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AIR QUALITY MONITORING AT THE REGIONAL LANDFILL SITE BANJA LUKA

Abstract: *Solid waste production has been evident since the earliest periods of human existence. It is a direct product of man's life and work as the product of his individual existence or in a frame of rural or urban area. The production of waste involves those activities when materials get into the state of losing their usability value so they are collected for disposal on the specific place.*

During the process of waste disposal there are possible negative impacts on the environment, so called ecological accidents such as dump site fires, possibility of soil and watercourses contamination, even the pollution of underground waters in the case of inadequate treatment of waste water, wind-blown litter, bad odor and smoke, uncontrolled gaseous emission in the concentration which is dangerous for biodiversity of fauna and flora and human health, and contamination with dust and other small particles. In order to assess the immediate impact of the landfill on the environment, among other facts it is necessary to be familiar with the composition of disposed waste. The purpose of this paper is to determine the air quality at the site of the regional landfill Banja Luka during the year

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2013. Air quality measurement was carried out once a month in the interval of 24 hours at two locations. The emission concentration of the following pollutants was measured; sulfur dioxide, nitrogen dioxide, nitric monoxide, nitric oxide, carbon dioxide, ozone, total suspended particles, total hydrocarbons, methane and non-methane hydrocarbons. The measured concentrations of the monitored pollutants are compared with the legislatively prescribed limit values from the Rulebook on air quality limit value.

Key words: *air quality, landfill, pollutant*

JEL Classification: *Q01, Q51, Q53*

INTRODUCTION

Production of waste materials includes those activities in which materials get into the state when they do not have any usability value so they are thrown away or collected for disposal.

In the average developed country one person produces 1 kilogram of solid waste per day, and in more developed country this amount is even higher. The main component of municipal waste is mostly household waste, which is daily produced in the residential parts. Most of it is organic waste, such as food waste-food scraps and green waste such as grass and leaves; the most important characteristic of the organic waste is that it decomposes rapidly and easily, and spreads bad odor.

The other component of household waste is inorganic waste, which can be combustible (cardboard, paper, plastic, textiles, rubber, leather, furniture) and noncombustible (glass, metal cans, house appliances) etc. The commercial waste is also a component of municipal waste. The composition of this waste is similar to the household waste. The part of industrial waste, precisely unhazardous is also a part of municipal waste. That is the waste from the food industry, textile industry, different wood and metal objects, blast furnaces slug, and scrap metal and so on. A type of waste which is similar to household waste. Non-hazardous medical waste is also part of the municipal waste. That is the waste generated in health care facilities

without pathogenic, infectious, radioactive and chemical characteristics, and which is not of a shape that can cause some mechanical injuries. Municipal waste is also the waste derived from street cleaning, green waste generated in parks, gardens and alleys. It is organic waste (leaves, branches, grass, food waste, dead animals) and partially inorganic waste (paper, cigarette packages, and other smaller packaging). The other types of waste are not the part of the municipal waste and according to the legislative regulations for the waste management cannot be mixed and require special treatment. This is especially important for hazardous waste.

Waste management presents the problem we face daily. Waste management presents the activities of removing the waste from the environment and preventing its negative impacts on environment and human health. Waste management is the priority issue when it comes to environmental protection. It is one of the most demanding tasks to ensure the compliance with the European Union (EU) standards. Solving this problem and orientation towards modern waste management is one of the preconditions for joining the EU.

There are many different methods of waste treatment: collection, sorting, recycling, deposition etc. The most common treatment is disposing waste in the landfills. It has been the oldest, simplest and most common method of organized waste disposal. Landfill is a specifically designed facility where the controlled waste disposal of solid waste municipal material is done. The landfill for solid waste has its waste body- contains firmly combusted waste, bottom liner- impermeable soil, natural or artificial, and top layer- made with the final lay over and other facilities. Late and inadequate waste treatment and the inadequate neutralization of its negative effects may cause the harmful effects on the environment. Recent European and world integrations request the fulfillment of the certain norms and regulations which modern landfill should have. That mostly refers to sanitary landfills.

The aim of this paper is to determine the air quality at the site of the regional landfill Banja Luka during the year 2013 n. Regarding the research topic the paper should check and confirm the null hypothesis. The null hypothesis of the research is that during the waste disposal of municipal waste in

the regional landfill Banja Luka, there is no larger emission of pollutants into the air at the monitored site, and that they do not have any harmful impact on air quality. Air quality monitoring was performed once a month in the interval of 24 hours at two locations. The emission concentrations of the following pollutants were measured; sulfur dioxide, nitrogen dioxide, nitric monoxide, nitric oxide, carbon dioxide, ozone, total suspended particles, total hydrocarbons, methane and non-methane hydrocarbons. The measured concentrations of the monitored pollutants are compared with the legislatively declared limit values from the Rulebook on air quality limit values.

1. MATERIALS AND WORK METHODS

The site of the regional landfill Banja Luka with its all natural elements is under the influence of anthropogenic degradation. The current degradation is reflected in air pollution, surface and groundwater pollution and soil pollution. The environmental pollution and the problems which appear are mostly connected with air pollution. Emissions, from the landfill Banja Luka, get into the air during the processes of waste transport, its storage and disposal, during the covering of the top layer, and during decomposing of disposed waste.

Landfill gases are the result of many chemical, biological, physical and other reactions, which are the result of the organic waste in aerobic and anaerobic conditions. Landfill gases direction and the intensity of their moving through layers of waste and soil is very complex. Gas follows the path of least resistance in order to leave the waste body. With the increase of the waste volume in height, the horizontal stream of gas gets more intensive. The amount of gas which is produced in the landfill depends on the quantity, type, and the age of the disposed waste, the time of disposal, method of maintaining the landfill, and meteorological conditions at the site. There is no pattern which could precisely determine the amount of gas. Based on the collected data we can conclude that the highest amounts of the landfill gas are emitted during the first fifteen years of the landfill exploitation, maximum values are recorded in second and third year. After

this period the production of gases has a rapid decline, and after twenty years it has constant value. In order to make air quality management more effective the unique functional system for testing and controlling the air pollution is established, with the recorded data base about air quality. In order to determine the air quality at the site of the regional landfill Banja Luka during the year 2013 the air quality measurements were performed.

Figure 1. Landfill entrance (*Authors ongoing research)*

Figure 2. Entrance-Exit area of the landfill site (*Authors ongoing research)*

The measurements were carried out in the mobile ecological laboratory from the Institute of Ecology and Information Technology Banja Luka according to regulations defined by ecological permit. Measurements were carried out at two locations, at the zone of the impact of the regional landfill- at the platform next to the reception point, which is placed 500m above the entrance gate towards the waste dump and at the parking lot near the entrance gate. The task was to measure the emission concentration of SO_2, CO_2, NO_2, NO, NO_X, O_3, CH_4, THC, (total hydrocarbons) and the amount of total suspended particles (TSP). With the measurement of the micrometeorological parameters; wind speed and direction, air temperature and humidity.

In order to determine the air quality at the site of the regional landfill Banja Luka during the year 2013 the air quality measurements were carried out once a month (in January, May and November) in the interval of 24 hours.

The measured concentrations of the monitored pollutants are compared with legislatively prescribed values from the Rulebook on air quality limit value and Decision on air protection in the area of Banja Luka. The results are shown in the tables 1, 2 and 3.

2. RESULTS AND DISCUSSION

The regional solid waste landfill is located in the northwest part of Banja Luka, at the site Crkvina in the settlement Ramići, on the left side of the main road M4 Banja Luka-Prijedor, at the distance of 150 m from the road. This is regional landfill for solid waste for complete Banja Luka region, and that includes city of Banja Luka, municipalities: Čelinac, Laktaši, Kotor Varoš, Kneževo, Gradiška, Prnjavor and Srbac. The region of Banja Luka makes 19% of the territory of the Republic of Srpska, which is 4.718 km^2. This area has 440.000 inhabitants. This means that this is the densest populated area compared to other parts of RS, since 30% of population of Republic of Srpska lives here. The regional landfill is 10 km far from the center of Banja Luka. The area of the landfill intended for the waste disposal is 31 ha, with the possibility of expansion for additional 14 ha.

This landfill has been in use for 30 years. This location was chosen to be the best one for the region of Banja Luka due to many aspects: terrain morphology, local conditions, hydrological, hydrogeological, geological, climate conditions, the possibility of environmental protection, transport distances, population, underground infrastructure, seismic characteristics, sources of the waste, for type and volume of the waste etc. The terrain on which the landfill was formed is stable, the bottom liner is impermeable soil, and acts as a hydrogeological isolator, and that is why there was no need for the artificial hydro isolation of the landfill bottom. During the 2013, 103.500 tons of mixed waste was disposed in the regional landfill Banja Luka. Every day 70 garbage trucks transport and dispose around 300 tons of waste. Daily waste layer would measure up to 20 m in height, and during the disposal perforated pipes were not set up to take away landfill gases, they would leak out without any control from the dump.

This caused bad odor and frequent fires. There was also a constant danger of explosions. The intensive activities of rehabilitation have started in the regional landfill. The aim of this rehabilitation is to form a sanitary regulated landfill, which will meet the regulations of the European Union, and the Republic of Srpska, and at the same time to gain the location for waste disposal for the future period with the minimal negative impact on the environment.

Table 1. Measured concentration of monitored pollutants in January, 2013 (*Institute for construction of Banja Luka)*

Pollutant	Sampling interval	Measured value	Measured unit	Target value ($\mu g/m^3$)	Limit value ($\mu g/m^3$)
SO_2	24 hours	23	($\mu g/m^3$)	60	90
	1 hour	36	($\mu g/m^3$)	60	90
NO_2	24 hours	27	($\mu g/m^3$)	40	60
	1 hour	39	($\mu g/m^3$)	40	60
TSP	24 hours	55	($\mu g/m^3$)	75	150
	1 hour	72	($\mu g/m^3$)	-	-
O_3	8 hours	22	($\mu g/m^3$)	High value 120 ($\mu g/m^3$)	High value 150 ($\mu g/m^3$)
NO	24 hours	23	($\mu g/m^3$)		
	1 hour	37	($\mu g/m^3$)		
CO_2	24 hours	235	ppm mean value		
	1 hour	312	ppm maximum value		
NOx	24 hours	50	ppm mean value		
	1 hour	66	ppm maximum value		
CH_4	24 hours	1,4	ppm mean value		
	1 hour	2,7	ppm maximum value		
THC	24 hours	6,2	ppm mean value		
	1 hour	7,5	ppm maximum value		

Table 2. Measured concentration of monitored pollutants in May, 2013 (*Institute for construction of Banja Luka)*

Pollutant	Sampling interval	Measured value	unit	Target value ($\mu g/m^3$)	Limit value ($\mu g/m^3$)
SO_2	24 hours	33	($\mu g/m^3$)	60	90
	1 hour	66	($\mu g/m^3$)	60	90
NO_2	24 hours	30	($\mu g/m^3$)	40	60
	1 hour	81	($\mu g/m^3$)	40	60
TSP	24 hours	59	($\mu g/m^3$)	75	150
	1 hour	93	($\mu g/m^3$)	-	-
O_3	8 hours	78	($\mu g/m^3$)	High value 120 ($\mu g/m^3$)	High value 150 ($\mu g/m^3$)
NO	24 hours	25	($\mu g/m^3$)		
	1 hour	42	($\mu g/m^3$)		
CO_2	24 hours	330	ppm mean value		
	1 hour	620	ppm maximum value		
NOx	24 hours	55	ppm mean value		
	1 hour	123	ppm maximum value		
CH_4	24 hours	8,4	ppm mean value		
	1 hour	23,0	ppm maximum value		
THC	24 hours	17,5	ppm mean value		
	1 hour	33,8	ppm maximum value		

Table 3. Measured concentration of monitored pollutants in November, 2013 (*Institute for construction of Banja Luka)*

Pollutant	Sampling interval	Measured value	unit	Target value ($\mu g/m^3$)	Limit value ($\mu g/m^3$)
SO_2	24 hours	46	($\mu g/m^3$)	60	90
	1 hour	81	($\mu g/m^3$)	60	90
NO_2	24 hours	26	($\mu g/m^3$)	40	60
	1 hour	37	($\mu g/m^3$)	40	60
TSP	24 hours	42	($\mu g/m^3$)	75	150
	1 hour	88	($\mu g/m^3$)	-	-
O_3	8 hours	41	($\mu g/m^3$)	High value 120 ($\mu g/m^3$)	High value 150 ($\mu g/m^3$)
NO	24 hours	26	($\mu g/m^3$)		
	1 hour	39	($\mu g/m^3$)		
CO_2	24 hours	33	ppm mean value		
	1 hour	54	ppm maximum value		
NOx	24 hours	52	ppm mean value		
	1 hour	76	ppm maximum value		
CH_4	24 hours	0,31	ppm mean value		
	1 hour	0,8	ppm maximum value		
THC	24 hours	0,9	ppm mean value		
	1 hour	1,4	ppm maximum value		

Tables 1, 2 and 3 show that the measured sulfur-dioxide (SO_2) concentrations in the air at the site of regional landfill Banja Luka during 2013 (January, May, November) are within prescribed values according to the Rulebook on air limit quality value. The measured concentrations of nitrogen-dioxide (NO_2) at the monitored site are within prescribed values in all monitored periods except in May during one hour measurement when the measured pollutants were in much higher concentrations than limit values, measuring 81(μg/m^3). The presence of suspended particles at the monitored site are within prescribed values in all monitored periods . The measured concentrations of ozone (O_3) in the air at the monitored site were within prescribed values in all monitored periods. The presence of nitric-monoxide (NO) in the air at the monitored site is found ranging from 23- 26 (μg/m^3) in 24 h interval. During 1 h measurement the pollutant is within average values except in May when the measured NO was in much higher concentrations than limit values, measuring 42(μg/m^3). The measured concentrations of carbon-dioxide (CO_2) in the air at the monitored site were in higher values in May, and lowest in November. The measured concentrations of nitrogen-oxide (NO_X) at the monitored site are within average values (50-76 ppm) in all monitored periods except in May during one hour measurement when the measured pollutant was in much higher concentrations than limit values, measuring 123(ppm). The presence of methane (CH_4) at the monitored site in May was 8.4 ppm and one hour measurement shows maximum value of the pollutant which is 23 ppm. Measured value of total hydrocarbons (THC) in the air at the monitored site are within average values, except in May, when there is mean value of 17,5 ppm and its maximum values are 33,8 ppm.

CONCLUSION

- Regional landfill Banja Luka in the term of its functioning and with intention to prevent any threats to natural eco-system, was founded on the vision that the waste disposal site should be enclosed system with all necessary elements of protections, which will not have any possible harmful effects on environment and human health.
- This type of landfill will fit into natural surrounding after its closure.

- In order to determine air quality at the regional landfill Banja Luka , air quality measurements were carried out once a month in interval of 24 and 1 hour during the monitored year.
- Measurements were carried out at two locations, at the platform- above the office facility and at the parking lot near the entrance gate.
- Measured concentrations of the monitored pollutants are compared with the prescribed values from the Rulebook on air limit quality value and it has been confirmed that the concentrations of the monitored pollutants in the air are within prescribed values, which confirms the null hypothesis.
- Future planned activities on the regional landfill Banja Luka are rehabilitation of the landfill and building the sanitary landfill, which will minimize the negative impact of the landfill on the air quality.

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