собівартість сортування, рециклінгу, утилізації, знешкодження, захоронення ТПВ.

Це оцінювання можна виконати, користуючись теоремою Байєса [3], яка дозволяє визначити імовірність того, що прийнята гіпотеза розподілу випадкових величин відповідає дійсності, якщо є лише непрямі підтвердження *(дані)*, які не є вичерпними (непредставницькі вибірки) й можуть бути неточними, як це й має місто під час моніторингу генерування ТПВ. Отриману за формулою Байєса імовірність можна при цьому далі уточнювати, приймаючи до уваги дані нових спостережень $a_i \le b_i \le c_i \le d_i$. Формула Байєса має наступний вигляд:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)},$$

де $P(A)$ — апріорна імовірність гіпотези A (тобто гіпотези функції розподілу тієї чи іншої лінгвістичної змінної);

$P(A|B)$ — імовірність гіпотези A за умов здійснення події B (тобто визначення реального розподілу) - апостеріорна імовірність;

$P(B \mid A)$ — імовірність здійснення події B за умов істинності гіпотези A;

$P(B)$ — імовірність здійснення події B.

Важливим наслідком теореми Байєса є формула повної імовірності події, яка залежить від декількох несумісних гіпотез:

$$P(B) = \sum_{i=1}^{N} P(A_i) P(B|A_i).$$

Тут імовірність здійснення події B, залежить від декількох гіпотез A_i, якщо відомі ступені достовірності цих гіпотез (наприклад, отримані експериментальні дані), причому за робочу гіпотезу варто прийняти $P(B_k)$, яка задовольняє умові

$$P(B_k) = \max \{P(A_1)P(B|A_1), P(A_2)P(B|A_2), \ldots, P(A_N)P(B|A_N)\}.$$

Висновки. Використання наведеного підходу разом з визначенням достовірних меж, в яких можуть знаходитися відповідні оцінки тих чи інших параметрів, дозволяє забезпечити оптимальний менеджмент у сфері поводження з ТПВ.

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THE INTEGRATED METHOD OF LANDFILL LEACHATE PRETREATMENT

Introduction

In Poland every year about 14 mlns ton of municipal waste are generated. More then 90% is deposited on landfills. Leachate is generated as consequence of rainwater percolation through wastes, chemical-biological process in waste and the inherent water content of wastes themselves [Afshin Maleki, 2009; Rivas et al. 2004]. The characteristics of the landfill leachate can usually be represented by the basic parameters COD, BOD, the ratio BOD/COD, pH, suspened solids(SS), ammonium nitrogen, ($N\text{-}NH_3$), total Kjeldal nitrogen (TKN) and heavy metal [Renou, 2008]. The leachate composition from different landfills, show a wide variations. There are many factors affecting the quality of leachates: i.e. age, precipitation, seasonal weather variation, waste type and composition. Depending on rainfall conditions, the colour of leachate varies from black to brown. A brownish colour in the leachate is generated by dissolved organic materials such as humic substances [Kurniawan, 2006].

The discharge of landfill leachate can lead to serious environmental problems, since the leachate contains a large amount of organic matter (both biodegradable and non-biodegradable carbon), ammonia –nitrogen, heavy metals, chlorinated organic and inorganic salts [Tatsi, 2003; Uygur, 2004]. Although some of these pollutants can be degraded by microorganisms, only limited removal of bio-refractory organic pollutants can be achieved. Therefore, alternative technologies based on physical-chemical stages are required.

Thus, the treatment processes used for landfill leachates often involve a combination of apprioprate techniques. They are designed as modular , multistage units, according to leachate characteristics. Well known processes drawn from wastewater technology have been applied for the treatment of landfill leachates, such as anaerobic and /or aerobic biological degradation, chemical oxidation, coagulation –precipitation, activated carbon adsorption, photo-oxidation and membrane processes [Tatsi, 2003; Trebouet, 2001; Wang, 2002;Calli, 2005].

Several authors [Maleki, 2009; Silva, 2004; Amokrane, 1997] suggest, that coagulation and flocculation is a relatively simple technique that may be employed successfully in treating old landfill leachates. Aluminum sulfate , ferrous sulfate, ferric chloride, were commonly used as coagulants. Iron salts were proved to be more sufficient than aluminum ones.

As a new processes applied to landfill leachates treatment, the use of membrane techniques are suggested, like microfiltration [Piatkiewicz, 2001], ultrafiltration [Syzdek, 1984; Van Dijk, 1997; Bohdziewicz, 2001], nanofiltration [Peters,1998; Trebouet, 2001], and reverse osmosis [Linde, 1995; Bilstad, 1992].

Several hybrid processes such as activated sludge –ultrafiltration-chemical oxidation and acvtivated sludge—ultrafiltration-reverse osmosis have been tested [Renou, 2008]. Combined methods like stripping, Fenton, SBR and coagulation are found as highly effective [Guo 2010].

Suitable treatment strategy depends on major criteria: the initial leachate quality and the final requirements given by local discharge water standards.

Chemical oxidation is a widely studied method for the treatment of effluents containing refractory compounds such as landfill leachate. Growing interest has been recently focused on advanced oxidation process (AOP). Sometimes, when conventional methods fail they are the only effective methods of removing toxic or even carcinogenic organic substances resistant to biodegradation. AOP methods consist in the generation of highly reactive hydroxyl radical (• OH). For this purpose various combinations of hydrogen peroxide, ozone, UV radiation, ultrasound and catalysts, for example TiO_2, Fe^{2+}, Fe^{3+} are applied. The resulting hydroxyl radical has the highest oxidation potential of 2.75 V and acts selectively on the majority of organic compounds. One of the methods of advanced oxidation is the Fenton reaction in which a mixture of iron (II) and hydrogen peroxide is used to generate hydroxyl radicals. Hydroxyl radicals are formed in the Fenton process as it is shown in the following equation:

$$\mathbf{Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + \bullet OH + OH^-}$$

During the Fenton reaction the iron (III) precipitating in the form of colloidal ferric hydroxide (III) is formed in addition to hydroxyl radical. The Fenton reaction enables to lead the processes of oxidation and wastewater coagulation parallely. The effect of Fenton's reagent oxidation is highly dependent on pH solution and the ratio of H_2O_2 : $Fe^{2+.}$ The optimal pH values are between pH 3 and 4, while the weight ratio of iron (II) to hydrogen peroxide is 1 : 5 [Świderska, 2007]. In order to improve the efficiency of coagulation of contaminants the ashes obtained from municipal heat- power plant were used.

2. Materials and methods

The process of pretreatment was conducted in six solutions of landfill leachate of COD_{KMnO4}=2400 gO_2/m^3. The leachate samples were taken. on 5 July 2010 from a lechate tank located in the municipal landfill in Promnik. Samples were collected in plastic bottles and transported to the laboratory and stored in 4°C. Leachates had strong black color, the specific smell of petroleum substances and pH = 7.81.

The test was conducted at pH = 3 (concentration correction H_2SO_4) for different doses of iron (50 and 100 g Fe/m^3) and for two ratios of Fe^{2+} : H_2O_2 (1:5 i 1:10) at 20 ° C ± 1 ° C. After 4 hours of oxidation on Conbest JLT6 device (fig.1) Samples were neutralized to pH 7.0 by $Ca(OH)_2$. To carry out the flocculation the samples of FA/m3 0-2000 g were mixed for 30 minutes with the ashes collected from Kielce Power Plant and then subjected to a 30-minute sedimentation.

After removal of the suspension by filtration through a filter of = 0.45 µm the colour of leachate was tested by optical method using SPECOL and COD was determined by permanganate method.

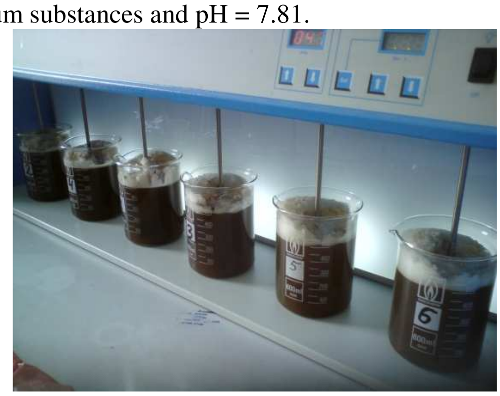

Fig.1 The test stand for the oxidation and coagulation of leachate from the landfill in Promnik

Table 1. Results of AOP oxidation of leachates from a landfill in Promnik

L_p	Designation	Unit	Raw leachate	Coagulant dose					
1.	-	gFe/m^3	0	50	50	100	100	100	100
				Hydrogen peroxide dose					
2.	-	gH_2O_2/m^3	0	500	500	500	1000	1000	1000
				Ash dose					
3.	-	gFA/m^3	0	0	200	200	400	800	2000
4.	pH	-	7.81	3.0	3.0	3.0	3.0	3.0	3.0
5.	Colour	gPt/m^3	1500	320	230	230	280	300	500
6.	% of colour reduction	%	0	79	85	85	81	80	67
7.	Permanganate index	gO_2/m^3	2400	125	120	120	160	400	450
8.	% of COD_{KMno4} removal	%	0	94	95	95	93	83	81

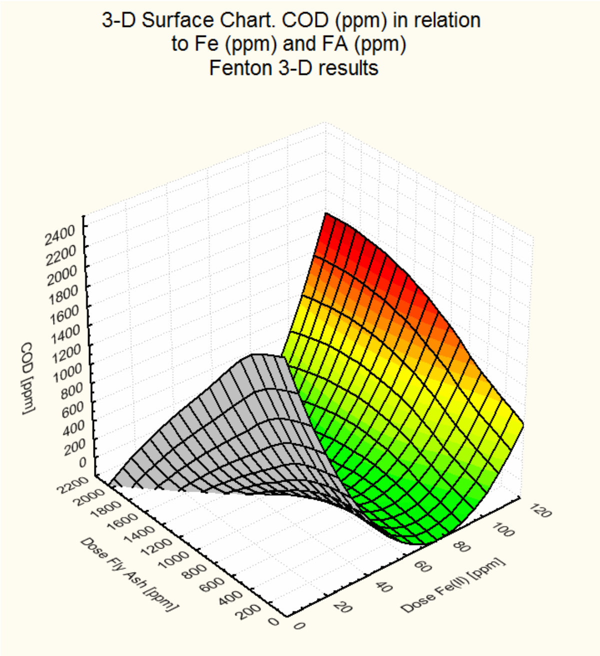

Fig. 2. The dependence of COD of treated leachates versus Fe(II) and FA dose

Results

The results show that oxidation by the Fenton's reagent is an effective pretreatment method for landfill leachate (Table 1). In all cases, the colour was reduced by approximately 80%. The exception was the dose of 100 Fe^{2+}/m^3 with a ratio of iron to hydrogen peroxide 1:10 and ash content gFA/m^3 . The resulting percentage of colour reduction was 67%.

In addition, in hydrogen peroxide dose of 500 gH_2O_2/m^3 approximately 94% of COD removal for different doses of iron and /or ash (Fig. 2) was observed. Tests have shown that satisfactory results were obtained even for a dose of iron of 50 gFe/m^3 (94.8%), and therefore, there is no need to increase the dose. However, at the ratio Fe^{2+} : H_2O_2 = 1:5 the dose of 100 g Fe^{2+}/m^3 allows 85% reduction in colour. At a ratio of Fe^{2+}: H_2O_2 = 1:10 the greatest efficiency was obtained for a 200 gFA/m^3 dose of ash .

Summary

Advanced oxidation processes enable mineralization of refractory organic compounds, which are not readily biodegradable, harmful to humans and the environment, to carbon dioxide and water. In the case of incomplete decomposition of organic compounds, the resulting forms have a simpler structure and lower molecular weight, and thus are easily assimilated by microorganisms in the biological processes of water and wastewater treatment or better absorbed on activated carbon. The addition of ashes (0.2%₀) during flocculation is beneficial for the efficiency of the removal of color and COD from landfill leachate. This refers to a weight of 0.2 kg of ashes for 1 m^3 of landfill leachate.

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THE RESULTS OF MONITORING A CULTIVATED LANDFILL AFTER AN ECOLOGICAL DISASTER

Introduction

The changes undergoing in the waste disposal site justify treating it as a gigantic „bioreactor" with the processes aimed at the stabilization of the weight of the disposed waste [3,9]. Decomposition products include solid, liquid and gaseous substances, most of which may pose threat for the environment. Chemical changes taking place in the disposal site comprise processes like hydrolysis, chemical weathering, precipitation, sorption, desorption and ion exchange [1,2]. Biological processes in the waste disposal site occur in stages, each of them requiring its own environment and substrata and resulting in characteristic final products. The key issue to be considered during the exploitation of waste management establishments is their proper location and operation [7], as well as the monitoring of the processes taking place in the three phases: the pre-exploitation phase, the exploitation phase and the post-exploitation phase for thirty years from its closing. The scope of the tested parameters and their frequency resulting from the appropriate binding regulations are presented in table 1.

Table 1. The scope of the tested parameters and their frequency in accordance with the "Environmental Ministry Regulation on the scope, time, manner, and conditions for monitoring landfills (Journal of Laws from 2002, No 220 item 1858 as amended)

No.	Measured parameter	Frequency of measurements		
		The pre-exploitation phase	The exploitation phase	The post-exploitation phase
1	The rate of the surface waters flow	one-time	every three months	every six months
2	The surface waters composition	one-time	every three months	every six months
3	The leachate waters volume	none	every month	every six months
4	The leachate waters composition	none	every three months	every six months
5	The underground waters level	one-time	every three months	every six months
6	The underground waters composition	one-time	every three months	every six months
7	The landfill gas emission	none	every month	every six months
8	The composition of the landfill gas	none	every month	every six months
9	The efficiency of the landfill gas draining system	none	none	every twelve months

The paper presents the results of selected monitoring tests performed for the landfill after the ecological disaster: electrical conductivity and Total Organic Carbon. The results of the tests conducted on the samples taken in the measuring points : Z1 - the reservoir of the leachate waters and C2 on the Lubrzanka watercourse flowing in the area affected by the landfill.

THE ISSUE CHARACTERISTICS

In the central part of Świętokrzyskie Province (southern Poland) there is a closed domestic waste disposal site which provided services for the agglomeration of Kielce. This landfill is located in the exhausted mineral working where quartzites had formerly been excavated. This location was exceptionally inappropriate and led to an ecological disaster. The exhausted mineral working had an area of 2.2 ha and had a shape of a basin filled with water. In 1972 waste started to be disposed of, directly into the water stagnating in the basin. The base had not been properly protected