Degradation of Diethyl Phthalate and Di (2-Ethylhexyl) Phthalate Using Chemical and Microbial Methods

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ABSTRACT

Phthalates are alkyl aryl esters of 1, 2-benzene dicarboxylic acid, with a broad range of applications, especially as plasticizers. They disrupt endocrine and have recently been implicated in obesity. The chemical method for the degradation of phthalates involved the synthesis of silicon ironic hydroxide (Si-FeOOH) used in conjunction with an improvised catalytic reactor transmitting at an ultraviolet wavelength of 365 nm. 100 ppm of fungi solution (Fusarium oxysporumsp) was used with a shaking incubator in the dark for 28 hours to remediate aqueous solution containing 0.2, 0.4, 0.6, 0.8, and 1.0 mg/L of diethyl phthalate (DEP) and di (2-ethylhexyl) phthalate (DEHP). Si-FeOOH showed infrared peaks at 3310.17 cm^{-1}, 1086.66 cm^{-1} and 442.64 cm^{-1} which corresponds to O-H, Fe-O-Si and Si-O vibrational frequencies. These peaks were suggestive and confirmation of the synthesized compound. The parent phthalates showed infrared peaks for $C=O_{ester}$, $C-O_{ester}$ and $C=C_{aromatic}$ at 1728.94, 1124.78, and 1600.43cm^{-1} (DEP), and 1738.01, 1123.01, and 1600.24cm^{-1} (DEHP). However, for the degraded DEP aqueous solution and DEHP aqueous solution, the functional groups were significantly absent which were indication of complete degradation. The HPLC gave peaks at early retention time between 3.50 – 3.57 minutes for un-degraded DEP, and 2.21 - 2.23 minutes for un-degraded DEHP. However, for the degraded phthalate esters, there are no peaks at this retention times which were also suggestive of successful phthalates degradation. This showed that these chemical and microbial methods were effective in the degradation of diethyl phthalate (DEP) and di (2-ethylhexyl) phthalate (DEHP) in aqueous media.

Keywords: Diethyl phthalate; di (2-ethylhexyl) phthalate; Synthesis, Chemical and microbial degradation.

INTRODUCTION

The impact of phthalates Esters (PAEs) has received a lot of attention around the globe in the past three decades and thus has been focused on in the environmental science field in recent times[1]. Phthalates Esters (PAEs) have a broad range of applications and are widely used as plasticizer (as vinyl softener) which are predominantly used in building materials, home furnishings, transportation, clothing, and even in food and medical product packaging[2]. Phthalates are not chemically bound, but they

leach into the immediate environment from the polymers and plastic products during their usage and after disposal[3]. Even at a trace concentration, they are active in interfering with the reproductive system in humans and wildlife, through disruption of the endocrine system[4]. In recent years, phthalate esters have attracted increasing attention due to their widespread use, ubiquity in the environment, and endocrine-disrupting activity[5]. Di (2ethylhexyl) phthalate (DEHP) is one of the mostly used PAEs in the worldwide plastic industries, thus making it the most predominantly detected PAEs in environmental samples[6]. PAEs can be found in water[7], rainwater[8], soils and sediments[9], indoor air and dust[10], fish or marine foods[11], dairy products[12], human blood[13], breast milk[14] and PAEs metabolites have been detected in adult and children's urine[15, 16]. When phthalate esters (PAEs) are primarily produced and heavily used in industrial processes, their fate in the environment has been regarded as a problem[1]. PAEs are well classified and characterized in terms of toxicological manifestations, such as developmental toxicity, carcinogenicity, mutagenicity, immunotoxicity, and neurotoxicity[18]. People are exposed to phthalates through their daily contact with consumer products, food, and indoor air[19, 20]. Research has shown that phthalates level is very high in children toys which are detrimental to baby's health[21]. In recent years, the extensive use of PAEs in the environment has received much concern since they are suspected of interfering with reproductive systems and behaviour of humans and wildlife, through disturbance of the endocrine system even at very low concentration[4]. As a result, the United State Environmental Protection Agency, and similar regulatory agencies in several other countries have classified phthalate esters as top priority pollutant for risk assessment, mandating the reduction and control of PAEs pollution. Therefore the main objectives of this study is the degradation of the major and dominant PAEs (DEP and DEHP) from the aqueous using a synthesized chemical and microbial method that posed no environmental risk.

MATERIALS AND METHODS

Chemicals and reagents

All chemicals used in this study were of analytical grade, and all solvents were further purified by triple distillation. Hydrogen peroxide (30 %), Iron (III) chloride salt, Sodium silicate, Chromic acid, Distilled water, Sodium hydroxide pellets, Hydrochloric acid, Acetonitrile (HPLC grade), Tris-HCl buffer, Phthalate standards of diethyl phthalate and di(2-ethylhexyl) phthalate were obtained from Sigma Aldrich (Germany), and *Fusarium oxysporum sp* was cultured from International Institute of Tropical Agriculture (IITA), Ibadan. Nigeria.

Preparation Phthalate Esters (PAEs) standards and catalyst

Preparation of PAEs

A 1 mg portion of each phthalate esters (PAEs) standards was weighed and transferred into different 10 mL standard flask; acetonitrile was added to make it up to mark. This was used to prepare a working standard with concentration ranges from 0.2 – 1.0 ppm.

Synthesis of Si-FeOOH catalyst

1.57 g sodium silicate was added into 100 mL of 10 M sodium hydroxide solution with gentle stirring. After dissolution, 1000 ppm of $FeCl_3$ was slowly added to the mixture, and with proper mixing, a colloidal Si-Fe complex was formed. The final pH of the solution was adjusted to 7 to ascertain the completion of the reaction. Stirring continued for 2 hours, and the mixture was allowed to stand for 24 hours for settling. The clear upper layer was decanted and the colloid lower layer was centrifuged for 10 min at 2000 rpm. The colloid was washed thrice and then dried for 8 hours to give an amorphous Si-FeOOH catalyst[22].

Photo-degradation of DEP and DEHP

The experiment was carried out in an improvised photocatalytic reactor operating at a wavelength of 365 nm. DEP solutions of different concentrations; 0.2 - 1.0 ppm were prepared. DEHP solutions of different concentrations as above were also prepared in a different set of glass sample bottles. Their pH was adjusted to 7. 25, Si-FeOOH catalyst was dosed into each of the 50 mL phthalates solutions, and stirred for 20 minutes for the phthalates to be adsorbed on the surface of the catalyst. 20 mL of 0.002 M hydrogen peroxide was added to the mixture and they were all placed in the photocatalytic reactor for 1 hr. After this, each solution was filtered to remove particulates before analysis. The extent of degradation was determined using high performance liquid chromatography (HPLC) and Fourier transform Infrared spectroscopy (FTIR).

Microbial Degradation of DEP and DEHP

DEP and DEHP solutions of different concentrations; 0.2 - 1.0 ppm were prepared in a different set of glass sample bottles. Their pH was adjusted to 7. 100 ppm fungi solution was prepared with tris-HCl buffer solution, 50 mL of fungi solution was added to each of the 50 mL prepared phthalate solutions. The solutions were kept in the dark in a shaking incubator for 28 hours at 30°C and 200 rpm for degradation to occur. After incubation, each solution was filtered to remove particulates before analysis. The extent of degradation was determined using high performance liquid chromatography (HPLC) and Fourier transform Infrared spectroscopy (FTIR).

Chromatographic conditions

HPLC analysis was carried out with a CECIL CE4900 series HPLC system. The instrument was equipped with a CE4020 degasser, CE4100 binary pump, CE4300 UV detector, CECIL4600

thermostated column compartment, variable wavelength detector and a computer system. Chromatographic separation was carried out using a 150 mm × 4.6 mm with C_{18} analytical column with particle size of 5 µm. Detection of phthalate ester was done at 226 nm wavelength (Adewuyi, 2012). Chromatographic separation was performed under isocratic elution condition using acetonitrile, methanol and water (40:30:30) as mobile phase. Under these conditions, separation lasted for about 10 minutes using 1 mL/min as the flow rate. 20 µL was used as the injection volume, and column temperature was set at 30˚C. Identification of PAEs were based on their retention time.

RESULTS AND DISCUSSION

Characterization of Si-FeOOH catalyst

The amorphous silicon ironic hydroxide Si-FeOOH catalyst was characterized using Fourier Transform Infra-red spectrometer to check for the formation of Silicon Ironic (Si-Fe) complex. Amorphous ironic hydroxide (FeOOH) was prepared by mixing Iron (III) Chloride salt and sodium silicate solution. Silicon is non-toxic and can enhance the physical strength of the Ironic hydroxide thereby making the catalyst more amorphous than crystalline. Silicon was introduced in the form of SiO_2 sol as the doping agent. The sol was produced by reacting sodium silicate solution with hydrochloric acid as represented in the chemical equation below.

$$Na_2SiO_{3(aq)} + H_2O_{(l)} + HCl_{(l)} \rightarrow Si(OH)_{4(aq)} + NaCl_{(aq)} \quad (1)$$

The reaction between $Si(OH)_4$ and ironic hydroxide brings about the polymerization of silicic acid on Ironic hydroxide to form Si-Fe complexes between Silicon and Iron (Swedlund and Webster, 2009). The formation of Si-Fe complex was confirmed with the FTIR result for Si-FeOOH in Table 1. The very strong and broad absorption band of the stretching vibration of 3310.17 cm^{-1} indicated the presence of O-H and $–OH^{+2}$ in the sample. A weak and small absorption band of Si-O can be identified as the stretching vibration frequency of 442.64 cm^{-1}. Crystal waters were also present in the sample with the indication or appearance of a characteristic bending vibration of O-H of crystals at 1637.43cm^{-1}. The formation of the catalyst was also backed up with the appeared peak of 1086.66 cm^{-1} (shoulder) indicating that a characteristic stretching vibration of Fe-O-Si is present thus showing that the Na in $NaSiO_3$ has been replaced with the Fe in $FeCl_3$, therefore suggestive for the formation of the Si-Fe complex.

Table 1: Infra-Red Spectrum data for the synthesized Silicon Ironic hydroxide complex (Si-FeOOH)

Absorption Band (cm^{-1})	Corresponding Group Assignment
3310.17 (Very broad and strong)	O-H,-OH^{+2} vibration frequency
1637.43 (Sharp and strong)	O-H bending vibration of water crystal
1086.66 (Shoulder)	Fe-O-Si vibration frequency
791.79 (Shoulder)	Fe-O-H vibration frequency
442.64 (Shoulder)	Si-O vibration frequency

Photochemical degradation of diethyl phthalate (DEP) and di (2-ethylhexyl phthalate) (DEHP)

The photochemical degradation of DEP and DEHP were confirmed based on the result of the HPLC and FTIR. The peak of DEP was ascertained by preparing different concentrations and were analysed. The result obtained was tabulated (Table 2). The highest concentration (1.0 ppm) gave the highest peak of 16.6mA, and as the concentration was reducing to 0.8 ppm, 0.6 ppm, 0.4 ppm, and 0.2 ppm, the peak height was also reducing to 13.3 mA, 8.3 mA, 6.4 mA and 5.2 mA respectively. This helped in confirming the peak of diethyl phthalate on the chromatogram. Likewise, the peak of DEHP was also ascertained by preparing different concentrations for analysis. The result obtained (Table 3) showed that the highest concentration (1.0ppm) gave the highest peak and as the concentration was reducing to 0.8 ppm, 0.6 ppm, 0.4 ppm, and 0.2 ppm, the peak height was also reducing confirming the peaks of DEHP on the chromatogram. The analysis of un-degraded (standard) DEP solution of different concentration: 0.2 ppm and 1.0 ppm, using HPLC, their peaks were seen at 4mins 06secs and 3mins 57secs respectively, but when the degraded DEP solutions of different concentrations (0.2 ppm and 1.0 ppm) were injected for an analysis time of 10 min, no peaks were seen. Also, the analysis of un-degraded (standard) DEHP phthalate solution of different concentration: 0.2 ppm and 1.0 ppm, using HPLC, they gave peaks at 2 mins 21 secs and 2 mins 23 secs respectively, but when the degraded DEHP solutions of different concentrations (0.2 ppm and 1.0 ppm) were injected for an analysis time of 10 mins, no peaks were seen. Thus, confirming a successful chemical degradation of the phthalate esters.

Table 2: Values for a retention time of diethyl phthalate (DEP) standard solution at different concentrations

DEP Concentrations (ppm)	Retention time	Peak height
0.2	3mins 57secs	5.2 mA
0.4	3mins 55secs	6.4 mA
0.6	3mins 56secs	8.3 mA
0.8	3mins 50secs	13.3 mA
1.0	3mins 57secs	16.6 mA

Table 3: Values for retention time of di (2-diethylhexyl) phthalate (DEHP) standard solution at different concentrations

DEHP Concentrations (ppm)	Retention time	Peak height
0.2	2 mins 21secs	0.3 mA
0.4	2 mins 22secs	0.4 mA
0.6	2 mins 21secs	0.7 mA
0.8	2 mins 21secs	1.0 mA
1.0	2 mins 23secs	1.4 mA

Table 4: Infra-Red Spectrum data for the standard solution of di (2-ethylhexyl) phthalate (DEP)

Absorption band (cm^{-1}) DEHP	Corresponding group assignment
1600.24 (Sharp)	C=C $_{aromatic}$ vibration frequency
1040.04 (Sharp)	C-C $_{aliphatic}$ vibration frequency
1738.01 (Sharp and strong)	C=O_{ester}vibration frequency
1123.01 (Sharp)	C-O_{ester}vibration frequency
3070.98 (Sharp)	C-H $_{aromatic}$ vibration frequency
2959.27 (very sharp)	C-H $_{alkane}$ vibration frequency

Table 5: Infra-Red Spectrum data for the standard solution of diethyl phthalate (DEHP)

Absorption band (cm-1) DEP	Corresponding group assignment
1600.43 (Sharp)	C=C $_{aromatic}$ vibration frequency
1017.41 (Sharp)	C-C $_{aliphatic}$ vibration frequency
1728.94 (Sharp and strong)	C=O $_{ester}$ vibration frequency
1124.78 (Sharp)	C-O_{ester} vibration frequency
3072.10 (Sharp)	C-H $_{aromatic}$ vibration frequency
2983.89 (very sharp)	C-H $_{alkane}$ vibration frequency

Table 6: Infra-Red Spectrum data for the product of photochemical degradation of diethyl phthalate and di(2-ethylhexyl) phthalate

Phthalate esters	Concentration (ppm)	Corresponding group assignment	Absorption band
Diethyl phthalate	0.2	O-H vibration frequency	3436.08 (Broad)
		C-C vibration frequency	1634.55 (Sharp)
Diethyl phthalate	1.0	O-H vibration frequency	3435.95 (Broad)
		C-C vibration frequency	1634.54 (Sharp)
Di (2-ethylhexyl) phthalate	0.2	O-H vibration frequency	3468.25 (Broad)
		C-C vibration frequency	1636.41 (Sharp)
Di (2-ethylhexyl) phthalate	1.0	O-H vibration frequency	3436.23 (Broad)
		C-C vibration frequency	1636.90 (Sharp)

Table 7: Infra-Red Spectrum data for the product of microbial degradation of diethyl phthalate and di (2-ethylhexyl) phthalate

Phthalate Esters	Concentration (Ppm)	Corresponding Group Assignment	Absorption Band
Diethyl phthalate	0.2	O-H vibration frequency	3436.17 (Broad)
		C-C vibration frequency	1637.09 (Sharp)
Diethyl phthalate	1.0	O-H vibration frequency	3436.27 (Broad)
		C-C vibration frequency	1637.09 (Sharp)
Di (2-ethylhexyl) phthalate	0.2	O-H vibration frequency	3436.19 (Broad)
		C-C vibration frequency	1636.27 (Sharp)
Di (2-ethylhexyl) phthalate	1.0	O-H vibration frequency	3448.58 (Broad)
		C-C vibration frequency	1637.21 (Sharp)

Also, the standard phthalate esters were analyzed using an Infra-red spectrophotometer. Table 4 showed the results of the IR spectrum of standard solution of DEHP. The very strong and sharp absorption band of the stretching vibration of 1738.01 cm^{-1} indicated the presence of C=O of an ester, a sharp absorption band of C=C of an aromatic compound was identified as the stretching vibration frequency of 1600.24 cm^{-1}, and the appeared peak of 1040.04 cm^{-1} (sharp)

indicated a characteristic stretching vibration frequency of C-C. The very sharp absorption band of C-O of an ester can be identified as the stretching vibration frequency of 1123.01 cm^{-1}. Likewise, the sharp absorption band of the stretching vibration of 3070.98 cm^{-1} indicated the presence of C-H of an aromatic compound while C-H of an alkane stretching vibration frequency was identified at 2959.27 cm^{-1} (very sharp). All these functional groups were suggestive of the presence of di (2-ethylhexyl) phthalate. Table 5 showed the result of IR spectrum of standard solution of DEP. The very strong and sharp absorption band of the stretching vibration of 1728.94 cm^{-1} indicated the presence of C=O of an ester, a sharp absorption band of C=C of an aromatic compound was identified as the stretching vibration frequency of 1600.43 cm^{-1} and the appeared peak of 1017.41 cm^{-1} (sharp) indicated a characteristics stretching vibration frequency of C-C. The very sharp absorption band of C-O of an ester can be identified as the stretching vibration frequency of 1124.78 cm^{-1}. The sharp absorption band of the stretching vibration of 3072.10 cm^{-1} indicated the presence of C-H of an aromatic compound while C-H of an alkane stretching vibration frequency was identified at 2983.89 cm^{-1} (very sharp). All these functional groups were suggestive of the presence of diethyl phthalate. The degraded phthalate esters were analysed with the Infra-red spectrophotometer to confirm the degradation of phthalate esters in aqueous solution. Table 6 showed the infra-red spectra data for the chemical degradation of the phthalates. 0.2 ppm of remediated diethyl phthalate showed peaks at 1634.55 cm^{-1} (sharp) which corresponds to C=C of an aliphatic and 3436.08 cm^{-1} (broad) corresponding to O-H vibrational frequency. 1.0 ppm of remediated diethyl phthalate also showed a peak at 1634.54 cm^{-1} (sharp) which correspond to C=C aliphatic and 3435.95 cm^{-1}correspondings to O-H vibrational frequency. 0.2 ppm of remediated di(2-ethylhexyl) phthalate showed peaks at 1639.90 cm^{-1} (sharp) which corresponds to C=C of an aliphatic and 3468.25 and 3400.67 cm^{-1} (broad) corresponding to O-H vibrational frequency. 1.0 ppm of remediated di(2-ethylhexyl) phthalate also showed peaks at 1636.90 cm^{-1} (sharp) which correspond to C=C aliphatic and 3436.23 cm^{-1} corresponding to O-H vibrational frequency. From the results of the Infra-red spectrum data, it has been evident that the functional group present in both diethyl phthalate and di (2-ethylhexyl) phthalate ($C=O_{ester}$, $C-O_{ester}$, $C-H_{aromatic}$, $C=C_{aromatic}$, $C-H_{aromatic}$) have all disappeared during the degradation, thus confirming the active chemical degradation of the phthalate esters (PAEs). This explains further that the Fenton reaction involving a catalyst Si-FeOOH with hydrogen peroxide under UV 365 nm irradiation

was 99 % effective in the degradation of phthalate esters. The degradation is due to the presence of hydroxyl radical (·OH) that is generated sequel to the decomposition of hydrogen peroxide on the surface of Si-FeOOH under UV 365 nm irradiation as explained[22]. The reaction processes are as follows:

$$Fe^{III}OH + H_2O_2 \rightarrow Fe^{III}OOH + H_2O \quad (2)$$

$$Fe^{III}OOH + hv\ (UV\ 365\ nm) \rightarrow Fe^{III}O + OH^{\cdot} \quad (3)$$

$$Fe^{III}O + H_2O \rightarrow Fe^{III}OH + OH^{\cdot} \quad (4)$$

$$DEP + OH^{\cdot} \rightarrow intermediate\ products\ or\ CO_2 + H_2O \quad (5)$$

$$DEHP + OH^{\cdot} \rightarrow intermediate\ products\ or\ CO_2 + H_2O \quad (6)$$

The pH adjustment of the phthalate esters (PAEs) solutions to pH 7 also increases the rate of adsorption of the phthalate esters on the surface of the catalyst, thus facilitating the degradation. It was reported that the adsorption rate of the phthalate on catalysts increases with increased pH until around 8, where adsorption decreases with pH[22]. This shows that as the pH increases, phthalates are with negative charge due to the effect of electron-donating groups and the surface of Si-FeOOH are positively charged when pH< 8.4, which would be favour to adsorption of phthalates and on the contrary, when pH > 8.4, the negative charges on the Si-FeOOH surfaces were not favoured to adsorption. This, therefore, shows that this method can be used in the degradation of phthalates in water bodies (neutral conditions), which is more feasible due to no pretreatment demanded as the pH of natural water is usually between 6 and 8.

Microbial degradation

The degradation of aryl alkyl phthalates using fungi has been less studied than bacterial degradation. The degradation ability of fungi is very wide, and this is due to the high activities of their extracellular ligninolytic enzymes, such as laccase, lignin peroxidase and manganese-dependent peroxidase. Plant pathogenic fungi produce an extracellular degradative enzyme that play an essential role in pathogenesis. They include cutinase, which hydrolyses to cutin, facilitating fungus penetration through the cuticle. A cutinase is an enzyme that catalyses the chemical reaction by acting on the carboxylic ester bonds present in phthalate esters thus reducing their toxicity and converting the phthalates to intermediate products or carbon dioxide and water. This enzyme belongs to the family of hydrolases, therefore, the systematic name of this enzyme class is cutin hydroxylase[23].

The standard phthalate esters were analyses using an Infra-red spectrophotometer. Table 4 showed the result of the FTIR spectrum of DEHP standard solution and Table 5 showed the result of FTIR spectrum of DEP standard solution. All these functional groups in the spectra were suggestive of the presence of the phthalates. Table 7 showed the infra-red spectra data for the microbial remediation. 0.2 ppm of remediated diethyl phthalate showed peaks at 1637.01 cm^{-1} (sharp) which corresponds to C=C of an aliphatic and 3436.17 cm^{-1} (broad) corresponding to O-H vibrational frequency. 1.0 ppm of remediated diethyl phthalate also showed peaks at 1637.09 cm^{-1} (sharp) which correspond to C = C aliphatic and 3436.27 cm^{-1} corresponding to O-H vibrational frequency. 0.2 ppm of remediated di(2-ethylhexyl) phthalate showed peaks at 1636.27 cm^{-1} (sharp) which corresponds to C=C of an aliphatic and 3436.19 cm^{-1} (broad) corresponding to O-H vibrational frequency. A 1.0 ppm of remediated di(2-ethylhexyl) phthalate also showed peaks at 1637.21 cm^{-1} (sharp) which correspond to C = C aliphatic and 3448.58 cm^{-1}[1]correspondings to O-H vibrational frequency. From the results of the Infra-red spectra data, it has been evident that the functional group present in both diethyl phthalate and di (2-ethylhexyl) phthalate ($C=O_{ester}$, $C-O_{ester}$, $C-H_{aromatic}$, $C=C_{aromatic}$, $C-H_{aromatic}$) have all disappeared during the degradation, thus confirming the active degradation of the phthalate esters.

The results from the high-performance liquid chromatography showed chromatogram of the remediated 0.2 ppm and 1.0 ppm of diethyl phthalate and 0.2 ppm and 1.0 ppm of di (2-ethylhexyl) phthalate showed no peaks at the expected retention time for both phthalate esters, which further confirms the effective degradation of the phthalate esters. Although we used relatively high concentrations of 100 ppm fungi solution considering natural circumstances, the fungal cutinase from *Fusarium oxysporum. sp* showed superior specific activity in the hydrolysis of DEP and DEHP. Based on the result of the chromatogram of high-performance liquid chromatography and the spectra of the Infra-red spectroscopy, 99 % degradation was achieved for DEP and DEHP. The effective fungal degradation is similar to findings by[24] degrading butyl benzyl phthalate (BBP). In the case of BBP, fungal cutinase (10 mg protein/L) from *Fusarium oxysporum sp* degraded almost 60 % of the initial BBP (500 mg/L) within 7 hours 30 mins. [25]also were successful in the biodegradation of diethyl phthalates, dimethyl phthalates and benzyl butyl phthalates using white rot fungi isolated in Korea.

CONCLUSION

There was a successful synthesis of the amorphous Si-FeOOH by the doping of silicon (in the form of Sol) to the Ironic hydroxide (FeOOH) through a retarding transformation of

crystalline structure. Its physical strength has been dramatically increased with the addition of the silicon. The synthesized new catalyst has shown a high catalytic activity by degrading 99 % of the diethyl phthalate and di (2-ethylhexyl) phthalate at a pH of 7 with the use of 25 mg dosage of Si-FeOOH, and 2 mmol/L of H_2O_2 in an improvised catalytic reactor operating at 365 nm wavelength for 60 min. The pH of the solution being monitored and adjusted to 7 also helps the degradation of the diethyl phthalate and di (2-ethylhexyl) phthalate. Also, *Fusarium oxysporum sp* solution (100 ppm) prepared with a Tris-HCl buffer (10 mM, pH 8) showed degradative properties, by releasing its enzyme called cutinase to make the remediation of the diethyl phthalate and di(2-ethyl hexyl) phthalate to be very effective. 99 % degradation was achieved with the use of *Fusarium oxysporum sp*. The chemical and the microbial methods have therefore been successful in the degradation of diethyl phthalate and di (2-ethylhexyl) phthalate in aqueous solution.

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