SPENT BLEACHING EARTH-BIOPROCESS (SBE) CHARACTERISTICS AGAINST INDONESIAN NATIONAL REGULATION FOR TOXIC-HAZARD WASTE AND SOIL AMENDMENT

Karakteristik Spent Bleaching Earth-Bioprocess (SBE) Berdasarkan Regulasi Nasional Indonesia Untuk Limbah B3 dan Pembenah Tanah

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Abstract

Currently, the palm oil industry disposes the Spent Bleaching Earth (SBE) to the land-field without a proper treatment process. Some peoples argue that the SBE still in high oil content and will pose an environmental problem due to hazardous content and it will easily catch fires. One possible solutions is optimizing SBE for land restoration, which could also be enhancing livelihood and reducing pollution. This paper identifies the SBE-bioprocess according to the Indonesian National Regulation for toxic-hazard waste and soil rehabilitation. SBE-bioprocess testing was conducted as toxic-hazard waste both on TCLP organic and anorganic form also as a soil amendment criteria both certain function and organic. Research shows that the SBE-bioprocess could not be categorized as toxic-hazard waste due to very low value of toxic and hazard compounds. Additional C-organic is important before using it as an organic soil amendments. Lab test shows that SBE-bioprocess is high value of CEC, then could be developed for specific function of soil amendments.

Keywords*: SBE, Waste, Soil Amendment, Indonesian Regulation*

Abstrak

Industri kelapa sawit akan membuang SBE di lapangan tanpa proses pengolahan yang tepat. Kondisi tersebut berpotensi menimbulkan masalah lingkungan karena masih mengandung minyak yang tinggi yang menyebabkan kebakaran serta beberapa senyawa berbahaya. Penggunaan limbah SBE sebagai pengganti pembenah tanah diyakini dapat meningkatkan nilai ekonomi dan mengurangi pencemaran lingkungan. Eksperimen ini bertujuan untuk mengidentifikasi kandungan SBE-bioproses berdasarkan Peraturan Nasional Indonesia sebagai limbah bahan berbahaya beracun dan pembenah tanah. Pelaksanaan analisis SBE-bioprocess dilakukan sesuai kriteria limbah beracun dan berbahaya baik TCLP organik maupun anorganik serta pembenah tanah baik organik maupun fungsi tertentu. Hasil penelitian menunjukkan SBE-bioproses tidak dapat dikategorikan sebagai limbah beracun dan berbahaya karena nilai senyawa berbahaya dan beracun yang sangat rendah. Sebagai pembenah tanah organik, bioproses SBE ini seharusnya ditingkatkan nilai C-organik karena terlalu rendah. SBE-bioproses memiliki nilai KTK yang tinggi, sehingga berpotensi untuk dikembangkan sebagai pembenah tanah fungsi tertentu.

Kata Kunci: SBE, Limbah, Pembenah Tanah, Peraturan Indonesia

1. INTRODUCTION

In general, the palm oil industry dispose of SBE in the land field without a proper treatment process. Some peoples argue that the SBE still in high oil contents and will pose an environmental problem due to hazardous content and it will easily catch fires. The SBE from oil refining process could raise the oil content to 20-40% of the mass (Loh, S. K. *et al*. 2006, Machmudah, S. *et al*, 2022). According to the Ministry of Environment and Forestry Regulation No. 101 Year 2014, this waste could be classified as an hazardous and toxic material waste. In the regulation, it is stated that hazardous and toxic materials are substances, energy, and/or because of their nature, concentration, and/or amount, either directly or indirectly, can pollute and/or damage the environment, and/or endanger the environment, health, and survival of humans and other living things (Indonesian Government, 2014).

The bleaching earth is an hydrated alumina silicate mineral, belong to a pilosilicate or layered silicate consisting of a tetrahedral network intertwined in an infinite plane to form an anion network with the chemical formula $Al_2O_3.4SiO_2.H_2O$ (Abdel Basir, S.M., *et al*. 2023). So far, SBE has been widely used as a substitute for making bricks or adobe bricks. Utilization of SBE as a substitute for soil amendments that could provide considerable added value, compared to use them as a substitute for bricks or adobe bricks (Park, E.Y. *et al*. 2004, Loh S.K. *et al*, 2013). SBE is potentially to be used as a soil amendment and is classified as a mineral similar to agricultural zeolite. Bleaching earth alone is more characteristic of increasing pH, increasing CEC, and improving soil physical properties. It is believed that using SBE waste as a substitute for soil amendments can increase economic value and reduce environmental pollution (Loh S.K. *et al*, 2013).

Soil amendments are synthetic or natural, organic or mineral substances in solid or liquid form which are capable of improving the physical, chemical, and biological properties of the soil. The main functions of soil amendments are: (1) stabilizing soil aggregates to prevent erosion and pollution, (2) changing hydrophobic and hydrophilic properties, meaning changing the capacity of soil to hold water, and (3) increasing the ability of soil to hold nutrients by increasing cation exchange capacity (CEC). The position of soil amendments from inorganic materials will enrich the position of the fixer from organic matter. The effectiveness of soil amendments from organic materials enriched with certain materials such as zeolite, dolomite, and bentonite can increase the function of soil conditioners (Dariah et al., 2007; Dariah et al. 2010). This paper identifies the SBE content based on Indonesian National Regulation for toxic-hazard waste and soil amendment and to observe the possibility of using the SBE as soil amendments.

2. LITERATURE STUDY

Palm oil refinery process that involves bleaching, filtering, and adsorbing creates Spent Bleaching Earth (SBE), abundantly. Inline with increases in palm oil production, the amount of SBE will also be increased over the year. In 2022, Indonesian palm oil production reaches 46.7 million tons, which produces the SBE more than 450 thousand tons (BPS, 2022).

Soil amendments are synthetic and/or natural, organic and/or mineral materials in solid and/or liquid form that are capable of improving the physical, chemical and/or biological properties of soil. A soil amendment formula is a composition of synthetic and/or natural organic materials, synthetic and/or natural minerals that make up a soil amendment. Soil amendment quality testing is carried out to analyze the content of the main ingredients and active ingredients and/or heavy metal elements or other elements in the soil amendment which is carried out in the laboratory in accordance with the specified quality requirements. Meanwhile, testing the effectiveness of soil amendments is a laboratory and/or greenhouse or field test activity to determine the effect of soil amendments on improving the physical and/or chemical and/or biological properties of soil and plant productivity (Ministry Agriculture Regulation No. 1 of 2019).

According to Government Regulation No. 101 of 2014, hazardous and toxic waste is the remainder of a business and/or activity which can pollute and/or damage the environment, and/or endanger the environment, health and survival of humans and other living creatures. Therefore, it is necessary to carry out a Toxic Characteristic Leaching Procedure, LD50 toxicology test, and subchronic toxicology test. TCLP is a laboratory procedure to predict the potential for hazardous and toxic material leaching from waste. The Lethal Dose-50

(LD_{50}) Toxicology Test is a biological test to measure the dose-response relationship between hazardous and toxic waste and the death of test animals which produces a 50% (fifty percent) death response in test animal population.

Waste processing aims to reduce the level of pollution, which can be done chemically, biologically and physically. Chemically by means of neutralization, precipitation, and coagulation, biologically by using microorganisms, and physically by filtration, adsorption and sedimentation (Reynolds, 1982). Kanjana *et al* (2012) stated that the use of bentonite as a soil amendment can increase cassava production. Meanwhile, Wafaa *et al* (2016) said that the use of bentonite can reduce evapotranspiration and increase crop yields on sandy soil.

3. MATERIAL AND METHOD

Material

The SBE bioproses is SBE that has undergone biological processing to reduce the oil content in it. This material was collected from plant site of PT Triputera Jaya Sentosa (TJS) that located in Kediri, East Java which is that company had collaboration with Indonesian Agricultural Environment Research Institute (IAERI) regarding this research. The sampling of SBE was following method SNI 19-0428-1998 about Guidance for Collection of Solid Sample.

Figure 1 Sample SBE.

Analysis of SBE-bioprocess Content as Toxic-Hazard Waste

Analysis of the content of SBE-bioprocess as Toxic-Hazard waste consists of analyzing the contaminant chemical compounds contained in SBE either with inorganic TCLP (Toxicity Characteristic Leaching Procedure) or organic TCLP as well as analyzing physical properties such as flash point and reactivity (SNI 8808, 2019). Analysis was conducted at Hazardous and Toxic Waste Laboratory, Ministry of Environmental and Forestry, Serpong, Tangerang. Indonesia.

Analysis of SBE-bioprocess content according to the criteria of soil amendment

Analysis of the content of SBE-bioprocess as a soil amendment was carried out using the criteria for a special function soil amendment as well as the criteria for an organic soil amendments (Balittanah, 2005). Analysis was conducted at Integrated Laboratory, Indonesia Agricultural Environmental Research Institute, Jaken, Pati, Indonesia.

4. RESULTS AND DISCUSSION

SBE-bioprocess as Toxic-Hazard Waste

The characteristics of SBE is shown in Table 1. Generally, all parameters tested were relatively low and meet the quality standard based on Government Regulation No. 101 year 2014 as toxic-hazard waste including for the characteristic test (flammable test and reactivity test), TCLP anorganic as well as TCLP organic. It happens was due to the microbiological treatment of SBE which reduces the content of toxic and dangerous chemicals that can cause disturbances in the environment. The decrease of value that occurs was below the maximum value of regulation so that it can guarantee if it is applied to the soil as a soil amendment it will not cause environmental problems.

Tabel 1 Results of Characteristic Test and TCLP of SBE.

No.	Parameter	Unit	Analysis Method	Quality Standard*		Analysis Results
				TCLP A	TCLP B	
Characteristic test						
1	Flammable Test	^oC	IK-13/B/P3KLL (Qualitatif)	-	-	Not Flammable
2	Test Reactivity	Second	IK-14/B/P3KLL (Qualitatif)	-	-	Not Reactive
TCLP Anorganic						
1	cadmium, Cd	mg/L	IK-03/B/P3KLL (AAS)	0.9	0.15	< 0.02
2	Copper, Cu	mg/L	IK-03/B/P3KLL (AAS)	60	10	< 0.03
3	Lead, Pb	mg/L	IK-03/B/P3KLL (AAS)	3	0.5	< 0.05
4	Zinc, Zn	mg/L	IK-03/B/P3KLL (AAS)	300	50	< 0.04
5	Mercury, Hg	mg/L	IK-02/B/P3KLL (Cold Vapor AAS)	0.3	0.05	< 0.0002
6	Nickel, Ni	mg/L	IK-03/B/P3KLL (AAS)	21	3.5	< 0.07
7	Silver, Ag	mg/L	IK-03/B/P3KLL (AAS)	40	5	< 0.06
8	Chromhexavalent, Cr^{+6}	mg/L	IK-03/B/P3KLL (AAS)	15	2.5	< 0.051
TCLP Organic						
1	Hexachlorobenzen	mg/L	IK-06/B/P3KLL (GC)	0.8	0.13	< 0.00003
2	γ-HCH (lindane)	mg/L	IK-06/B/P3KLL (GC)	0.6	0.1	< 0.000089
3	Heptachlor	mg/L	IK-06/B/P3KLL (GC)	0.12	0.015	< 0.00004
4	Aldrin + Dieldrin	mg/L	IK-06/B/P3KLL (GC)	0.009	0.0015	< 0.00002
5	cis-Chlordane	mg/L	IK-06/B/P3KLL (GC)	0.06	0.01	< 0.00003
6	DDT+DDD+DDE	mg/L	IK-06/B/P3KLL (GC)	0.3	0.05	< 0.00002
7	Endrine	mg/L	IK-06/B/P3KLL (GC)	0.12	0.02	< 0.00003
8	Metoxychlor	mg/L	IK-06/B/P3KLL (GC)	6	1	< 0.00003

Remarks : (-) Quality standard does not exist

(<) below of detection limit

(*) environment quality standard based on Government Regulation No. 101 Tahun 2014

Spent Bleaching Earth as special function soil amendment.

Chemical analysis of the special function of the SBE-Bioprocess is shown on Table 2. In general, the SBE-bioprocess could be categorized as a special function soil amendment that potentially increases soil cation exchange capacity (CEC) since the analysis results of the CEC as well as heavy metal content (As, Hg, Pb, Cd, Ni, and Cr) complies with Technical Quality Requirements Standards (Table 2). The decomposition process by microbes has led to an increase in the quality of SBE, both in the CEC value and a decrease in the heavy metal content in SBE itself. Increasing the CEC value means that it can increase nutrient transport in the soil if applied as a soil amendment, as well as low heavy metal content which will reduce the risk of plant poisoning and bad consequences for the environment.

Table 2 Results of the chemical analysis of the special function of the SBE-Bioprocess soil amendments.

Function	Parameter	Unit	Value	Instrument Limit Detection	*Quality Standar
I.	General Criteria Applies to All Soil Amendments				
	Heavy Metals				
	As	ppb	< LoD	*0.020*	Maximum 10
	Hg		< LoD	*0.020*	Maximum 1
	Pb	ppm	20.19	*0.0022*	Maximum 50

Function	Parameter	Unit	Value	Instrument Limit Detection	*Quality Standar
	Cd		1.63	*0.0021*	Maxmimum 2
	Ni		11.37	*0.0027*	Maximum 50
	Cr		21.96	0.0032	Maximum180
II.	SPECIAL CRITERIA REQUIREMENTS ACCORDING TO CLAIM				
	CEC	cmol(+)/Kg	95.46		Minimum 60
	Water Content	%	5.16		Maximum 10
	Fineness	%	72.45**		Minimum 90***

* Technical Quality Requirements of Agriculture Ministry Regulation No.261/KPTS/SR.310/M/4/2019

** Pass sieve 35 mesh

*** Pass sieve 48 mesh

Spent Bleaching Earth as organic soil amendment.

Analysis result of SBE-bioprocess was shows in table 3 with C-organic content, C/N ratio, and water content still below the standard requirements while pH, total and available Fe, total Zn, and heavy metals were meet with TQR criteria.

Table 3 Results of the chemical analysis of SBE-Bioprocess organic soil amendments.

Parameters		Unit	Value	*Quality Standar
pH			5.60	4-9
Water Content			5.16	8-20
C-organic		%	11.21	Minimum 15
N-Total			1.20	-
C/N Ratio			9.30	≤ 25
Fe	Total	Ppm	1379.92	Maximum 15.000
	Available		249.38	Maximum 500
Zn			51.98	Maximum 5000

* Technical Quality Requirements of Agriculture Ministry Regulation No.261/KPTS/SR.310/M/4/2019

Discussion

Testing the quality of the soil amendment is important to analyze the content of the main ingredients and active ingredients and/or heavy metal elements or other elements in the soil amendments which is carried out in the laboratory in accordance with the established quality requirements. While testing the effectiveness of soil amendments is a laboratory and/or greenhouse or field test activity to determine the effect of soil amendments on improving soil physical and/or chemical and/or biological properties and plant productivity (Indonesian Agriculture Ministry Regulation no 1 of 2019).

The value CEC of SBE-Bioprocess was 95.46 cmol(+)/Kg while the requirements based on Indonesian Ministry of Agriculture Rule No. 261 Year of 2019 is 60 cmol(+)/Kg (table 4). Surprisingly, another research showed the value CEC was only 8-39 cmol(+)/Kg (S.K. Loh, et al. 2013). The value was so high above the standard that is potential to develop as certain function soil amendments. As and Hg concentration were below the limit of detection (0.02 ppb) while the Indonesian standard was 10 and 1 ppb, it is very well condition that neglect possibility to pollute the soil and any fact that another research showed SBE can remove heavy metal (Martin and Grossmann, 2023). Pb, Cd, Cr, and Ni content in SBE-Bioprocess were 20.19, 1.63, 21.96, and 11.37 ppm while standards were 50, 2, 180, and 50 ppm respectively.

Tabel 4 Technical Requirements of Certain Function Soil Amendment.

No.	Function	Parameters	Unit	Quality Standard
I.	GENERAL CRITERIA FOR ALL SOIL AMENDMENTS TYPE			
1.		Heavy Metal :		
		As	ppm	Maximum 10
		Hg	ppm	Maximum 1
		Pb	ppm	Maximum 50
		Cd	ppm	Maximum 2
		Cr	ppm	Maximum 180
		Ni	ppm	Maximum 50
II.	CERTAIN CRITERIA BASED ON CLAIM			
2.	Enhancer of Cation Exchange Capacity (CEC) Non Zeolit Soil	● CEC	cmol(+)/Kg	Minimum 60
		● Water Content	% (w/w)	Maximum 10
		● Fineness	mesh	Following INS for zeolit
3.	Organic Soil Stabilisator	● Total of polivalen cation	%	Minimum 7
		● Water Content	% (w/w)	Maksimum 5
		● Bulk Form		
		Fineness:		
		- Pass 40 mesh	%	100
		- Pass 100 mesh	%	50
		● Granule Form		
		- 2-4.75 mm	%	Minimum 75
4.	Water Holding Capacity (WHC)			Minimum 350 times of dry weight
5.	Enhancer of Soil Carbon (*Biochar*)	Total Carbon of Grade A	%	>60
		Total Carbon of Grade B	%	30-60
		pH		7-12

*) Polivalen Cation ; Fe, Al, Cu, dan/atau Zn

Source: Indonesian Ministry of Agriculture Rule No. 261 Year of 2019

pH, water content, C-organic, Nitrogen total, and C/N ratio of SBE bioprocess were 5,6, 5,16 %, 11,21 %, 1,2%, and 9,3 while the technical requirements were 4-9, 8-20%, ≥ 15%, no standard for N total, and ≥25, respectively (Table 5). As organic soil amendments, this SBE bioprocess should increase value of C organic because it was too low. To increase the value of C organic could be added by organic material such as cattle manure, paddy straw and others while water content could be adjusted by heating process that also affected to C/N ratio value. Another research results of SBE showed that pH, C-organic and N content were lower than SBE bioprocess that were 5,05, 0,46 % and 0,08%, respectively (Cheong, K.Y. *et al.,* 2013).

Tabel 5 Technical Requirements of Organic Soil Amendment.

No	**Parameter**	**Unit**	**Quality standard**	
			Solid	**Liquid**
1	C-Organic	%	Min 15	Min 10
2	C/N		≤ 25	-
3	Water content	% (w/w)	8-20	-
4	Micronutrient: Fe Total Fe Tersedia Zn	ppm	 Max 15000 Max 500 Max 5000	 Max 15000 Max 500 Max 5000
5	pH		4-9	4-9
6	E. coli Salmonella	cfu/g atau ml, MPN/g atau ml	$<1x10^2$	$<1x10^2$
7	Heavy Metal: As Hg Pb Cd Cr	ppm	 10 1 50 2 180	 5 0,2 5 1 40

No	Parameter	Unit	Quality standard	
			Solid	Liquid
	Ni		50	10
8	Impurity material: (Plastic, glass, gravel)	%	Max 2	-
9	Another compound: Na Cl	ppm	Max 2000	Max 2000

Source: Indonesian Ministry of Agriculture Rule No. 261 Year of 2019

Hazardous and Toxic Waste is the residue of a business and/or activity containing B3 which can pollute and/or damage the environment, and/or endanger the environment, health, and the survival of humans and living things. Therefore it is necessary to carry out the Toxicity Characteristic Leaching Procedure, the LD50 toxicological test, and the subchronic toxicological test. TCLP is a laboratory procedure to predict the potential for leaching of B3 from a waste. Lethal Dose-50 Toxicology Test (LD50) is a biological test to measure the dose-response relationship between B3 waste and the death of test animals resulting in a 50% (fifty percent) death response in test animal population (Government Regulation No. 101 of 2014).

The SBE-Bioprocess has characteristics that are non-flammable and non-reactive. According to the analysis TCLP anorganic, the concentration of Cd, Cu, Pb, Zn, Hg, Ni, Ag, Cr^{6+} were < 0,02, <0,03, <0,05, <0,04, <0,0002, <0,07, <0,06, <0,051 ppm, respectively. The standard values of them are 0,15, 10, 0,5, 50, 0,05, 3,5, 5, 2,5 ppm, respectively (Table 6). According to the analysis TCLP anorganic, the concentration of Hexachlorobenzene, γ-HCH (lindan), Heptachlor, Aldrine+dieldrine, cis-Chlordane, DDT+DDD+DDE, Endrine, Metoxychlor were <0,00003, <0,000089, <0,00004, <0,00002, <0,00003, <0,00002, <0,00003, <0,00003 ppm, respectively. The standar value of them are 0,13, 0,1, 0,015, 0,0015, 0,01, 0,05, 0,02, 1 ppm, respectively (Table 6). The SBE is categorized as hazard-toxic waste group two, so it used standard TCLP-B. According to above data SBE bioprocess could not categorized as hazardous and toxic waste due to very low value of hazard dan toxic compound (Government Regulation No. 101 of 2014) .

Table 6 Standard Values for Toxic Characteristics Through TCLP and Total Concentrations for Determination of Management of Soil Contaminated with Hazardous and Toxic Wastes (Government Regulation No.101 of 2014).

Pollutants	TCLP-A	TK-A	TCLP-B	TK-B	TCLP-C	TK-C
Unit (Dry Weight)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)
Mandatory Parameter						
ANORGANIC						
Antimoni, Sb	6	300	1	75	0.4	3
Arsene, As	3	2000	0.5	500	0.2	20
Barium, Ba	210	25000	35	6250	14	160
Berilium, Be	4	4000	0.5	100	0.2	1.1
Boron, B	150	60000	25	15000	10	36
Cadmium, Cd	0.9	400	0.15	100	0.06	3
Chrom six valence, Cr^{6+}	15	2000	2.5	500	1	1
Copper, Cu	60	3000	10	750	4	30
Lead, Pb	3	6000	0.5	1500	0.2	300

Pollutants	TCLP-A	TK-A	TCLP-B	TK-B	TCLP-C	TK-C
Unit (Dry Weight)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)
Mercury, Hg	0.3	300	0.05	75	0.02	0.3
Molibdenum, Mo	21	4000	3.5	1000	1.4	40
Nickel, Ni	21	12000	3.5	3000	1.4	60
Selenium, Se	3	200	0.5	50	0.2	10
Silver, Ag	40	720	5	180	2	10
Tributyltin oxide	0.4	10	0.05	2.5	0.02	R
Zinc, Zn	300	15000	50	3750	20	120
ANION						
Chloride, Cl^-	75000	N/A	12500	N/A	5000	N/A
Cyanide (total), CN^-	21	10000	3.5	2500	1.4	50
Fluoride, F^-	450	40000	75	10000	30	450
Iodide,I^-	40	N/A	5	N/A	2	N/A
Nitrate, NO_3^-	15000	N/A	2500	N/A	1000	N/A
Nitrite, NO2-	900	N/A	150	N/A	60	N/A
ORGANIC						
Benzene	3	16	0.5	4	0.2	1
Benzo(a)pirene	0.004	20	0.0005	5	0.0002	0.6
C6-C9 petroleum hydrocarbon	N/A	2600	N/A	325	N/A	100
C10-C36 petroleum hydrocarbon	N/A	40000	N/A	5000	N/A	1000
Carbon tetrachloride	1.2	48	0.2	12	0.08	2.5
Chlorobenzene	120	4800	15	1200	6	620
Chloroform	24	960	3	240	1.2	R
2 Chlorofenol	120	4800	15	1200	2	140
Cresol (total)	800	32000	100	8000	40	R
Di (2 etylhexil) ftalat	2.4	160	0.4	40	0.16	5
1,2-Dichlorobenzene	300	24000	50	6000	20	R
1,4-Dichlorobenzene	90	640	15	160	6	R
1,2-Dichloroetane	15	48	2.5	12	1	R
1,1-Dichloroetane	12	480	3	120	1.5	R
1-2-Dichloroetane	15	960	2.5	240	1	R
Dichlorometane	6	64	1	16	0.4	R
2,4-Dichlorofenol	80	3200	10	800	4	R
2,4-Dinitrotoluene	0.52	21	0.065	5.2	0.026	R
Ethylbenzene	90	4800	15	1200	6	R
Ethylene diamine tetra acetic acid	180	4000	30	1000	12	R
Formaldehide	200	8000	25	2000	10	R
Hexachlorobutadiene	0.18	11	0.03	2.8	0.012	R
Methyl ethyl ketone	800	32000	100	8000	40	R
Nitrobenzene	8	320	1	80	0.4	R

Pollutants	TCLP-A	TK-A	TCLP-B	TK-B	TCLP-C	TK-C
Unit (Dry Weight)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)	(mg/L)	(mg/kg)
PAHs (total)	N/A	400	N/A	50	N/A	1
Phenol (total, non-halogenized)	56	2200	7	560	2.8	R
Polychlorinated biphenyls	N/A	50	N/A	2	N/A	0.02
Stirene	6	480	1	120	0.4	R
1,1,1,2-Tetrachloroetane	40	1600	4	400	0.16	R
1,1,2,2-Tetracloroetane	5.2	210	0.65	52	0.26	R
Tetrachloroetane	20	800	2.5	200	1	R
Toluene	210	12800	35	3200	14	R
Trichlorobenzene (total)	12	480	1.5	120	0.6	R
1,1,1-Trichloroetane	120	4800	15	1200	6	R
1,1,2-Trichloroetane	4.8	190	0.6	48	0.24	R
Trichloroetane	2	80	0.25	20	0.1	R
2,4,5-Trichlorofenol	1600	64000	200	16000	80	R
2,4,6-Trichlorofenol	8	320	1	80	0.4	R
Vinyl chloride	0.12	4.8	0.015	1.2	0.006	R
Xylene (total)	150	9600	25	2400	10	R
PESTICIDE						
Aldrin + dieldrin	0.009	4.8	0.0015	1.2	0.0006	R
DDT + DDD + DDE	0.3	50	0.05	50	0.02	R
2,4-D	9	480	1.5	120	0.6	R
Chlordane	0.06	16	0.01	4	0.004	R
Heptachlor	0.12	4.8	0.015	1.2	0.006	R
Lindane	0.6	48	0.1	12	0.04	R
Metoxychlor	6	480	1	120	0.4	R
Pentachlorofenol	2.7	120	0.45	30	0.18	R

5. CONCLUSION

According to the result of analysis, SBE bioprocess could not be categorized as hazardous and toxic waste due to the very low value of hazard dan toxic compounds. As organic soil amendments, this SBE bioprocess should increase value of C organic because it was too low. The SBE has high value of CEC, so it has potential to develop as certain function soil amendments.

It needs to try using SBE bioprocess or others soil amandments on massive applications to overcome soil degradation and also increase soil healthy in Indonesia so that it can increase crop production.

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