydroxylamine for evaluating the simultaneous nitrification and denitrification reaction in a sequencing batch biofilm reactor

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Key Words: Simultaneous nitrification and denitrification (SND), hydroxylamine, SND removal efficiency, reused WAS pellets

ABSTRACT

The wasted activated sludge (WAS) was sintered with laterite and iron oxide to form porous pellets which were added into a sequencing batch biofilm reactor (SBBR) in two different filling ratios (20 and 40%) as a cell immobilizing carrier for nitrogen removal. Hydroxylamine (NH_2OH) production was used for identifying and modelling the simultaneous nitrification and denitrification (SND) process in SBBR. The results showed that the more NH_2OH was released, the more ammonium was converted into nitrite, and the SND nitrogen removal efficiency (E_{SND}) also increased due to higher nitrification rate constant in the system. In the first part of the SND process, the specific NH_2OH and NO_2^- release rates of 9.5×10^{-7} mg NH_2OH g^{-1} MLSS min^{-1} and 6.1×10^{-5} mg NO_2^- g^{-1} MLSS min^{-1} were measured. When the COD/N ratio was 8.1, the removal efficiencies of COD and ammonium were 95 and 98%, respectively. The hydroxylamine and nitrite production rates during the nitrification reaction were 5.8×10^{-7} mg NH_2OH g^{-1} MLSS min^{-1} and 9.5×10^{-7} mg NO_2^- g^{-1} MLSS min^{-1}, respectively. Furthermore, the SND reaction rate coefficient (k_{SND}) for the SBBR-40% filling ratio system (k_{SND} = 7.4 mg inorganic N L^{-1} h^{-1}) was better than that of the 20% SBBR filling system (k_{SND} = 7.3 mg inorganic N L^{-1} h^{-1}). The E_{SND} of the SBBR with pellet filling ratio of 20 and 40% were 94 and 98%. The overall results suggest that the higher the carrier filling ratio, the more biomass could be retained in the reactors, and this could increase biomass concentration in reactors with corresponding higher specific removal efficiencies.

INTRODUCTION

The activated sludge process is currently one of the most popular and efficient biological wastewater treatment systems in Taiwan. However this process will generate a significant amount of wasted activated sludge (WAS) and indirectly cause a waste disposal problem. The WAS consists of majorly microbial cells and the residue of their metabolic products. In this study, WAS was sintered to make spherical pellets and were added into a biofilm wastewater treatment system as cell-immobilizing carriers.

Many literatures have reported to reuse WAS by a sintering method to make bricks, lightweight aggregates, ceramics and cell-immobilizing carrier [1,2]. Heating the sludge will increases the strength of the powder mass and possibly results in densification and recrystallization by transport of materials [3]. Hence, this approach has been used to gain an optimal formula to sinter the porous WAS pellets with the required characteristics of high porosity and compressive strength for reusing WAS pellets as immobilized material.

The phenomenon of simultaneous nitrification and denitrification (SND) is referred to these two biological processes occurring simultaneously in the same reactor. SND has been found in various reactors such as activated sludge, plug-flow reactor and sequencing batch reactor (SBR) for nitrogen removal. The sequencing batch biofilm reactor (SBBR) system

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Effect of concentration and size of inorganic suspended solids on microbial-mediated nitrogen transformation in freshwater column

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Key Words: Inorganic suspended sediment, ammonification, nitrification, bacteria biomass

ABSTRACT

The microbially mediated interaction between nitrogen (N) and suspended solids (SS) is not comprehensively understood despite its importance in N transport and transformation, especially in turbid freshwater columns. Herein, the biochemical interaction among inorganic SS (ISS), bacteria biomass, and aerobic N transformation (i.e., ammonification and nitrification) is examined to understand the roles of ISS in N transformation in naturally turbid rivers. Batch experiments were conducted for 7 d with an ISS concentration range of 0-1200 mg L^{-1} and sizes of 11-500 μm, which are typically observed in natural waters. The results indicated that bacterial biomass was higher in the system containing higher ISS concentration, and it was not significantly affected by ISS size. Furthermore, nitrogen transformation rate constants and growth and mortality rates of bacteria varied under different ISS conditions, with the highest values observed for ISS sizes in the range of 20-38 μm at concentration of 200 mg L^{-1}. These findings indicate the substantial impact of ISS on the biological transformation of N in natural freshwaters.

INTRODUCTION

Nitrogen (N) dynamics in freshwater systems are complex because of their various chemical states and association with microbially mediated transformation processes. Those transformations include the assimilatory and dissimilatory processes of N by bacteria. In the former process, both autotrophic and heterotrophic bacteria can obtain N for structural synthesis through the uptake and fixation of dissolved nitrogen [1]. In the latter process, bacteria catalyze electron transfer reactions, resulting in energy production, with ammonia (NH_4^+) as a reducing agent (i.e., nitrification) and nitrate (NO_3^-) as an oxidizing agent (i.e., denitrification) [2]. Through such bacterial processes, the N dynamics in freshwater systems are governed by factors such as pH, suspended solids (SS), temperature, dissolved oxygen (DO), and substrate availability [3].

Among these factors, the effect of SS on microbially mediated N transformation is not well understood despite the fact that many large rivers in the world are highly turbid, with SS concentrations and sizes varying over wide ranges [4-6]. High SS concentrations, on one hand, limit phytoplankton growth by reducing light penetration in water columns resulting in reduced N uptake [7]. On the other hand, high SS concentrations increase bacterial production and rates of organic matter mineralization in water columns [8]. More specifically for N dynamics, the microbially mediated nitrification rate and biomass of ammonia-oxidizing bacteria have been found to increase as a power function of the SS concentration [9]. The effect of SS size on bacterial biomass in a freshwater column has not been well investigated. However, the river bed sediment and detrital particles in addition to biomass of bacterial communities are significantly affected by the physicochemical properties of SS, including the particle size [10-12]. Thus, a similar effect of SS size on bacterial biomass

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Identification and cleaning effect of active intermediates in the O_3/ultraviolet ray/supersonic wave multiple reaction using a low-temperature sprayed TiO_2 photocatalyst

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Key Words: Ozone, nano-reaction field separation type of TiO_2 photocatalyst, ultraviolet ray irradiation, supersonic wave irradiation, OH radicals

ABSTRACT

Water for cleaning wafers intended for integrated circuit (IC) fabrication was produced using a combination of ozone (O_3), ultra-violet ray (UVR), super-sonic wave (SSW) and a TiO_2 photocatalyst deposited on quartz glass by low-temperature spraying. Using both UVR and SSW led to a decrease in the concentration of oxidants in the treated water compared to the case for UVR alone. However, the oxidant concentration increased in the presence of the photocatalyst. Although the O_3 concentration was reduced by SSW irradiation, in the presence of the photocatalyst over half of the oxidants were species other than O_3. Following UVR, no O_3 was detected and only a small amount of other oxidants was present. Using both SSW and UVR irradiation led to an increase in the concentration of other oxidants. The concentration was further increased in the presence of the photocatalyst. Following SSW and UVR irradiation, the oxidants continued to exist for 5 min. The results of a chemiluminescense analysis indicated that the treated water contained mainly OH radicals associated with the ionization of metals. This water is expected to be effective for cleaning wafers prior to IC fabrication, in addition to other applications.

INTRODUCTION

As integrated circuit (IC) dimensions continue to shrink, it is becoming increasingly important to remove contamination in the form of particles, organic and inorganic substances, prior to IC fabrication [1-3]. At present, the most common cleaning method is the use of a reagent containing ozone (O_3). However, there is a strong need for a cleaning method that is lower in cost and does not require wastewater treatment [4-6].

We previously reported [7-10] the cleaning effects of water containing a high concentration of OH radicals, produced using a combination of ultra-violet ray (UVR), super-sonic wave (SSW) and a TiO_2 photocatalyst deposited on quartz glass by low-temperature spraying [11-13]. OH radicals have a higher oxidation potential than O_3 [14] and are converted to nontoxic compounds after they react, thus avoiding environmental pollution. Such water is expected to be effective for cleaning wafers prior to IC fabrication. In the present study, the production and cleaning effect of active intermediates in water treated with separate and combination of O_3, UVR, SSW and a low-temperature sprayed TiO_2 photocatalyst were studied and the lifetime of the OH radicals was investigated.

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Comparison of Azithromycin COD removal from wastewater by Fenton, Fenton like and Electro-Fenton processes

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Key Words: Azithromycin, Electro-Fenton, Fenton, Fenton like, wastewater

ABSTRACT

This work makes a comparison between Fenton (Fe^{2+}/H_2O_2), Fenton like (Fe^0/H_2O_2) and Electro-Fenton processes to investigate the removal of Chemical Oxygen Demand (COD) from synthetic wastewater. The effects of operational parameters such as initial pH, current density, amount of hydrogen peroxide, amounts of Fe^0 and Fe^{2+}, applied voltage and electrolysis time on COD removal efficiency were investigated. The optimum values were determined for the Electro-Fenton process: current density = 20 mA cm^{-2}, hydrogen peroxide concentration = 2 mM, electrolysis time = 60 min, and pH 3.0. Desired pH in both Fenton and Fenton like processes was 7.0 and hydrogen peroxide concentrations for the Fenton and Fenton like processes were found to be 0.2 and 0.4 mM, respectively. In the optimum operating range for each of these operating variables, the Azithromycin COD removal efficiency was in order of Electro-Fenton > Fenton like > Fenton.

INTRODUCTION

In recent years pharmaceutical drugs have emerged as a novel class of water contaminants for which public and scientific concern is increasing steadily because of their persistence in the environment, impacts of pharmaceuticals for human and veterinary use in the environment [1]. Huge amounts of these chemicals in terms of thousands of tons are annually used to prevent or treat microbial infections in each European country, and may be excreted both unmetabolized and as active metabolites [2-5]. Their presence in the effluent of sewage treatment plants (STPs) indicates their poor biodegradability in municipal sewage and STPs that can be emitted into the receiving water systems [6,7]. Microbial resistance is one of the greatest concerns related to use and antibiotics disposal in environment. The Azithromycin (Formula: $C_{38}H_{69}NO_{13}$, Brand names: Zithromax, Sumamed, Zitrocin), is a member of the macrolide antibiotics that is more effective in destroying Gram-negative bacteria, especially *Haemophilus* influenza [8]. Hence, biological treatment processes have a low effect on the degradation of the medicine (because of the toxicity of this medicine for microbes). It is a cause for concern, because of theirs large-scale production and their common use in the treatment of bacterial infections. Therefore a pretreatment process is often required prior to discharge into the biological treatment processes. Advanced oxidation processes (AOPs) are one of the new technologies used for various applications in wastewater treatment, water reclamation, indirect potable water reuse, drinking water production, and recently in micro-pollutant control of sewage treatment effluents. Compared to other technologies (e.g., membrane filtration, adsorption, ion exchange, evaporation, and stripping), the organic compounds in water are degraded rather than concentrated or transferred into different phases. AOPs have the ability to generate elevated concentrations of hydroxyl radical ($^{\bullet}OH$), a strong oxidant capable of complete oxidation of most organic compounds into carbon dioxide, water, and mineral acids or salts [9-12]. The free radical chemistry makes AOPs interesting to the destruction of recalcitrant, anthropogenic and toxic organic pollutants, bacteria, viruses, and last but not least, the emerging

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