Air pollution in the area around the Mining Complex Trepça in Kosovo

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Abstract:- In this paper are presented the results of air pollution in Mining Complex Trepça in Kosovo. The region is significantly affected by industrial pollution which is affected by the mining sector. Associated to the region there is effluents by toxic/acidic pollution, uncontained waste rock, dust emissions and unsafe working procedures, poorly contained and unstable tailings wastes. Unfortunately, there are very limited data available concerning the environmental pollution of this area, due to many transitions and difficulty periods that Kosovo has passed.

Key-words: Air Pollution, Waste, Dust Emissions, P_b, C_d, Dust/Airborne Heavy Metals, Fugitive Dust

1 Introduction

The air pollution is a major concern in many areas of Kosovo. The major sources of air pollution at present are energy production in coal fired power plants and the transport sector. Major air pollutants comprise CO_2, SO_2, NO_x, dust/airborne heavy metals, and organic halogen compounds.

Based also on old equipment and inadequate exploitation of them the environmental pollution around such an industrial complex is quite evident. One of the main problems in the area are emissions of heavy and toxic metals bound to the airborne dust from the unprotected waste tailings and contaminated construction materials in Mining Industrial Park into the air and into the surface water courses. Another source of the omnipresent high heavy metals' background levels in the area were emissions from the smelter company (300 m high stack), which is located approximately 3 km to the northwest. Atmospheric transport leads to serious heavy metal pollution of a vast area. Soils within a radius of at least 10 kilometers from the stacks are heavily polluted mostly for highly toxic elements such as lead and cadmium [1]. The long going activity of mining and smelting in the area has had a great impact on the health of the people living in a heavy metal contaminated area. Although the plant does not operate currently, the waste is piled up in the open air and due to a lack of street cleaning equipment dust with a high lead concentration keeps circulating [3].

2 Environmental issues

The deposition of lead contaminated dust is of much greater concern for the community, especially near the centre of town, where road dust is mobilized by heavy traffic [2]. There, lead deposition exceeds 1000mg/m^2/day, i.e. four times higher than the WHO (world health organization) guidelines. Due to the contact and respiration of household dust the population of the region is exposed to this pollution during the entire day [4]. The typical seasonal trend showing elevated concentrations of lead during autumn-winter period deteriorates the exposure to heavy metals bound to the airborne dust in winter period [5]. According to an available wind rose major part of winds blow from in the north-south direction, substantial part is constituted by calm, with an average speed of 2 –3 ms^{-1} [4].

Dust emissions containing toxic elements are a further source for contaminant disposition in the region. Mitrovica city, and its south-east part in particular, has a high level of pollution with the dust particles, where the maximum value reaches 5560.8 mg/m^2/day, which exceeds WHO recommended values for 20 times. It can be seen that in the area of 1m^2, the level of pollution is 542.3 mg per day, where the population of the region is exposed to this pollution during the entire day. These data originate form study on Spatial Distribution of Settled Air Pollution in Mitrovica, Comparison between Seasons 2006-2007 [4].

4 Sampling of fugitive dust

It was realized close to potentially exposed recipients in the surroundings of the tailings impoundment during weather conditions with high potential for wind erosion of tailings materials; measurement of airborne dust concentration was carried out with portable light scattering particle analyzer (optical particle sampler) for monitoring of total suspended particles, PM_{10} particles, $PM_{2,5}$ particles with incorporated membrane filter for gravimetric determination and subsequent chemical and mineralogical analyses of the selected samples for dust source apportionment. Measurement campaign of suspended particles consisted from the following phases:

- On site sampling of fugitive dust
- Gravimetric determination of concentration of fugitive dust in controlled conditions
- Chemical analyses of collected samples and determination of concentration of heavy metals.

Measurements are conducted on four sides of in different area in Mitrovica which are presented below:

- Primary school “Bedri Gjina” (N:42^0 53’22,5”E:20^{0}52’24,5”)
- Primary school “Migjeni” **(**N:42^{0}52’41,9”E:20^0 51’23,5”)
- Primary school “Mother Theresa” **(**N:40^0 53’07,3”E:20^0 52’14,5**”)** and
- Mitrovica industrial park in the area of former Battery plant (N:42^0 53’16,1”E:20^{0}52’58,3”)

Aims of these measurements are determination of:

1. Concentration of suspended particles in the air with diameter less than 10 and 2.5 micrometers (PM10 and PM2.5).
2. Content of certain heavy metals in the collected particles.
3. Obtaining information about the level of pollution in the ambient air in Mitrovica by evaluating the results for concentration of particulate matter (fugitive dust) and their content of heavy metals.

Technical details

For sampling of fugitive dust was used the following equipment:

- Adapter with PUF for PM10 and PM2,5 and sampling cassettes (Cassela)
- Low volume sampling pump *(*Allegro A100)
- Flow meter (Cole Palmer)
- Quartz filter 37mm (Millipore), switcher
- Stand and plastic tubes 5 mm.

Photo 1. Allegro A100 Pump

For gravimetric analysis was used the following equipment:

- Thermo reactor (Binder ED),
- Desiccators and microbalance with resolution 0,001 mg.

The methodology of the dust samples collection is done as follows.

Preparation: Quartz filters (37 mm diameter) were prepared for sampling in laboratory conditions. Filters were dried at 105 °C temperature in Thermo reactor and then cooled and kept in desiccator in order to prevent from absorption of humidity on them. The prepared filters were weighed on microbalance in room with the controlled and stable conditions (RH=50% and 200C).

Photo 2. Picture of the used set-up for the collection of the fugitive dust

4.1 On site sampling

PUF adapters for filters were used to collect aerosol particles in $PM_{2.5}$ and PM_{10} size fraction. The equipment was installed at height of 5m above ground level. It was connected to the low volume air sampling pump Allegro A100. The air flow was limited to 5l/min by a flow meter Cole Palmer with range (4 – 30 l/min). The duration of every sampling period differed from 6 to 24 hours during 23rd and 24th July 2009. The set-up is presented in the Photo 2.

After the collection, filter samples were stored in plastic and sealed cassettes and kept in safe box.

4.2 Gravimetric determination

Particle mass was gravimetrically determined in horizontal position and afterwards transported to the laboratory. Weighing the filters with samples, after 48 hours conditioning in a desiccator, in clean and conditioned room, (T=20°C, RH around 50%). For a quality assurance of the procedure, two blank filters were also prepared and carried on with other filters.

4.3 Chemical analyses of dust particles

The collected samples were analyzed for heavy metals concerning the objectives of the project “Environmental Assessment and Remedial Action Plan for Mitrovica Industrial Park”.

The elements of interest are as follows:

- HM – heavy metals: Cd, Cu, Pb, Zn
- Other metals: Mn

The filters were placed in laboratory glass beakers (100 ml) and diluted in 2 portions of 10 ml nitric acid (1:1). After evaporating to dryness the filters were washed with doubly distilled water and the residues were transferred into 5 ml volumetric glass flasks and fill to the mark with redistilled water. For determination of heavy metals a Thermo Model Solaar 2 flame atomic absorption spectrometer with air/acetylene flame was used. Instrumental parameters are optimized according to the Manual. A Varian SpectrAA 640 Z Zeeman electro thermal atomic absorption spectrometer with a Varian PSD-100 Autosampler was used. Hollow cathode lamps were used as a source.

4.4 Analyses of results

The limit values recommended by World Health Organization (WHO) were used for the evaluation. A primary pathway for the human health exposure to heavy metals is inhalation of the air particles containing heavy metals. Results of chemical analyses of the dust particles are mentioned in the tables1 and 2. The dust particles show high content of Cd, Mn, and Pb in comparison with the guideline values for concentration in air for heavy metals [6] and [7].

Measurements points	Size fraction	Mass of collected dust (mg)	European Guidelines (μg/m^3)	Determined concentration (μg/m^3)
MIP former battery Plant	$PM_{2.5}$	0.126	25	20
	PM_{10}	0.242	50	38
Primary School “Migjeni”	$PM_{2.5}$	0.116	25	18
	PM_{10}	0.249	50	38
Primary Schhool “Mother Theresa”	$PM_{2.5}$	0.071	25	35
	PM_{10}	0.167	50	83
Primary School “Bedri Gjina”	$PM_{2.5}$	0.075	25	25
	PM_{10}	0.046	50	41

Table 1. Results from gravimetric analyses of fugitive dust PM_{10} and $PM_{2.5}$

Measurements points	Size fraction	Cd (ng/m^3)	Cu (ng/m^3)	Pb (ng/m^3)	Zn (ng/m^3)	Mn (ng/m^3)
MIP former battery Plant	$PM_{2.5}$	8.547	20057.100	4302.840	3215.546	2140.209
	PM_{10}	7.013	29.895	251.540	322.571	91.151
Primary School “Migjeni”	$PM_{2.5}$	1.100	4251.080	776.080	332.562	9.306
	PM_{10}	1.684	15.432	489.198	67.361	43.472
Primary Schhool “Mother Theresa”	$PM_{2.5}$	50.754	40357.790	5226.131	7618.090	1326.633
	PM_{10}	1.719	339.698	66.985	50.251	27.452
Primary School “Bedri Gjina”	$PM_{2.5}$	23.346	109.857	3776.338	172.507	1153.239
	PM_{10}	0.563	849.014	101.296	146.648	367.155

Table 2. Results from chemical analyses of collected dust

The results of airborne dust measurement conducted within MIP area shown concentrations of airborne particulate matter at the levels of PM_{10} = 38 μg/m3 and $PM_{2.5}$ = 20 μg/m3. Concentrations of heavy and toxic metals analyzed in the dust fraction of PM2.5 are presented in the following table. The measurement of dust took place during the dry period of the year, after approx. two weeks of dry and warm weather.
The results of airborne dust measurement were taken from “Mother Theresa” primary school (settlement Bair) where the highest concentration of airborne dust (PM10 = 83 μg/m^3 and PM2.5 = 35 μg/m3) in air and the highest content of heavy and toxic metals in airborne dust were found. The place is at the same the closest place to MIP from the three measurement locations in the town. The measurement of dust took place during the dry period of the year, after approx. two weeks of dry and warm weather. Concentrations of heavy and toxic metals analyzed in the dust fraction of PM2.5 are presented in the following table.

5 Conclusion

However, the investigate hot spot represents also an immediate health risks to the adjacent residential areas through uncontrolled emissions of airborne dust containing heavy and toxic metals. In this respect the unfavorable state of current MIP premise afflicts virtually the whole population of Mitrovica. The adverse situation is deteriorated by elevated dustiness in the city - conducted measurements showed that concentration of particulate matter PM_{10} in the settlement Sitnica closest to MIP does exceed maximum 24-hour EU limit 50 μg/m^3 according to the Directive 2008/50/EC, while $PM_{2.5}$ does exceed daily mean guideline value 25 μg/m3 recommended by WHO in 2006. Exposure to fine fractions of particulate matter and toxic metals should be an issue of concern for the future investigation of the area. This investigation should focus on the long-term measurement of the airborne dust concentration in the air and also on the analyses of a broader range of toxic metals content in the airborne dust.
It is also important monitoring the air quality in the region. The air quality monitoring continuous monitoring of weather parameters like wind direction, wind velocity, ambient air temperature, precipitation, concentration of dust particles, monthly collection of fugitive dust particles and laboratory analyzes focused on assaying the concentration of Cd, Cu, Pb, Sr and Zn.

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