METEOROLOGICAL AND HUMAN FACTORS INFLUENCE ON LEACHATE DYNAMICS

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Abstract

The more urbanized society is, the larger the volumes of waste generated, and more problems are associated with their management. The aim of this article is to analyze Jarubaičiai landfill leachate generated content and dynamics of the factors causing this problem. This article analyzes Jerubaičiai landfill leachate resulting from the dynamics of the exchange of meteorological conditions and therefore increasing the amount of waste. This study was carried out from 05/15/2008 to 12/31/2008. The reference periods covers all seasons and are representative of Sightseeing meteorological conditions. Throughout the year, 6500 m^3 leachate is formed at the Jerubaičiai landfill. The study found that during the year the amount of waste was 1050 tons of waste per weak. The landfill is covered by approximately. When the average air temperature is about - 10 °C, the leachate recycled content ranges from 40 to 140 m^3. At the average temperature of 0 °C the leachate recycled content ranges from 250 - 270 m^3 of leachate. During winter when the temperatures are below 0°C, 250-270 m^3 of leachate transpires through the pile of waste. In summer, the total amount of precipitation was 52%, and the amount of leachatee setting-up to only 23% of the total filtrate. Correlation between air temperature and leechate r=0,784. It shows that air temperature strongly affects the amount of extracted filtrate. It was concluded that when the amount of waste in landfill increases, the amount of leachate discharged also increases at r = 0.641.

Keywords: Waste, leechate, waste management

Introduction:

Human activities are inevitably associated with the generation of waste. The more urbanized society is, the larger the volumes of waste generated, and more problems are associated with their management. Landfill leachate, is problem of growing generation at cities and relevant environmental problem. Landfill leachate is characterized by high BOD_5, it is also have a big concentration of heavy metals and organic compounds (Kaunelienė and Gelažienė, 2002). Landfill leachate collection and treatment at Lithuania and the EU is pressing problem because of treatments prices, technology, and the most appropriate site selection. Leachate ie full of the chemical composition of various landfill wastes varies depending on waste age, the degree of compression, waste type, and landfill shape and height of the average the air and slag temperature, precipitation, humidity (Barber and Maris 1984, Crawford and Smith, 1985).

According to Jeskelevičius and Lynikienė (2009) on the landfill volume occurring physical, chemical and biological reactions occur both in the landfill gas is also harmful to the leachate. Because of the lack of supervision and control - landfills with household waste within industrial, biodegradable or even hazardous waste leachate observed a large quantity of toxic compounds, and maximum steady groundwater pollution sources. Especially for those of landfill sites who have not necessary protective measures. Here the most important ground water chemical composition of the formation factor is the leachate (Williams, 2005). Our

conditions of high concentrations of chemical components in the leachate can form more than 20-30 years after the closure of landfills and liquid pollutant pathways to 1.5-2.0 km from the site (Williams, 2005). Crawford and Smith (1985) found that the seasonal and climatic features have a direct impact on leachate composition and key environmental factors inducing the biological decomposition of landfill waste is considered the temperature and humidity. The optimum moisture content of the landfill should be approximately 40%. The moisture content of less than 40 % is identified as a factor would reduce the biological activity of the heap and is therefore observed BOD_5 concentrations were decreased (Hamoda et al., 1998; Renou et al., 2008). Frank and others (2002) suggest that the ambient temperature has a similar effect on leachate migration, since most of the landfill bacteria are anaerobic, they preferred a constant temperature between 20 and 40 ° C and the seasonal change in temperature can reduce the biological activity of waste degradation and therefore may reduce leachate release (Crawford & Smith, 1985; Hamoda et al,. 1998). Leachate release to the environment is influenced by many cases. They change the concentrations and emission levels. This study aims to determine the meteorological conditions and volume of waste impact the landfill leachate dynamics.

Methodology

The leachate sampling was performed in a landfill leachate storage reservoir of municipal solid waste landfill in Plunges district. The landfill is 0.8 kilometers away from Plunge-Medingenai road. This landfill is the only one left in the Telsiai district. It serves Plunge, Rietavas, Mazeikiai, Telsiai regions. Currently, there are six sections for the waste to be accumulated. The waste, when it comes at the landfill, is accumulated in sections. When the waste is decomposing, the leachate forms which are gathered by the leachate-drain systems collected underneath the pile of waste. The leachate gathered later gets into the storage reservoir. From here it often is pumped up into the leachate cleaning equipment. The cleaning of the leachate happens in reverse of the osmosis after which forms the condensate and water. The condensate formed is returned back to the top of the pile of waste, and the already clear leachate, like water, is let out to the bio storage reservoirs, from which later gets into the nearby canal Fig. 1. Throughout the year, 6500 m^3 leachate is formed at the Jerubaičiai landfill.

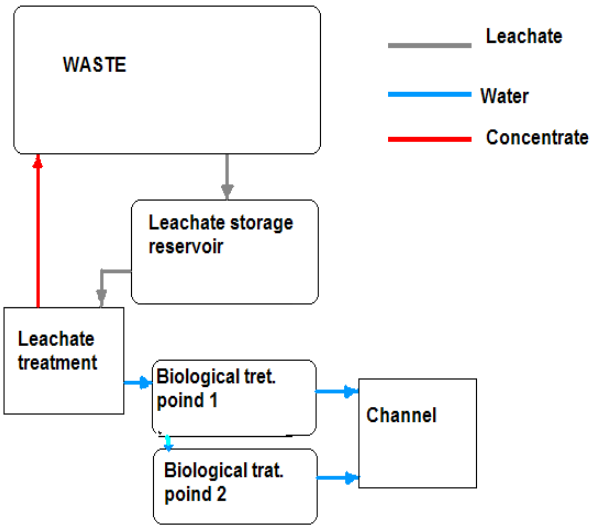

Fig. 1. Filtrate cleaning chart of the Jerubaičiai landfill

The leachate from the leachate storage reservoir is served in the ring whirl in which when a certain amount of HCl is added, the filtrate reaches the necessary ph 6.5. The leachate is mixed and circulated by the vacuums in leachate storage reservoir, until it reaches the necessary ph level. From the ring whirl the leachate is sent by the vacuum through a re-

filtering system, which consists of sand and special cassette filters. The reverse osmosis principle applies in all of leachate's processing equipment stages. If half conductive membrane, which allows through only a certain size particles, divides two sodium solutions or contaminated liquids, the concentration then equalizes. In the reverse osmosis modules the process takes part when the filtrate moves through the membrane's surface. Unclean leachate's concentration is slowly increases when the water runs through the module. The waste is filtered through and is left behind the membrane. So called "concentrate" is taken out. The strained clean water flows into the water reservoir.***The ascertainment of the amount of cleaned filtrate.*** There is a mounted meter put in order to observe this process. ***Waste excess formation and the calculation of the trash brought into the landfill.*** The scales are used in order to determine the amount of waste brought in. Data alteration of meteorological changes at the Jerubaiciai landfill was determined according to the Telšiai district meteorological center's observation journal.

Results and their discussion

The analysis of the dynamics of the environmental temperature's data. When establishing the effect of the meteorological conditions to the leachate, it is necessary to study their dynamics during that period. The data is received from the meteorological stations' database. The average weather temperature dynamics was fixated every Monday and Thursday at 7 o'clock in the morning. The final results can be seen below (Fig. 2).

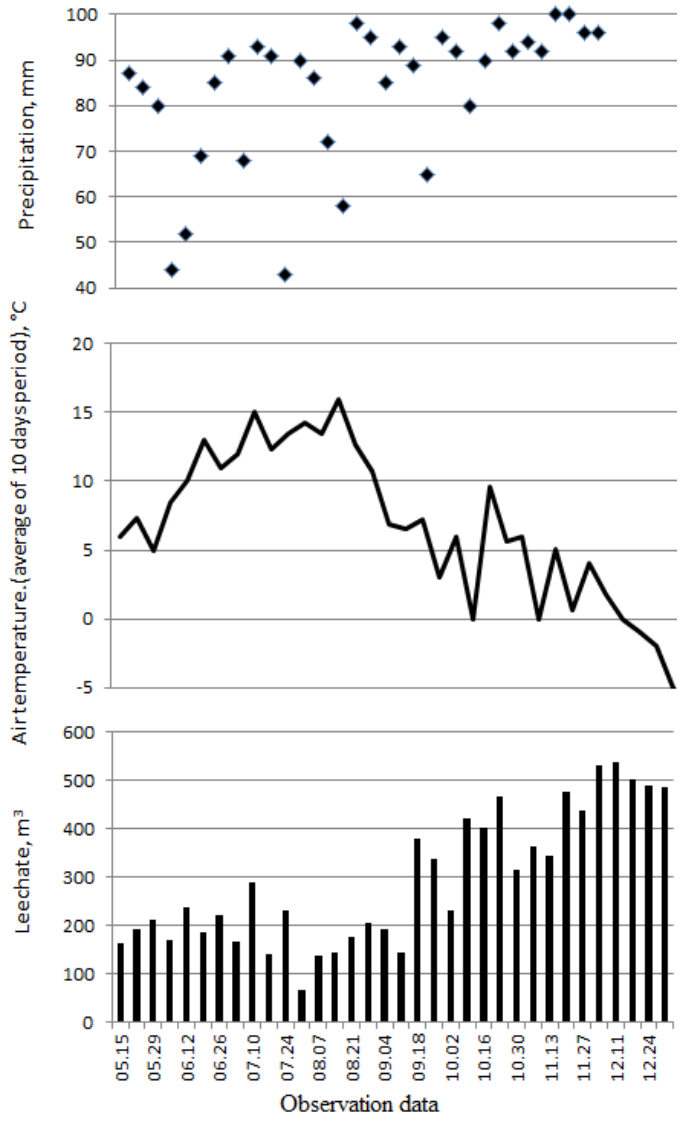

Fig. 2. The dynamics of the climatic conditions at research period

This data is compared within itself. During warm period from 2008 May 15 until 2008 September 15 when the temperature is 10°C at 7 o'clock in the morning the cleaned leachate dimension is fluctuating from 40 to 140 m^3. When the temperature decreases, the level of the cleaned leachate begins to increase. During winter when the temperatures are below 0°C, 250-270 m^3 of leachate transpires through the pile of waste. From this graph (fig. 2) is seen that cooler weather affects the increase in the amount of leachate.

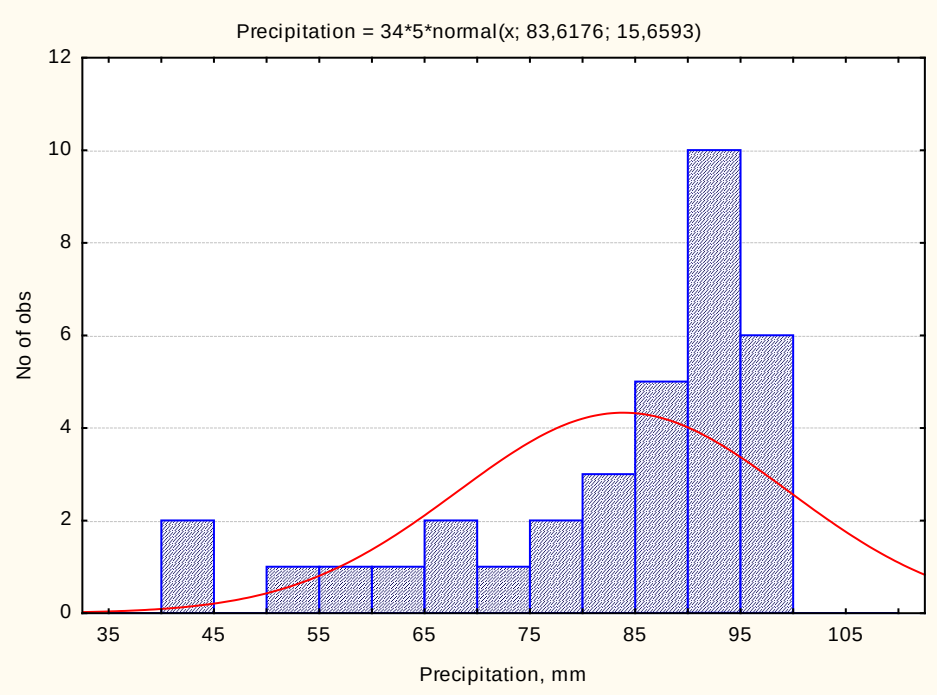

Fig. 3. Precipitation histogram of observation period and density function

Correlation between air temperature and leechate r=0,784. It shows that air temperature strongly affects the amount of extracted filtrate. More statistical data are presented at table1.

Table 1. Statistical data of research results

	Valid, N	Mean	Min	Max	Stand. Dev	Standart. eror	T- value	df	CORRELATION	Leechate	Temperature	Precipitation
Leechate	34	29,42	66	537,0	138,58	23,76	12,37	33		1	-0,78	0,45
Tepperature	34	6,90	-5	15,9	5,47	0,93	7,355	33		0,78	1	-0,43
Precipitation	34	83,17	43	100	15,65	2,68	31,13	33		0,45	0,43	1

Influence of precipitation for the formation of the filtrate. In the landfill, the leachate forms when the precipitation and water from the melting snow filtrates through the waste. Leachate is one of the main environmental problems associated with the clearing of the landfill because it has toxins such as organic materials, heavy metals and mineral oils which could harm water quality both underground and on the surface (Amokrante, 1997). According to the schedule of the amount of precipitation, the changeable dynamics of precipitation is being fixed. During warm periods most precipitation falls between the months of June and July-80-93 mm, and least-only 38 mm in May. In October there can also be seen clear increase in precipitation - 81 mm. When analyzing data from 2008 (Fig. 3.), it can be seen that most precipitation fell during the months of June and July. When observing the dynamic of amount of leachate. It is seen that during the research period the amount of leachate

decreases. Heat extracts in the pile of waste during the process of disintegration. There is around 60 °C temperature 3 meters deep underground independently from the season of the year. It allows us to come up to a conclusion that precipitation in the summer evaporates and therefore the amounts of leachate are lower. In the fall there is higher amount of leachate extracted. That means that smaller amounts of precipitation is evaporated. The most leachate is extracted in winter, when the amount of precipitation is lower. This data differs from the average amount of precipitation in Lithuania. They are registered in Plunge district where climate is more humid.The relative air humidity is directly dependent from the amount of precipitation. During warm periods, from 2008 May 15 to 2008 September 15, the relative air humidity is lower and less leachate is formed in the landfill. The relative air humidity minimums were registered four times during the research period that is May 3-18, July 24-30 and August 24-31. The relative air humidity stays high at the end of fall and all winter long because humidity does not evaporate as quickly during lower temperatures. If we would analyze the amount of materials dissolved in the leachate during that time, we would see that it increased during the chosen period. From this we could make a presumption that if air's relative humidity is lower, the amount of materials dissolved in the leachate, which ends up in the mechanisms of the reverse osmosis, is higher. During the period when the relative air humidity is lowest, and when the amount of materials dissolved in it is higher, more concentrate is formed at the time of leachate's cleaning. The leachate is sent to the cleaning installation at the same diversion rate of 3200l/h. Because the system cleans itself automatically each 120 hr, the work of the installation can be kept steady. The decrease of the amount of runoff water is observed at the end of July. This decrease of the cleaned leachate was influenced by the existing high temperatures and low level of precipitation. The amount of the runoff water reaches 100-200 m^3 during the months of July-August. Constant increase from 200-450 m^3 per week is seen in autumn months, when the temperature decreases and the relative humidity is higher. A slight dependency was determined when analyzing the influence of air humidity to the contamination of filtrate. Correlation coefficient is r=0.473. However, not a strong dependency was determined between air humidity and the amount of filtrate.

Leachate cleaning data. The landfill serves Telšiai county citizens and factories which have decreased their production levels. Such dynamics of the amount of waste influences the amount of particles dissolved in the leachate which is registered by the distinct electrical measuring instrument. Measurements were started in the middle of May and at that time the measuring instrument showed around 630 S/cm. Much higher meanings are registered during the summer months. The biggest registered meaning is July 27, even 1008 S/cm. Such a high increase in the amount of particles may have been caused by the constant high temperatures and low level of precipitation. During the existing high temperatures, the reactions in the pile of waste become more active.

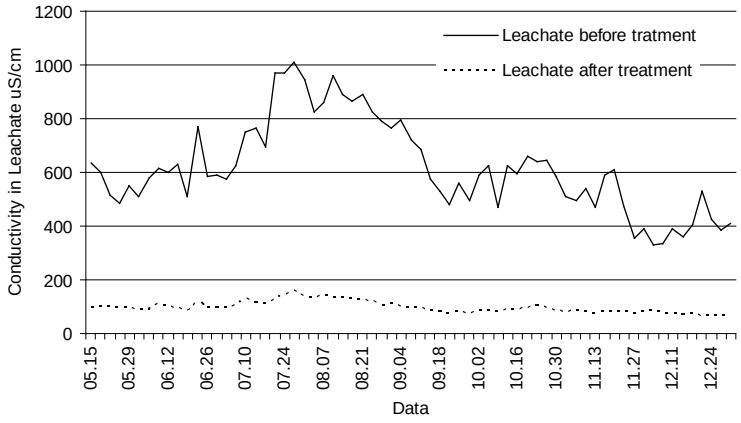

Fig. 4. The dynamics of the leachate conductivity before and after cleaning

When further observing changes it was determined that when the summer season ends and temperatures drop, the amount of dissolved particles decreases. In the beginning of the fall the amount of dissolved particles in the leachate is from 500-650 S/cm. Such numbers stay throughout almost all fall. The changes in them are noticed at the end of fall when air temperature drops below 0°C. During that period the amount of dissolved materials is lower than 400 S/cm. During steady temperature our received meanings also slightly fluctuate. When noticing even the smallest change in temperature, the leachate is also seen as changing. When analyzing cleaned leachate's conductivity we can see (Fig. 4.) that the received results are also not steady. In May it is around 90-100 S/cm and stays as such until the summer. From the earlier discussed graph we already know that in summer during the increase in temperature the leachate got into our previously discussed leachate cleaning installations in which the amount of dissolved particles was higher. So when observing already cleaned leachate we can see that the contamination level is increasing, and the biggest meaning is noticed on July 27, and that is 160 S/cm. The leachate's average conductivity in summertime is registered at around 110-140 S/cm. The amount of dissolved materials decreases only when the fall comes. We also registered that throughout almost all fall the changes stay still, at 70-90 S/cm. The only increase is registered in the middle of October. The already cleaned leachate data schedule seems to follow the schedule of the cleaning of leachate. From this we can conclude that there is a direct dependency between both data. Such effect could have been influenced by the changes in air temperature. When there is a higher level of contamination of leachate, which is affected by the higher temperatures, the efficiency of the filtration increases. When processing the data statistically, we determined that the average meaning of the conductivity in the leachate before cleaning is 725 S/cm, standard error -154, after the cleaning the average meaning-112 S/cm, standard error-19,5.

The analysis of the amount of waste delivered. The amount of waste in the landfill is always changing. Such instability is affected by the inconsistent use of consumption. This also depends on the season of the year and State holidays. As seen in the fig 8, the amount of waste brought in constantly increases. Currently, around 1050 tons of waste per week gets into the landfill. Fig 8. shows until July the amount of waste brought in was from 850-950 tons per week. From July 1, 2008 Jerubaiciai landfill became the only household waste type of landfill working in Telsiai district. An increase from 950 to1050 t of waste per week has already been noticed. At the end of December the amount of waste is registered at the increase of 1130 t. This was due to Christmas period when the consumption increases. Comparing the dynamics of the amount of waste brought in to the landfill with the dynamics of the formed filtrate, it was determined that there is a tendency for increase (fig. 5).

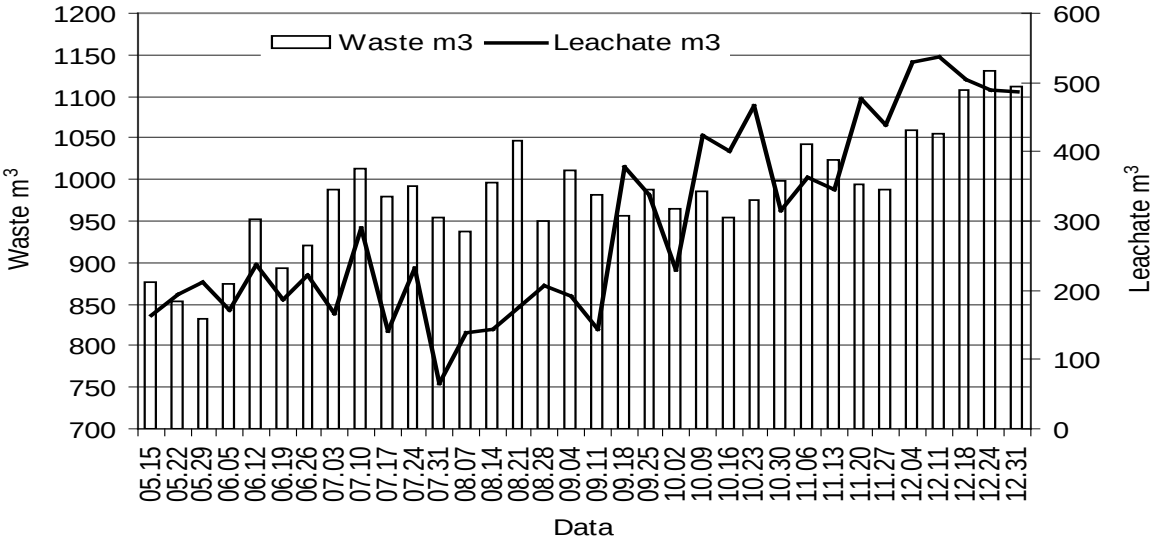

Fig. 5. Ddynamics' of the amount of waste brought in to the landfill

Waste brought in to the landfill often times is already rotten and its disintegration has already begun. Therefore, when the waste gets into the pile of the existing waste, the extraction of leachate intensifies. After the analysis of the statistical data, it can be seen from Fig. 5 that when the amount of waste brought in to the landfill increases, the amount of leachate formed in the landfill also increases. These increases are dependent from one another. The data has been amended during the existing reliability level p=0.0001, also 34 measuring data was examined, and it was determined that the standard error between measurements of the amount of filtrate is 138.5, and between dynamics of the amount of waste brought in is 69.2. When analyzing the increase in the amount of waste and the dynamics of the leachate extracted, it was determined that this data is dependent from one another (Cureton et. All., 1991). The dependency was determined during the existing level of reliability p=0.0001. The average of 294 m^3 of leachate is extracted and 982 t of waste is brought into the landfill during the week. The average strength correlation is determined between them, and that is r=0,641. It allows us to form a conclusion that when the amount of waste increases, the amount of filtrate also increases.

Conclusion:

Meteorological conditions affect the dynamics of the leachate in landfills. During the day's higher average temperatures the amount of leachate decreases, and during lower temperatures-increases. During lower relative air humidity less leachate is formed, and when the humidity increases, the amount of leachate increases. When the average air temperature drops below 10 °C, the amount of leachate increases. A strong correlated dependency has been determined between air temperature and the amount of leachate extracted.

During research most levels of precipitation have been registered in the months of June-July, but there was no increase in the amount of leachate. Precipitation from the summer evaporates from the pile of waste and does not get into the system of leachate gathering.

When the relative air humidity decreases, higher amounts of dissolved materials are registered, that is, the concentration of leachate pollution increases because less leachate is formed.

The amount of leachate depends on the amount of waste brought in to the landfill. When the amount of waste increases, the amount of leachate proportionally increases as well. The dependency has been determined between the increase in the amount of waste in the pile and the extracted leachate. Regression coefficient is R=0,41. It shows that when we pour waste into piles, we will need to take care of the large amounts of leachate that forms.

The filtrate is cleaned better when filtrate's conductivity is bigger and when the average air temperatures are higher.

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