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KARYA ILMIAH: JURNAL ILMIAH**

Judul Karya Ilmiah (Artikel) : Waste valorization using solid-phase microbial fuel cells (SMFCs): Recent trends and status

Jumlah Penulis : 8 orang

Status Pengusul : Penulis Utama

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b. Volume/Nomor : Volume 277, 2021, Article 111417
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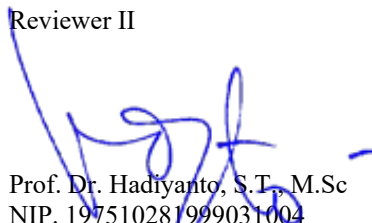
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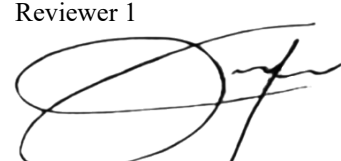
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Semarang, 5 Agustus 2021

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Reviewer I


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Judul Karya Ilmiah (Artikel) : Waste valorization using solid-phase microbial fuel cells (SMFCs): Recent trends and status

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Jabatan Fungsional : Guru Besar
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Budihardjo M.A.^a [✉](#), Syafrudin^a [✉](#), Effendi A.J.^b [✉](#), Hidayat S.^b [✉](#), Purnawan C.^c [✉](#),Lantasi A.I.D.^d [✉](#), Muhammad F.I.^e [✉](#), Ramadan B.S.^a [✉](#)[Save all to author list](#)^a Department of Environmental Engineering, Faculty of Engineering, Universitas Diponegoro, Semarang, 50277, Indonesia^b Department of Environmental Engineering, Faculty of Environmental and Civil Engineering, Institut Teknologi Bandung, Bandung, 40132, Indonesia^c Department of Chemical Sciences, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret, 57126, Indonesia^d Master of Environmental Sciences, School of Postgraduate Studies, Universitas Diponegoro, Semarang, 50241, Indonesia[View additional affiliations](#) ▾

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Waste valorization using solid-phase microbial fuel cells (SMFCs): Recent trends and status

Mochamad Arief Budihardjo^{a,*}, Syafrudin^a, Agus Jatnika Effendi^b, Syarif Hidayat^b, Candra Purnawan^c, Ayudya Izzati Dyah Lantasi^d, Fadel Iqbal Muhammad^e, Bimastyaji Surya Ramadan^a

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ABSTRACT

This review article discusses the use of solid waste processed in solid-phase microbial fuel cells (SMFCs) as a source of electrical energy. Microbial Fuel Cells (MFCs) are typically operated in the liquid phase because the ion transfer process is efficient in liquid media. Nevertheless, some researchers have considered the potential for MFCs in solid phases (particularly for treating solid waste). This has promise if several important factors are optimized, such as the type and amount of substrate, microorganism community, system configuration, and type and number of electrodes, which increases the amount of electricity generated. The critical factor that affects the SMFC performance is the efficiency of electron and proton transfer through solid media. However, this limitation may be overcome by electrode system enhancements and regular substrate mixing. The integration of SMFCs with other conventional solid waste treatments could be used to produce sustainable green energy. Although SMFCs produce relatively small amounts of energy compared with other waste-to-energy treatments, SMFCs are still promising to achieve zero-emission treatment. Therefore, this article addresses the challenges and fills the gaps in SMFC research and development.

1. Introduction

The increase of municipal solid waste generation is an issue faced by nearly all countries, due to the expansion of industrial activities and global development. In developing countries, almost 90% of municipal waste is transported directly to landfills without any intermediate treatment that could reduce the solid waste volume (Barik and Paul, 2017). This waste management activity contributes 5% to the total global greenhouse gas emissions. Recycling, effective waste treatment, and source-segregation are the primary strategies to reduce emissions and environmental impacts due to increased waste generation (Florio et al., 2019). Waste is considered to have a relatively large energy content such that waste-to-energy is considered a viable alternative (Chiu et al., 2016). Composting and anaerobic digestion are biological

treatment technologies that have been used and explored extensively in various countries (Yu et al., 2015; Xin et al., 2018). However, conventional composting under aerobic conditions requires more energy for mixing and an air supply, which could produce vast amounts of leachate (Chu et al., 2019). Anaerobic composting, which is commonly known as anaerobic digestion, can be an alternative solution to convert solid waste into reusable energy and biofuel (Khudzari et al., 2016). Recent research has shown that anaerobic digestion has many constraints, such as a long residence time, a low purification of biomethane and its conversion to electricity, and a variety of safety issues, which makes this technology an imperfect solution for zero-discharge treatment (Xin et al., 2018).

Recently, microbial fuel cells (MFCs) were found to be an alternative treatment to generate electricity from waste (waste valorization) without intermediate treatment steps because anaerobic digestion

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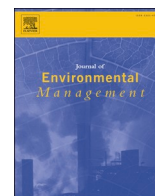
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Research article

A high-resolution nitrate vulnerability assessment of sandy aquifers (DRASTIC-N)

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ABSTRACT

Groundwater protection against agricultural diffuse nitrate pollution is of paramount importance for safeguarding groundwater-dependent aquatic ecosystems and protecting human health by securing clean groundwater for drinking water production. Nitrate vulnerability assessment of aquifers is the core of a scientifically sound strategy for management and protection of groundwater by authorities. A multitude of methods exists for assessing intrinsic aquifer vulnerability. The objective of this paper is to develop a nitrate-specific groundwater vulnerability assessment method based on the globally recognized DRASTIC method, which was developed by the US Environmental Protection Agency in the 1980s. We propose a new method “DRASTIC-N” for assessing aquifer nitrate vulnerability, which for the first time expands the seven original geological and hydrogeological parameters with a geochemical parameter for redox condition. The development of DRASTIC-N is based on the longstanding Danish practice of performing detailed groundwater mapping based on dense sampling of geophysical, geological, and geochemical data. DRASTIC-N is compared to the widely used and documented Danish nitrate vulnerability assessment method SCANVA in a study area where the primary aquifer used for drinking water production is composed of heterogeneous sandy glacial deposits. Both SCANVA and DRASTIC-N result in vulnerability maps, which show similar patterns of nitrate vulnerability with a fair overall agreement of 71%. DRASTIC-N provides a framework for systematic and transparent application, which can facilitate stakeholder involvement and help authorities in groundwater protection and decision-making with regards to nitrate pollution. DRASTIC-N is suitable for nitrate vulnerability assessments of glacially deposited sandy aquifers, an abundant and important water resource worldwide, potentially threatened by nitrate pollution from anthropogenic activities.

1. Introduction

Groundwater protection is essential as groundwater is a valuable drinking water resource and because it discharges to vulnerable aquatic ecosystems. The Danish limit for nitrate (NO₃⁻) in groundwater and drinking water (50 mg/L) follows the drinking water guideline of the World Health Organization (WHO), which is almost equal to the US Environmental Protection Agency's (US EPA) maximum contaminant level of 10 mg nitrogen (N) per L (EPA, 2016). This level is based on epidemiological evidence and aims to protect infants from the acute condition methemoglobinemia (WHO, 2011). However, lower threshold levels may be warranted for protecting sensitive aquatic ecosystems (Hinsby et al., 2012) and there is increasing evidence that the current

drinking water guideline value may not adequately protect the general population against adverse chronic health effects (Espejo-Herrera et al., 2016; Schullehner et al., 2018; Temkin et al., 2019).

Environmental protection, and especially groundwater protection, has a high priority in Denmark, where the entire drinking water supply is based on groundwater (Hansen et al., 2017). Numerous waterworks and wells closed in the last 30 years because of nitrate pollution (Danish Economic Councils, 2015). Approximately 19% of Denmark was classified as a nitrate-vulnerable groundwater abstraction area (Danish Environmental Portal, 2015; Hansen et al., 2016). The Danish protection strategy demands remediation of groundwater pollution at the source. In regards to agricultural activities, this mainly concerns nitrate leaching. N-regulation of Danish agriculture, enforced by national and European

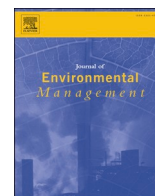
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Research article

Technical evaluation and optimization of a mobile septage treatment unit



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ABSTRACT

A mobile septage treatment unit was built in India using readily available filters and membranes (mesh fabric, sand, granular activated carbon (GAC), microfilter, ultrafilter) and installed on the bed of a small truck. The target application was emptying of septic or sewage holding tanks and concentration of suspended solids while generating a liquid that could be discharged. The system was evaluated for operational and treatment performance while processing septage in the field at 108 sites in Tamil Nadu, India. After one phase of evaluation (Phase I), the system was improved and three replicate systems with slight modifications were fabricated for a second round of evaluation (Phase II) alongside the original, but modified unit. In Phase I, 105 m³ of septage was processed at an average flow of 623 L h⁻¹ and with high removal efficiencies: 83% chemical oxygen demand (COD), 75% total suspended solids (TSS), and 98.4% total coliform (TC). In Phase II, the original and three new systems combined treated 168 m³ of septage. One of the new systems doubled in capacity and processed septage at an average flow of 2700 L h⁻¹ while the other three averaged 1290 L h⁻¹. The removal efficiencies in Phase II were 80% COD, 81% TSS, and 99% TC averaged between the four systems. Pass through of soluble contaminants (e.g. soluble COD, NH₃-N) remain the primary challenge for treatment performance. Success may be limited with some septage due to seasonality, location, or septage age, and further validation and optimization may be necessary. However, the septage in this study was treated to local standards, and the system offers a method of onsite treatment while reducing the need of costly and often inefficient septage emptying services. Further, the system can be produced at a cost competitive to traditional septage hauling trucks.

1. Introduction

The 2011 India census found that 38.2% of urban households with toilets are connected to septic tanks (Government of India, 2011). This percentage increases to greater than 62% for cities with less than one million residents. Under the Swachh Bharat Mission, 21% of already constructed toilets in rural households are connected to septic tanks, and 24% of those under construction will be connected to septic tanks (Water Aid, 2017). Based upon these findings, India's wastewater framework is heavily reliant on septic tank services. Septic tanks in India's urban and peri-urban regions typically do not have liquid overflows to soak pits or soil absorption fields, as seen in many other locations, but are large vaults that are emptied when full. Septic truck operators are hired to empty these tanks once full, with the purpose of transporting contents to tipping stations or sewage treatment plants. However, it is often found that septic contents do not arrive at these

treatment stations. The distance to travel, fuel cost, time demand and expenses all motivate emptiers to dump their contents in alternative, nearby locations without providing sanitary treatment of the septic truck contents. Evidence of this indiscriminate dumping is seen in the global city-wide excreta flow diagrams that show as much as, or more than 50% of collected septage is not treated in cities of India or many other countries (SuSanA, 2020). Two excreta flow diagram examples in India include the major city of Chennai (population 7.1 million) and smaller city of Kochi (population 2.1 million). Chennai's excreta flow diagram shows 58% of population using onsite sanitation of which 66% requires emptying, and only 61% of that is treated (Narayan and Ramachandran, 2019). Meanwhile, 78% of Kochi's population uses onsite sanitation, of which only 14% is treated (Roeder, 2016).

Due to these issues, decentralized wastewater/sewage treatment has garnered greater attention lately (Capodaglio et al., 2017; Chirisa et al., 2017; Singh et al., 2015; UN-Habitat and Asian Institute of Technology

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