Landfill leachate and domestic wastewater treatment biology essay

Environment

Different methods of biological intervention were used for intervention of landfill leachate and effluent.

Sequencing batch reactor SBR is a sort of biological intervention. This survey was carried out to look into the landfill leachate and domestic effluent intervention by a fresh adsorbent (powdery ZELIAC) augmented SBR technique. The ZELIAC includes zeolite, activated C, rise chaff ash, lime rock, and Portland cement. The research was carried out in six 2000 milliliter surfs. The beakers were filled with 120 milliliters activated sludge, and 1080 milliliter landfill leachate and domestic effluent in different ratios. The reactors were divided into 2 groups consisting 3 for normal SBRs, and 3 for powdery ZELIAC SBRs (PZ-SBR) .

Prior to aeration, 3. 24g (3 g/L) of powdered ZELIAC (PZ) was added to each PZ-SBRs. Different aeration rates of 0. 5 to 7. 5 L/min, contact times of 2 to 24 H and leachate to effluent of 20 to 80 % were applied to both SBR and PZ-SBR. The groundss provided by current work indicated that the PZ-SBR showed higher public presentation in removal efficiencies while compared to SBR. At the optimal conditions of aeration rate (1.

60 L/min) , contact clip (15. 43 H) and leachate to wastewater ratio (20 %) for the PZ-SBR, the remotion efficiencies for coloring material, COD, NH3-N, and phenols were 82. 04 % , 71. 56 % , 98. 27 % , and 61. 98 % , severally. Cardinal words: Co-treatment, Landfill Leachate, Nickel, Phenols, Sequencing Batch Reactor, Wastewater, ZELIAC

1.

Introduction

Solid waste disposal ways contain unfastened shit, healthful landfill, incineration, composting, crunching and discharge to sewer, compression, pig eating, milling, dumping, decrease, and anaerobiotic digestion. Sanitary landfill is the most general urban solid waste (MSW) . Soon, there are over 230 landfills in Malaysia, largely old garbage dumps. Most are merely dumping evidences without any environmental protection. The ensuing leachate is discharged straight into H2O classs without any intervention, which can endanger the environing ecosystem, peculiarly in instances where landfills are located upstream of H2O consumptions (Aziz et al. , 2010) .

Leachate is created while H2O penetrates through the waste in a landfill, transporting some signifiers of pollutants like ammonia-nitrogen (NH3-N) , chemical O demand (COD) , biological O demand (BOD5) , colour, suspended solids and heavy metals. Leachate composing depends on some diverseness parametric quantities like kind of waste, site hydrology, landfill age, landfill operation and landfill type. Landfill leachates are reflected one of the sorts of effluent with the extreme environmental influence. The most serious characteristics of leachate are connected of the high concentrations of some contaminations.

Urban landfill leachates enclose contaminations which can be separated into four key groups including dissolved organic affair and inorganic compound like Ca, K, Na, ammonium, Ca, Mg, sulfates, chlorides, Fe and heavy metals like Ni, lead, Cu, Cr, Cd, Zn, xenobiotic organic stuffs (Tengrui et al. , 2007) . Obviously, as landfill age additions, the biodegradable fraction of organic pollutants in leachate lessenings due to anaerobic decomposition happening in a landfill site. In general, available landfill leachate intervention options include: (1) spray irrigation on next grassland ; (2) recirculation of leachate through the landfill ; (3) co-treatment of sewerage and leachate ; (4) leachate vaporization utilizing landfill-generated methane as fuel ; and (5) biological or physical/chemical intervention (Mojiri, 2011) .

Today, landfill leachates are frequently treated with municipal sewerage in the municipal effluent intervention workss. Due to stricter ordinance for N release and job with possible consequence of fractious leachate components on the biological intervention measure an addition of demands for separate intervention and disposal of landfill leachate is detected. The solution which can take to disconnection landfill leachate from the municipal sewerage intervention may be co-treatment with domestic effluent (Neczaj et al. , 2008) . The chief applicable methods of landfill leachate intervention are biological, chemical, membrane separation and thermic intervention procedures. Sequencing batch reactor is one of the biological processed applied to take several contaminations (Mojiri et al. , 2011) .

Because landfill leachate has a high grade of fluctuation in quality and measure, the sequencing batch reactor (SBR) , which has greater process flexibleness among biological intervention methods, is hence good fitted for leachate intervention (Lim et al. 2010) . The high concentrations of organic affairs, low biodegradability ratio, heavy metals, NH3-N, and other contaminations in leachate clearly affect SBR public presentation (Foo and Hameed, 2009) .

In the literature, adsorbents like activated C were added to activated sludge and SBR for the betterment of the biological intervention of landfill leachate (Foo and Hameed 2009 ; Aziz et Al. 2011b, degree Celsius, vitamin D) . A spread of cognition can still be noticed in the literature, peculiarly in the remotion of pollutants (such as phenols, heavy metals, and other contaminations) , settleability of sludge, and nitrification and denitrification procedures in different landfill leachates utilizing low costs stuffs augmented SBR engineering.

Recently, application of several autochthonal and low-priced stuffs for effluent and leachate intervention has received greater involvement (Foul et al. , 2009) . Some of these stuffs contain zeolite, limestone, activated C, rice chaff ash, and Portland cement ; ZELIAC was created from these stuffs. The ends of this survey is to analyze the SBR public presentation in the absence and presence of powdery ZELIAC on the followers: (1) the remotion of phenols, ammonium hydroxide (NH3-N) , colour, and chemical O demand (COD) from Sungai Petani landfill leachates, and domestic effluent from Bayan Baru Wastewater Treatment Plant in Malaysia ; and (2) present a new low cost media viz. ZELIAC.

2. Materials and Methods

2. 1. Landfill Leachate SamplingLeachate samples were collected from the Sungai Petani landfill site from June 2012 to January 2012. The landfill site

(geographical co-ordinates, 05 & A ; deg ; 43? N and 100 & A ; deg ; 29? Tocopherol) is located in Kedah, Malaysia.

The landfill received about 350-400 dozenss of solid waste daily, it step by utilizing Weight Bridge. This unfastened dumping site was actively used beginning 1990. Entire landfill country of Sungai Petani is 11. 24 hour angle. Leachates remain in the aggregation pool depending on keeping clip, and so are disposed of straight in the environment without any intervention. After aggregation, the samples were instantly transported to the research lab and stored in a cold room at 4 & A ; deg ; C prior to minimising biological and chemical reactions (Aziz et al.

, 2011c) . The features of the samples are shown in Table 1. To find the environmental hazards of the leachates, the parametric quantity values obtained were compared against the 2009 Regulations of the Malaysia Environmental Quality Act of 1974 (Environmental Quality, 2009) .

2. 2.

Domestic Wastewater and Activated Sludge Sampling

The domestic effluent and activated sludge were obtained from Bayan Baru effluent intervention works located in Penang, Malaysia. The features of the effluent and activated sludge are shown in Table 1.

2. 3. Reactors features

The six 2000mL beakers each holding a on the job volume of 1200 milliliter, an interior diameter of 113mm, and a tallness of 200mm were used throughout the survey. There was a magnetic scaremonger for blending in the underside of reactors.

The experiments were conducted at room temperature, and air was supplied to the reactors by an air pump (YASUNAGA, Air pump INC. electromotive force: 240 V, Frequency: 50 Hz, Input power 61 W, Model: LP-60A, Pressure: 0. 012 MPa, Air volume: 60 L/min, Serial No.

: 08110014, Made in China) . The air flow rate was manually regulated by an air flow metre (Dwyer Flow metre, Model: RMA-26-SSV) .

2. 4. Sludge Acclimatization

Based on Aziz et Al. (2011c) surveies, about 1080 milliliter of the activated sludge (90 %) was assorted with 120 milliliters (10 %) of the collected landfill leachate. After expiration of the reaction and subsiding stages, 120 milliliter of the supernatant was withdrawn.

In a new rhythm, an extra 120 milliliter of natural leachate was added to the reactor. This procedure was sustained for at least 10 vitamin D to let the system to set to the experimental conditions. The acclimated sludge was subsequently used as seed in the SBRs.

2. 5.

ZELIAC Preparation

For readying of ZELIAC, zeolite, activated C, rice chaff ash, lime rock, and Portland cement were grinded and passed through a 300 µm mesh screen. Entirety of them was assorted, and so was assorted with H2O. After equally, the commixture was poured in the cast. The stuffs were removed from the cast after 24 hours, after that they were soaked in H2O for bring arounding procedure for three yearss.

The stuffs were dried within two yearss, and so they were crushed and passed through a screen. Table 2 shows the features ZELIAC with the autosorb (Quantachrome AS1wintm, version 2. 02) testing. Table 3 and Figure 1 show the consequences of XRF, and XRD testing of ZELIAC, severally. In this survey, powdered ZELIAC of size 75-150 ? m (go throughing sieve No. 100 and retained on sieve No. 200) was used as adsorbent in the PZ-SBR (Aziz et al. , 2011a) .

2. 6. Operation of ReactorsSBR phases contain fill, react, settle, pull and tick over. In all experiments, the continuance for make fulling and blending (20 min) , settling (90 min) , pulling, and idle (10 min) was fixed. Different contact times of 2, 12, and 22 H, aeration rates of 0. 5, 4, and 7. 5 L/min, and different ratio of leachate to effluent (20 to 80 % ; v/v) were used to both SBR, and PZ-SBR.

The beakers were filled with 120 milliliters (10 %) of acclimated sludge and 1080 (90 %) of domestic effluent and Sungai Petani landfill leachate (in different ratio) , utilizing a blending ratio of 25 % to 75 % (v/v) . The chief features of leachate, effluent and activated sludge are presented in Table 1. The reactors were divided into 2 groups consisting 3 for SBR (normal SBR) and 3 for PZ-SBR (powdery ZELIAC augmented SBR) . Based on preliminary experiments, 3. 24g of PZ (i. e.

PZ dose = 3 g/L) was added to each PZ-SBR before aeration. The PZ (powdery ZELIAC) used for surface assimilation pollutants in the PZ-SBR pre-dried at 103-105 -C and sized 75-150µm (go throughing sieve No. 100, retained on sieve No. 200) . Table 2 was showed the features of PZ. The removal efficiency of COD, coloring material, NH3-N, and phenols were monitored in the experiments. Removal efficiency was determined by mensurating the mark parametric quantities before and after intervention.

The undermentioned equation was used for ciphering removal efficiency (Eq. 1) : Removal (%) = (Eq. 1)Where Ci and Cf are the initial and concluding concentrations of the parametric quantities, severally. 2. 7. Analytic MethodsAll trials were conducted in conformity with the Standard Methods for the Examination of Water and Wastewater (APHA, 2005) .

YSI 556 MPS (YSI incorporated, USA) was used for entering the values of pH, electrical conduction (ms/cm) , temperature (-C) , salt (g/L) , TDS (%) , and oxidization decrease possible i. e. ORP (millivolt) . A spectrophotometer (DR/2500 HACH) was used for mensurating phenols (mg/L) , coloring material (Pt. Co) , ammonia NH3-N (mg/L) , entire P (PO43? mg/L) , Entire Nitrogen (mg/L) , Nitrite (mg/L) , entire organic C (mg/L TOC) , COD (mg/L) , sulfide (mg/L S2?) , entire Fe (mg/L Fe) , manganese (mg/L Mn) , Cu (mg/L Cu) , zinc (mg/L Zn) , aluminium (mg/L Al) , Cr (mg/L Cr) , and Ni (mg/L Ni) . The ICP (ICP Varian, OES 715) was used for mensurating Cd (mg/L Cd) , Co (mg/L Co) , molybdenum (mg/L Mo) , Li (mg/L Li) , Mg (mg/L) , and Ca (mg/L CaCO3) .

2. 8. Experimental design and information analysis

Central composite design and response surface methodological analysis were employed in order to exemplify the nature of the response surface in the experimental design and clarify the optimum conditions of the independent variables. CCD was established through Design Expert Software (6. 0. 7) . The behaviour of the system is described through Eq.

(2) an empirical second-order multinomial theoretical account:(Eq. 2)where Y is the response ; Xi and Xj are the variables ; ? 0 is a changeless coefficient ; ? j, ? jj, and ? ij are the interaction coefficients of additive, quadratic and second-order footings, severally ; K is the figure of studied factors ; and vitamin E is the mistake. The consequences were wholly analyzed by analysis of discrepancy (ANOVA) in the Design Expert Software. The design consisted of K2 factorial points augmented by 2k axial points and a centre point, where K is the figure of variables. Four replicates at the cardinal points were employed to suit the 2nd order multinomial theoretical accounts and to obtain the experimental mistake for this survey. Each of the 4 operating variables was considered at 3 degrees, low (? 1) , cardinal (0) , and high (+1) . In the present work, CCD and RSM were applied to measure the association between the most of import operating variables i. e.

(Mojiri et al. , 2013) aeration rate (L/min) , contact clip (H) , and leachate to wastewater blending ration (% ; v/v) and their responses (dependent variables) in add-on to optimising the appropriate state of affairs of operating variables to foretell the best value of responses. Aeration rates (0. 5, 4, and 7.

5 L/min) , contact times (2, 12, and 22 H) , leachate to wastewater blending ratio and (80, 50, and 20 v/v %) were used with SBR and PZ-SBR.

To transport out an equal analysis of the aerophilic procedure, 4 dependent parametric quantities (COD, coloring material, NH3-N, and phenols) were measured as responses (Tables 4 and 5) .

3. Consequences and treatment

Table 1 shows that Sungai Petani leachate contained high-intensity coloring material (1690 Pt. Co) , high concentration of COD (1301 mg/L) . The concentration of NH3-N was besides high (532 mg/L) . An mean BOD5 value of 269 mg/L was recorded (Table 1) , which gave a low biodegradability ratio (BOD5/COD) of 0. 20 (age & A ; gt ; 15 old ages) .

Furthermore, the concentration of phenols, suspended solids, BOD5, COD, BOD5/COD, NH3-N, and sulfide surpassed the allowable bounds issued by the 1974 Environmental Quality Act of Malaysia (Environmental Quality, 2009) . In the current work, natural leachate of SG. Petani landfill was treated as co-treatment with domestic effluent by PZ (Powdered ZELIAC) augmented SBR procedure in order to cut down the environmental hazards from the SG. Petani landfill leachate.

3. 1. Reactor public presentation

3. 1. 1.

COD remotionChemical O demand (COD) is the sum of O used for complete chemical oxidization of the organic components to carbon dioxide and H2O (Tchobanoglous et al. , 1991) . It is obvious that correspondingly with the lessening in BOD5/COD ratio there is a lessening in intervention effectivity

(Kulikowska and Klimiuk, 2004) . The removal efficiency of SBR ranged from 25.

64 % (aeration rate = 0. 5 L/min, contact clip = 22 H, and leachate to wastewater ratio= 80 %) to 46. 29 % (aeration rate = 7. 5 L/min, contact clip = 2 H, leachate to wastewater ratio= 20 %) (Table 4) . Azimi et Al.

(2005) reported that the addition in aeration rate from 25. 2 to 90 L/h resulted in an addition in COD concentration of treated effluent from 10. 4 to 10.

9 mg/L. In SBR, an optimal COD remotion efficiency of 46. 36 % was achieved at an aeration ratio of 4. 43 L/min, 9. 29 H contact clip, and 21. 01 % leachate to wastewater ratio. The removal efficiency of PZ-SBR ranged from 47.

61 % (aeration rate = 0. 5 L/min, contact clip = 2 H, and leachate to wastewater ratio= 80 %) to 72. 19 % (aeration rate = 0. 5 L/min, contact clip = 22 H, and leachate to wastewater ratio= 20 %) (Tables 5) . The present consequences are in line with those reported in literature (Azimi et al, 2005 ; Aziz et al.

, 2011c) . Using PZ with SBR clearly enhanced the COD remotion efficiency. It is in conformity with the consequences reported in literature (Uygur and Kargi, 2004 ; Aziz et al. , 2011c) . Dhas (2008) reported the limestone and activated C mixture provides alternate medium for taking COD. In PZ-SBR, an optimal COD remotion efficiency of 72. 01 % was achieved at an aeration ratio of 0.

50 L/min, 15. 07 H contact clip, and 20. 0 % leachate to wastewater ratio.

3. 1. 2. Ammonia remotionLeachates with such high NH4+-N content are by and large hard of entree to conventional biological intervention procedures (Li et al. , 1999) . The being of high degrees of NH3-N in landfill leachate over a long period of clip is one of the most of import jobs faced by the landfill operators.

This high measure of unrefined NH3-N leads to cut down public presentation efficiency of biological intervention methods, accelerated eutrophication, and increased dissolved O decrease. Consequently, NH3-N is highly toxic to aquatic being (Bashir et al. , 2010) . A old survey (Li and Zhao, 1998) confirmed that the public presentation of a conventional activated sludge procedure could be significantly affected by a high concentration of NH4+-N (Li et al. , 1999) . The removal efficiency of SBR ranged from 71. 26 % (aeration rate = 0.

5 L/min, contact clip = 22 H, and leachate to wastewater ratio= 80 %) to 96. 11 % (aeration rate = 4. 0 L/min, contact clip = 12 H, leachate to wastewater ratio= 20 %) (Table 4) . This consequence is in line with determination of Aziz et Al. (2011b and degree Celsius) . In SBR, an optimal ammonium hydroxide remotion efficiency of 97. 97 % was achieved at an aeration ratio of 5. 09 L/min, 14.

15 H contact clip, and 23. 95 % leachate to wastewater ratio. The removal efficiency of PZ-SBR ranged from 79. 42 % (aeration rate = 0.

5 L/min, contact clip = 22 H, and leachate to wastewater ratio= 80 %) to 98. 27 % (aeration rate = 4. 0 L/min, contact clip = 12 H, leachate to wastewater ratio= 20 %) (Table 5) . ZELIAC can be effectual as ion money changer in ammonium hydroxide remotion because of zeolite presence in the ZELIAC complex. Ion exchange offers an alternate method in the remotion of the ammonium ion (Jorgensen and Weatherley, 2002) .

Jorgensen and Weatherley (2002) reported zeolite can be effectual in taking ammonium hydroxide from effluent. In PZ-SBR, an optimal ammonium hydroxide remotion efficiency of 98. 63 % was achieved at an aeration ratio of 2.

64 L/min, 7. 24 H contact clip, and 26. 54 % leachate to wastewater ratio. The bulk of NH3-N was removed biologically (Aziz et al.

, 2011c) . However, harmonizing to Uygur and Kargi (2004) , the add-on of PAC to trip sludge reactors enhanced nitrification efficiency in biological intervention of landfill leachate. 3. 1.

3. Colour remotionColour is a common pollutant in landfill leachate (Aziz et al. , 2011) . The decomposition of organic affair such as humic acid may do the H2O to be xanthous, brown or black.

There are several techniques used for color remotion. These include chemical precipitation, surface assimilation through farinaceous activated C, nanoi¬? ltration, ozonation, radiation, UV photolysis, chemical curdling, biological intervention with assorted additives, anaerobiotic procedure, i¬, uidized biofilm procedure, and advanced oxidization with UV/H2O (Aziz et al. , 2007) . In the current survey, lower limit and maximal coloring material remotion efficiency achieved by SBR reactors was 27. 43 % (aeration rate = 7. 50 L/min, contact clip = 2 H, leachate to wastewater ratio= 80 %) and 58. 26 % (aeration rate = 4. 0 L/min, contact clip = 12 H, leachate to wastewater ratio= 20 %) , severally (Table 4) .

In SBR, an optimal ammonium hydroxide remotion efficiency of 56. 88 % was achieved at an aeration ratio of 7. 50 L/min, 15. 29 H contact clip, and 20. 00 % leachate to wastewater ratio. Minimum and maximal coloring material remotion efficiency achieved by PZ-SBR reactors was 60. 19 % (aeration rate = 0.

50 L/min, contact clip = 22 H, leachate to wastewater ratio= 80 %) and 84. 26 % (aeration rate = 4. 0 L/min, contact clip = 12 H, leachate to wastewater ratio= 20 %) , severally (Table 5) .

In PZ-SBR, an optimal ammonium hydroxide remotion efficiency of 82. 98 % was achieved at an aeration ratio of 3. 51 L/min, 13. 71 H contact clip, and 20. 00 % leachate to wastewater ratio. Aziz et Al. (2011c) reported the consequences obtained demonstrated that the riddance of organic substances (indicated by COD and coloring material) was due to both biological and surface assimilation phenomenon (Aziz et al.

, 2011c) . Treatment of low biodegradable leachate by SBR resulted in low remotion of COD and coloring material. However, adding PAC (powdered activated carbone) to SBR well enhanced the remotion efficiency. Activated C is the most effectual adsorbent owing to its superior ability for remotion of a broad assortment of dissolved organic pollutants from effluent. The high surface country, broad scope of pore size distribution and hydrophobic surface helped activated C to adsorb organic pollutant from leachate (Aziz et al. , 2011c) . 3. 1.

4. Phenols remotionLandfill leachate contain a big figure of risky compounds, including aromatics, halogenated compounds, phenols, pesticides, heavy metals, and ammonium, which can be assumed to be risky even in little sums and their damaging effects are frequently caused by multiple and interactive effects. Particularly, phenolic compounds released into the environment are of high concern because of their possible toxicity.

These compounds found in the leachate include phenol, methyl phenols and substituted and chlorinated phenols. Phenol, methyl phenols, short-chain phenols antecedently reported in leachates of municipal and industrial landfills (Benfenati et al. , 1999) may arise from different types of wastes. Phenol and substituted phenols are common transmutation merchandises of several pesticides (Varank et al.

, 2011) . Kurata et Al. (2008) measured 41 types of phenols in three landfill sites in Japan. The consequences yielded in the present survey agree with the literature (Kurata et al. 2008 ; Aziz et Al. 2010) .

In this research, the 4-aminoantipyrine method was used to mensurate phenols by finding all ortho-substituted and meta-substituted phenols or napthols, but non para-substituted phenols. In the current survey, lower limit and maximal phenols removal efficiency achieved by SBR reactors was 13.

93 % (aeration rate = 7. 50 L/min, contact clip = 2 H, leachate to wastewater ratio= 80 %) and 33. 17 % (aeration rate = 4. 0 L/min, contact clip = 12 H, leachate to wastewater ratio= 20 %) , severally (Table 4) . In SBR, an optimal phenols removal efficiency of 34. 23 % was achieved at an aeration ratio of 3.

61 L/min, 20. 41 H contact clip, and 22. 59 % leachate to wastewater ratio. Minimum and maximal phenols removal efficiency achieved by PZ-SBR reactors was 45. 01 % (aeration rate = 0. 50 L/min, contact clip = 2 H, leachate to wastewater ratio= 80 %) and 62. 71 % (aeration rate = 0.

50 L/min, contact clip = 22 H, leachate to wastewater ratio= 20 %) , severally (Table 5) . In PZ-SBR, an optimal phenols removal efficiency of 63. 10 % was achieved at an aeration ratio of 0.

51 L/min, 21. 03 H contact clip, and 20. 01 % leachate to wastewater ratio.

3. 2. Statistical analysis and Experimental status optimisation

Central composite design and response surface methodological analysis were employed in order to exemplify the nature of the response surface in the experimental design and clarify the optimum conditions of the independent variables.

CCD was established through Design Expert Software (6. 0. 7) . Aeration rate (L/min) , contact clip (H) , and leachate to wastewater blending ration (% ; v/v) were independent factors ; to transport out an equal analysis of the aerophilic procedure, 4 dependent parametric quantities (COD, coloring material, NH3-N, and phenols) were measured as responses (Tables 4 and 5) . Table 7 shows the response values for each parametric quantity. These restraints were chosen comparatively close to the acquired maximal remotion and practicableness criterions of intervention workss. The optimisation of experimental conditions was identified by sing whether the rates of COD, coloring material, NH3-N, and phenols remotion were higher than the arbitrarily chosen restraint values.

The optimal conditions were predicted by the Design Expert Software. Harmonizing to the theoretical account, the optimized conditions occurred for the SBR reactor at the aeration rate of 4. 49 L/min, contact clip of 12. 05 H and leachate to wastewater ratio 20 % , which resulted in 55. 83 % , 45. 92 % , 98. 27 % , and 33. 56 % remotion rates for coloring material, COD, NH3-N, and phenols, severally.

The 2nd predicted optimal conditions for the PZ-SBR reactor occurred at the aeration rate of 1. 6 L/min, contact clip of 15. 43 H and leachate to wastewater ratio 20 % , which resulted in 82. 04 % , 71. 56 % , 98.

27 % , and 61. 98 % remotion rates for coloring material, COD, NH3- N, and phenols, severally.

4.

Decision

Recognition

The writers would wish to admit the University Sains Malaysia (USM) for provides of research grant to carry on this work, and their supports.