Treatment of Landfill Leachate Using A High Rate Algal Pond System

Emienour Muzalina Bt. Mustafa

Institute of Postgraduate Studies,

University of Malaya, Kuala Lumpur.

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ABSTRACT

Landfill leachate containing a variable mixture of organic and inorganic compounds, has been found to be suitable for microalgal growth in the High Rate Algal Pond (HRAP) system. Five species of microalgae namely *Chlorella vulgaris* UMACC 011, *Scenedesmus quadricauda* UMACC 039, *Euglena* sp. UMACC 058, *Ankistrodesmus convolutus* UMACC 101 and *Chlorococcum oviforme* UMACC 110, were screened for growth in treated leachate (TL). Studies on TL obtained from the Air Hitam Sanitary Landfill show that pH value in TL ranged from 6.0 to 8.8. The Chemical Oxygen Demand (COD), Ammoniacal-nitrogen (NH_4-N), Phosphate (PO_4) and Total Suspended Solid (TSS) contents in TL ranged from 860 to 8067 mgL^{-1}, 3.2 to 151.7 mgL^{-1}, 2.4 to 8.2 mgL^{-1} and 555.3 to 3651.1 mgL^{-1} respectively. Based on COD, NH_4-N, PO_4 content in TL, C:N:P ratio value in TL ranged from 81 : 26 : 1 to 4607 : 58 : 1. In this study, the HRAP system was used to complete the final polishing of the TL. Two HRAPs were used. The ponds were of the single-looped raceway mixed by paddlewheel type, measuring 1m x 0.5m x 0.3m. Total volume of microalgae culture for each pond was 40L while the surface area of each pond was 0.71 m^2. Culture depth was 0.15m and the flow rate was 15 cms^{-1}. The HRAP system is capable of integrating biomass-culture of algae with treatment of TL. This system produced algal biomass ranging from 2000 to 5290 mg DWL^{-1}. Chiefly, through algal growth, the system is capable of producing between 16.27 to 98.95%, 63.39 to 99.90% and 5.25 to 98.38% reduction in COD, NH_4-N and PO_4 contents respectively. The HRAP therefore offers a good treatment system for TL which simultaneously generates a useful algal biomass.

ABSTRAK

'Landfill leachate' mengandungi pelbagai campuran bahan organik dan bukan organik telah didapati sesuai untuk pertumbuhan mikroalga di dalam Sistem Kolam Alga Kadar Tinggi (HRAP). Lima spesis mikroalga dinamakan *Chlorella vulgaris* UMACC 011, *Scenedesmus quadricauda* UMACC 039, *Euglena* sp. UMACC 058, *Ankistrodesmusconvolutes* UMACC 101 and *Chlorococcum oviforme* UMACC 110, telah disaringkan untuk pertumbuhannya di dalam 'treated leachate' (TL). Kajian ke atas TL yang diperolehi daripada 'Air Hitam Sanitary Landfill' menunjukkan nilai pH di dalam TL berjulat antara 6.0 – 8.8. Kandungan Permintaan Oksigen Kimia (COD), Ammoniacal-nitrogen (NH_4-N), Phosphate (PO_4) dan jumlah pepejal terampai (TSS) berjulat antara 860 - 8067 mgL^{-1}, 3.2 - 151.7 mgL^{-1}, 2.4 - 8.2 mgL^{-1} dan 555.3 - 3651.1 mgL^{-1} masing-masing. Berdasarkan kepada kandungan COD, NH_4-N, PO_4 didalam TL, nilai nisbah C:N:P di dalam TL berjulat antara 81 : 26 : 1 – 4607 : 58 : 1. Dalam kajian ini, kita menggunakan system HRAP untuk melengkapkan pengilapan terakhir TL. Dua buah HRAP digunakan. Kolam ini terdiri daripada 'single-looped raceway mixed by paddlewheel type' yang berukuran 1m x 0.5m x 0.3m. Jumlah isipadu kultur microalga setiap kolam ialah 40L manakala luas permukaan setiap kolam ialah 0.71 m^2. Kedalaman kultur ialah 0.15m dan halajunya ialah 15 cms^{-1}. Sistem HRAP berupaya menggabungkan biomas kultur alga dengan rawatan TL. Sistem ini menghasilkan biomass alga berjulat 2000 – 5290 mg DWL^{-1}. Kebanyakannya, melalui pertumbuhan alga, sistem ini berupaya untuk menghasilkan 16.27 – 98.95%, 63.39 – 99.90% dan 5.25 – 98.38% penurunan didalam kandungan COD, NH_4-N and PO_4 masing-masing. Oleh itu HRAP memberikan sistem rawatan yang baik bagi TL yang sekaligus menghasilkan biomas alga yang berguna.

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LIST OF ABBREVIATIONS

AAS	Atomic Absorption Spectrophotometer
BBM	Bold's Basal Medium
BOD	Biochemical Oxygen Demand
CCAP	Culture Collection of Algae and Protozoa
Chl *a*	Chlorophyll *a*
CH_4	Methane
COD	Chemical Oxygen Demand
CO_2	Carbon dioxide
DHA	Docosahexaenoic Acid
DO	Dissolved Oxygen
DW	Dilution water
DW	Dry weight
GAC	Granular Activated Carbon
HDPE	High Density Polyethlene
HRAP	High Rate Algal Pond
LCS	Leachate Collection and Storage
LC-PUFAs	Long- Chain Polyunsaturated Fatty Acids
MSW	Municipal Solid Waste
NH_4-N	Ammoniacal-nitrogen
OD_{620nm}	Optical Density at 620 nm
PO_4	Phosphate
PUFAs	Polyunsaturated Fatty Acids
SBR	Sequencing Batch (Bio) Reactor
SCP	Single Cell Protein