

16. Tatsi A.A., A.I., Zouboulis, K.A., Matis and P. Samara, 2003, Coagulation flocculation pretreatment of sanitary landfill leachates, *Chemosphere*, 53: 737-744.
17. Trebouet, D. J.P. Schlumpf, P. Jaouen and F.Quemeneur, 2001, Stabilized landfill leachate treatment by combined physicochemical –nanofiltration processes, *Water Research*, 35(12): 2935-2942.
18. Uygur , A. And F. Kargi, 2004, Biological nutrient removal from pre-treated landfill leachate in a sequencing batch reactor. *Journal of Environmental Management*, 71: 9-14.
19. Van Dijk, L., G.C.G. Roncken, 1997, Membrane bioreactors for wastewater treatment : the state of the art and new developments, *Water Sci. Technol.*, 35: 35-41
20. Wang, Z.P., Z.Zhang, Y.J.Lin, N.S.Deng, T.Tao and K.Zhuo, 2002, Landfill leachate treatment by a coagulation – photooxidation process, *Journal of Hazardous material*, 95(1/2): 153-159.

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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

and the daily amount of the dry waste was over 1000 m³. Until 1978 also liquid waste was disposed of in the landfill, as well as post-neutralization slime from the Automotive Plant. The waste included i.a. effluents containing cyanides, chloramines as well as acid and alkaline waste containing sulphuric acid, phosphoric acid, hydrochloric acid, boric acid, and the waste resulting from the processes of steel blackening and tempering.

As a result of the improper location of the facility, as well as the lack of necessary technical protections, hazardous substances permeated deep into the ground, which led to the pollution of underground waters and soils in the surroundings of the working. As the landfill bowl was filling up, an increasing volume of leachate waters drained from the landfill, badly poisoning plants on an adjacent slope. The extent to which the forest got destroyed can be compared to that caused by the most troublesome chemical industry plants [8].

In 1978 the recultivation of the facility started. Consequently, year by year, the negative impact of the topical landfill on the natural environment decreases [4].

The recultivation works covered the area of the landfill and its surroundings on the west side. The works comprised:

- constructing a watertight clay barrier in the front edge of the landfill in order to minimize the seepage of leachate waters into the valley of the nearby river Lubrzanka,
- profiling the waste deposit with the slope app.10% to the west ,
- building a leachate drainage system from the western part of the landfill and directing the waters to a reinforced concrete tank (Z1) with the volume of 21 m³,
- conducting passive degasification of the landfill bowl through a network of gravel-filled trenches, with an outlet to six reinforced-concrete degasification wells,
- building a sealing layer for a side slope and the landfill bowl from clay with the thickness of 30-40 cm,
- recreating a soil-forming layer with the thickness of 20 cm, using fertile ground on which lupine was planted,
- building surrounding collector trenches to direct rainwater and meltwater to the Lubrzanka river
- In order to drain the degraded area, in the years 1990-1992 lateral drains were constructed below the landfill, to direct the polluted groundwater to the lower tank (Z2) with the capacity of 27 m³.

MONITORING RESULTS

In 1978 first tests aimed at investigating the effect of leachate waters on the purity of the Lubrzanka river were conducted. Samples were taken four times within fifteen months. The leachate waters were investigated in twelve points, along the whole length of the trench, starting at the edge of the landfill bowl and going as far as the outlet into the Lubrzanka river. The leachate waters flowing out of the waste disposal site showed very high level of chemical pollution increasing with time, and in the case of some parametres exceeding the standard for sewage introduced into the sewage system . The destruction of the greenery around the landfill was documented in scientific literature as a classical example of ecological disaster [8].

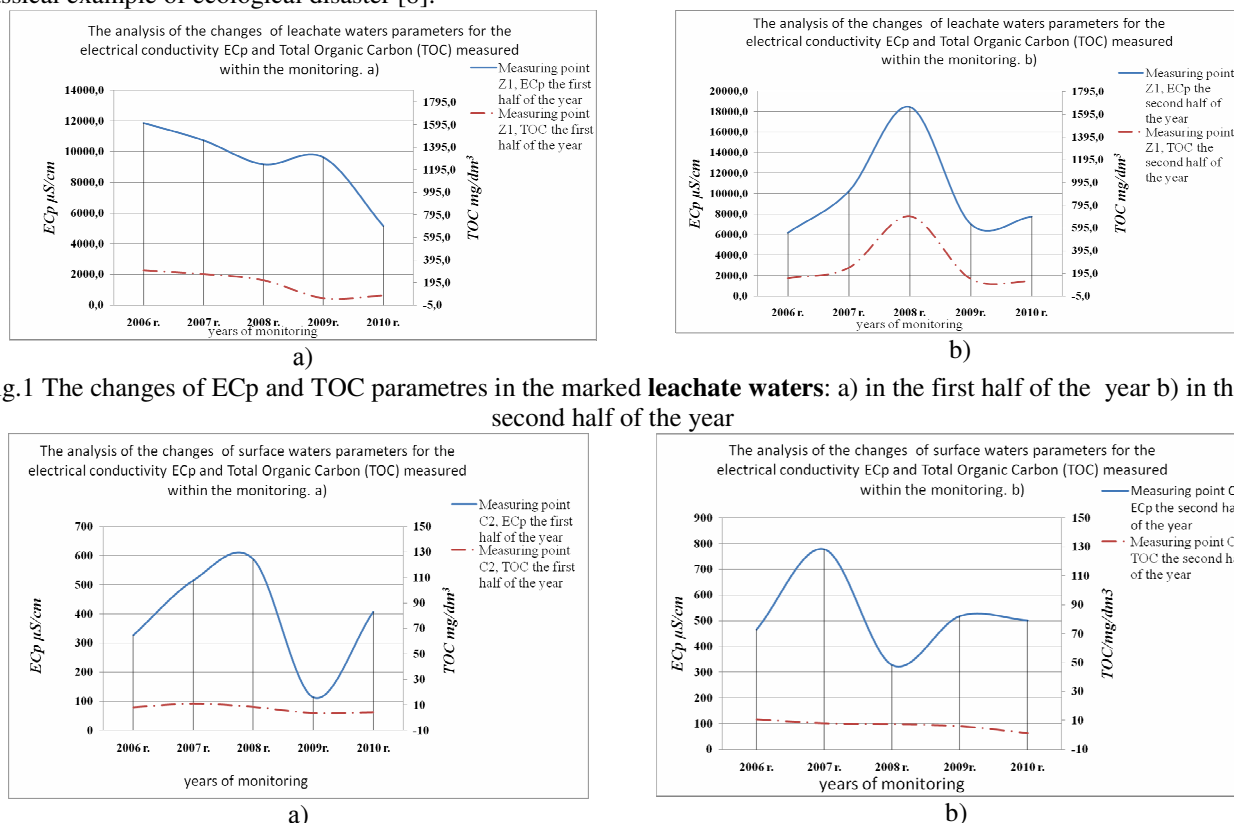
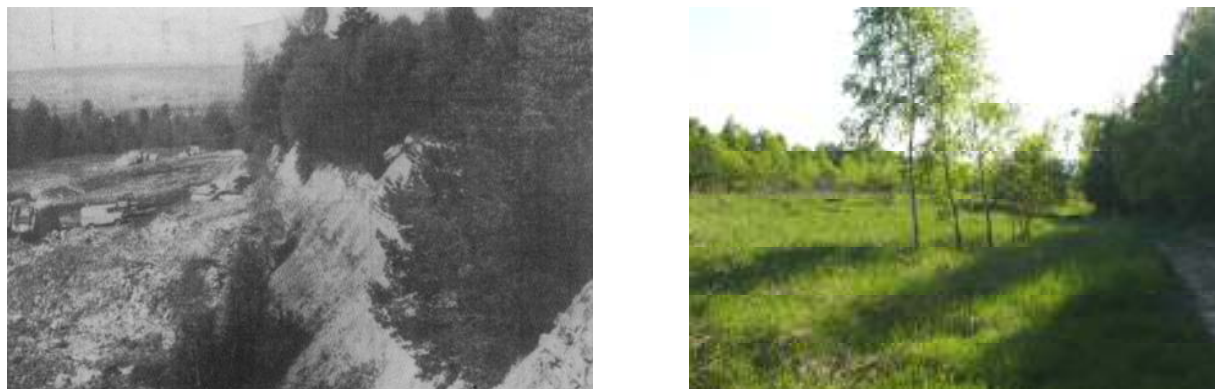


Fig.2. The changes of ECp and TOC parametres in the marked **surface waters**: a) in the first half of the year b) in the second half of the year.

After the landfill had been closed, the recultivation works were performed. The monitoring research is conducted in accordance with the binding regulations in the area of the exhausted waste disposal site in Barcza and comprises the monitoring of: surface waters, underground waters, leachate waters and measuring the landfill gas. The results obtained for the years 2006-2010 for selected parameters of leachate and surface waters are presented in Fig.1 and 2.

The results of testing leachates (Fig.1) and surface waters (Fig.2) are different in the first and the second half of the year, which is connected with the amount of atmospheric rainfall, and consequently the emission of pollutants in leachates. A positive sign of the environmental restoration is that the pollution level in leachates and surface waters shows the tendency of decreasing. Changes in the condition of plants that are growing again confirm the improvement in the state of the environment. The tree crop that used to be destroyed is gradually restoring itself.



Pic. 1. The waste disposal site in Barcza during the exploitation and after its recultivation (the present state)

CONCLUSION

The analysis of the results of the monitoring tests conducted for the waste disposal site in Barcza shows that the technical works performed within the environment recultivation contribute to the decrease of its negative impact on the environment. The surface water in the area of the landfill (the Lubrzanka River) falls within the first class of purity, according to the current regulations [6]. The leachate waters do not exceed the highest admissible values of the sewage parameters [5] except for the total organic carbon concentration. With years one may notice that the negative impact of the topical landfill on the natural environment is decreasing. In the area of the landfill the greenery is starting to grow again.

REFERENCES

1. Debra R. Reinhard and A. Basel Al-Yousfi, (1996); The impact of leachate recirculation on municipal solid waste landfill operating characteristics. *Waste Management & Research* 14, 337-346.
2. McBean E.A, Rovers F.A., Farquhar G.J., (1995); *Solid waste landfill engineering and design*, Prentice Hall PTR, New Jersey.
3. Mostafa Waritch, (2002), Bioreactor landfills: experimental and field results, *Waste Management* 22, 7-17.
4. Przedsiębiorstwo Geologiczne Sp. z o.o, 2010: *Sprawozdanie roczne z lokalnego monitoringu przeprowadzanego w 2009 r. w rejonie składowiska odpadów w Barczy, gmina Zagnańsk*.
5. Rozporządzenie Ministra Środowiska z dnia 24 lipca 2006 r. w sprawie warunków, jakie należy spełnić przy wprowadzaniu ścieków do wód lub ziemi, oraz w sprawie substancji szczególnie szkodliwych dla środowiska wodnego (Dz. U. z 2006, Nr 137 poz. 984 ze zm.).
6. Rozporządzenie Ministra Środowiska z dnia 20 sierpnia 2008 r. w sprawie sposobu klasyfikacji stanu jednolitych części wód powierzchniowych (Dz. U. z 2008, Nr 162 poz. 1008).
7. Rozporządzenie Ministra Środowiska z dnia 24 marca 2003 r. w sprawie szczegółowych wymagań dotyczących lokalizacji, budowy, eksploatacji i zamknięcia, jakim powinny odpowiadać poszczególne typy składowisk odpadów (Dz. U. Nr 61, poz. 549 ze zm.).
8. Wasiak G., (1983): *Gospodarka odpadami komunalnymi w środowisku przyrodniczym* (Municipal waste management in natural environment), Warszawa 1983.
9. Xian Qu, Pin-Jing He, Li-Ming Shao, Duu-Jong Lee, (2008), Heavy metals mobility in full-scale bioreactor landfill: Initial stage, *Chemosphere* 70, 769 – 777.

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ДЕЯКІ ПЕРСПЕКТИВНІ НАПРЯМКИ ПОВОДЖЕННЯ З ТЕХНОГЕННИМИ ВІДХОДАМИ

На шлях загальносвітової практики законодавчого врегулювання відносин у сфері поводження з відходами Україна стала з прийняттям 5 березня 1998 року Закону «Про відходи», який розглядає основні принципи і напрямки державної політики, поводження з відходами всіх рівнів виконавчої влади, повноваження органів