STUDY ABOUT THE POLLUTION WITH SETTLED POWDERS IN THE INFLUENCE AREA OF THE EXPLOITATION IN ROSIA QUARRY

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Abstract: The mining industry is contributing in a significant measure in the pollution of the surrounding environmental factors, through the huge quantities of waste that it produces, as well as their diversity. Elaborate research about the development of future worldwide mining activities conducted to the conclusion that this activity will increase, especially because of the extend of daily exploitation, especially in the quarries where can be obtained a productivity far higher than the one obtained underground, fact that will allow the exploit at a reasonable price of the huge deposits that contain a low quantity of useful components. In this study information about the pollution with settled powders in the influence area of Rosia quarry will be submitted. The Rosia by Jiu Quarry is located in the Rovinari mining basin ,from Gorj County in the administrative territory of Rovinari city and the mining villages Farcasesti and Balteni.The quality of the air in that region is mostly affected by the technological process that takes place in the quarry, in the dump and in the coal deposits. For the monitoring of the quantity of settled powders, there have been established seven sampling locations, five of them in the influence area of the coal deposit, and two of them in the Rosia Quarry influence area. The determination of the settled powders was realized in conformity with STAS 10195-75 by using the gravimetric method.The highest value of settled powders recorded during the two years of studies was located in the Rosia Quarry in the area of the coal deposit, in the S3 sampling point, whose concentration was 2.7 higher than the maximum allowed and it represented over 15% of the sum of all concentrations in this site.

Keywords: coal, mining, dump, sampling, monitoring, environment

1. INTRODUCTION

The lignite deposits from Romania are quartered in regions in which mostly youngest geological formations are developing, that are made of soft rocks, cohesive and non-cohesive, like marls, clay and sand. The Rosia by Jiu Quarry is located in the Rovinari mining basin, from county Gorj in the administrative territory of Rovinari city and the mining villages Farcasesti and Balteni. At the moment it is administrated by the Energetic Complex of Oltenia.

The opening of Rosia by Jiu Quarry started in 1973 and it was made with the E2000-01 excavator through a trench opening excavation from east to west along the whole length of the quarry.

The quarry is located in the interfluve between the rivers Jilt and Jiu and it is developed on over 1/3 of the surface of the Jiu waterside, and the rest in the hilly area. So the exploitation perimeter contains two land-forms:

- the waterside area, located in the regulated river course of Jiu river along the towns Farcasesti, Moseni, Rosia by Jiu and Rovinari.
- the hilly area, bordered by Timiseni Valley by north and Parului Valley by south.

Considering the fact that in the case of lignite mining exploitation [1,2] all the

working equipments are electrically operated, the characteristic pollutant is represented by the coal dust. The coal exploiting represents a particles pollution [3,4,5,6,7,8,11,12,13,14] source during it's whole lifetime, since the moment the terrain surface started to be disrupted until the moment when the whole area is covered again with vegetation.

In terms of impact over the surrounding environment, the lifetime of a quarry involves the period of exploitation cumulated with it's rehabilitation.

The coal exploitation activity in the quarry involves the ground's and the coal's movement, as well as the exposure of the weathered surfaces, generating this way certain quantities of pollutants, the particles emissions are the most representative for this fact. From all the particles that are in the air in the influenced areas, the characteristic pollutant is represented by waste dust and coal, other pollutants are not taken in consideration because all the working equipments are operated electrically.

The most important sources of atmospheric pollution in the influence area of Rosia Quarry are the dumping excavators, the conveyors ,the distribution nods, the coal deposit, the waste dump and the access routes. From the whole set of activities of a coal quarry, the storage of the coal it is the most important source of the surrounding's air pollution with powders. In most cases of monitoring, the highest concentration of powders, settled ones as well as the air floated powders were measured in the influence area of the coal deposits.

2.EXPERIMENTAL

When the settled powders sampling points were placed the first thing that has been had in mind were the populated areas that were closest the sources of pollution. In this context, the sampling locations of the samples used for the determination of settled powders concentration in the influence area of Rosia Quarry were established in most of these areas. For the monitoring of the settled powder content there have been used seven points of sampling, that will be presented in figure 1 of which five are in the influence area of the coal deposit and two in the influence area of the Rosia Quarry.

Figure 1. Location of the sampling points for the settled powders.

The placement of these points is the following:

- S1 - located at the north-west of the coal storehouse, at a distance of about 600 m of it and at about 5 m of the belt section which is used for the transportation of the coal in the storehouse from Rovinari thermal.
- S2 – located to the west of the coal deposit at a distance of about 1000 m of it
- S3 – located to the south-west of the deposit, at about 300 m
- S4 – located south of the deposit, at about 350 m
- S5 – located to the north-west of the deposit, at a distance of 150 m of it and of the closest residence from Rovinari city
- S6 – located in the influence area of Rosia Quarry, to the south-east, at a distance of about 150 m
- S7 – located to the south-east of the quarry, at a distance of about 300 m

The determination of the settled powders was realized in conformity with STAS 10195-75[10] by using the gravimetric method. For the gathering of the samples the figure 2 device is recommended.

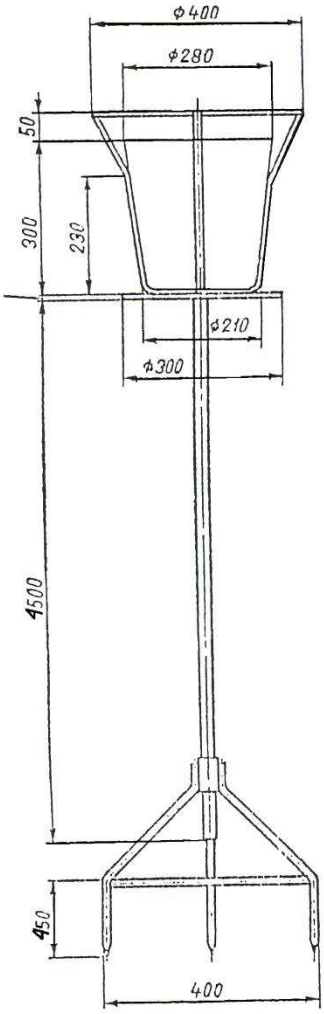

Figure 2. The settled powders sampling device.

In the cold season of the year, to prevent freezing, it is introduced in the collecting recipients a mixture of distilled water and ethyl alcohol instead of distilled water in a proportion of 3%. In the hot season of the year, to prevent the development of microorganisms, it is added in the distilled water from the collecting recipients a quantity of copper sulfate. The collecting recipients' exposure period will be of 30 days. In the event that the water (abundant precipitations) crosses the volume of the collecting recipient, those samples are not taken into consideration. The recipients that contain settled powders are covered and placed into the laboratory, taking care not to be polluted or to be spilled during transportation. The recipients' exterior is wiped first with a wet gauze and, after with a dried one. By means of a pincers the leafs, the insects and other foreign bodies are lifted, being washed with a jet of distilled water.The content of the recipient is quantitatively passed in a beaked glass with the help of a glass stick provided with a rubber collar at one end. The passing of the sample in the glass is done by means of a bolt with the side of a mesh of 1 mm, the impurities on the bolt then being washed with a jet of distilled water that is placed also in the glass. The sample in the glass is evaporating almost to the point of dryness and the content of the glass is then quantitatively passed in a porcelain capsule, brought previously at a constant mass at a temperature of 105^0C. The solution from the saggar (porcelain capsule) is evaporated to the point of dryness on the water bath or on the electric hob, being careful that the temperature will not get beyond 100^0C. After evaporation, the capsule with the sample is wiped at the exterior with clean gauze and kept in the stove at a 105^0C temperature for two hours. It is cooled in the exicator for one hour and then weighted at the analytic balance. The drying, cooling and weighting operations are repeated until the constant mass.

2. RESULTS AND DISCUSSION

The content of settled powders is expressed in g/m^2/month and is calculated with the ratio:

$$P_{sed} = \frac{(m - 0{,}0177 \cdot V)}{S} \cdot \frac{30}{n} \quad \left[g / m^2 / month\right] \quad (1)$$

where:

m - the mass of the settled powders from the sample, [g];

0.0177- quantity of $CuSO_4$+H_2O added, [g];

V- the volume of the collecting recipient, in [l];

S - the surface of sedimentation,[m];

n - the numbers of days for exposure

Under this standard, the maximum allowable amount of settled powders in the air protected areas is 17g/m^2/month.

The result interpretation for the settled powders has been made accordingly to the stipulations in standards 12574/87 "Air from protected areas. Quality conditions"[9]

According to these norms the admitted quantity of settled powders in the air of the protected areas is 17g/m^2/month.

In table 1 are presented results of the measurements conducted during two years of study: 2014 and 2015.

Table 1. Values of settled powders in the Rosia Quarry area.

Year	Sampling Point	Month												CMA
		J	F	M	A	M	J	J	A	S	O	N	D	
2014	S1	12,36	18,71	12,8 9	15,73	7,11	11,50	15,45	13,09	20,4 4	16,10	14,14	10,80	17g/m^2/month
	S2	12,62	28,05	11,04	14,16	8,59	9,42	10,89	10,12	14,32	12,40	10,52	9,92	
	S3	14,10	44,92	10,86	29,99	21,15	22,69	27,29	31,85	22,33	27,51	21,73	23,27	
	S4	12,55	25,93	14,81	16,29	13,45	12,84	13,28	23,82	25,04	27,94	17,30	15,24	
	S5	13,11	15,31	14,37	15,18	13,23	13,04	16,00	13,06	13,89	15,16	20,84	11,49	
	S6	9,61	32,04	16,66	30,83	24,83	12,76	25,85	9,28	9,83	22,59	7,03	4,60	
	S7	8,71	18,39	13,37	13,01	9,67	18,12	6,76	7,89	11,56	14,73	5,18	8,54	
2015	S1	17,14	16,26	14,12	5,13	10,68	12,65	13,52	12,57	15,13	13,36	12,61	9,61	
	S2	14,72	7,10	9,655	8,1 9	11,46	8,01	9,74	11,08	10,89	10,12	14,43	10,70	
	S3	25,24	17,69	17,67	13,07	23,95	21,11	21,96	22,32	12,69	18,80	12,13	15,65	
	S4	17,61	17,17	7,96	9,10	14,72	19,07	16,84	15,21	12,98	9,95	13,62	11,74	
	S5	26,18	17,26	13,32	10,21	14,37	15,63	7,01	14,11	17,71	7,76	19,11	13,21	
	S6	12,19	20,48	20,84	7,46	12,58	13,48	11,51	20,42	11,03	17,20	15,24	7,22	
	S7	4,84	12,80	12,04	9,03	6,63	15,03	11,07	10,63	10,76	11,35	9,63	7,14	

So, in the sampling point S1, located in the proximity of the belt section which is used for the transport of coal towards the Rovinari thermal, during year 2014 from out of a total of 12 measurements conducted, only two were above the maximum admitted concentration, so the exceeding frequency recorded was 16.66%. The exceeding were recorded in months February and September and they were with 10.64% respectively 20.3% above the maximum allowed concentration. The smallest concentration was recorded in May (7,14 g/m^2/month), and it was 58% under the limit value.

In year 2015, the exceeding frequency in S1 was smaller than in 2014, of only 8.34%. The only value that was above the admitted limit was recorded in January and it was with about 0.6% above the maximum admitted concentration. The smallest concentration from this location, during 2015 was measured in April (5,13 g/m^2/month) and it was only 30.16% of the maximum allowed concentration.

In the next location, S2, located at a distance of about 100 m towards the coal deposit, out of a total of 12 measurements that were conducted during 2014, only one was above the admitted limit, which means an exceeding frequency of only 8.34%. This was recorded in February and it represented the highest concentration during 2015, being with 70% above the maximum concentration allowed.

The smallest value was recorded also in May and it was almost half of the admitted limit. During year 2015, in S2, all the values obtained were under the maximum

concentration admitted. The biggest value of settled powder has been measured in January and it was about 7.5% under the admitted limit. The smallest concentration during this year in S2, has been recorded in February and it was about 42% of the maximum allowed concentration.

In sampling location S3, placed at a distance of about 300 m south-west of the deposit, but also close to an access route for vehicles, has been recorded the highest exceeding frequency as well as the highest values. So, out of a total of 12 gravimetric determinations conducted during 2014, 10 were above the admitted limit, which means an exceeding frequency of 83.2 %.

The biggest concentration during this year has been measured in February and it was 2.7 times higher that the admitted limit. The smallest value has been recorded in March and it represented about 65% of the maximum allowed concentration. Even in year 2015 the exceeding frequency kept on growing, and it represented 74%, which means that from the total of 12 measurements, 9 were above the allowed limit. Even if the exceeding numbers is close to the one in the previous year, though, the sum of concentrations recorded in 2015 is almost 33% lower than in 2014, which points the fact that the values recorded are smaller. So, the highest concentration of settled powders in 2015 has been recorded in January and it represented almost 49% more than the maximum allowed concentration and with 82% less than the highest value in 2014.

The lowest concentration has been measured in November, being about 28% under the allowed limit. The sampling location S4 had a exceeding frequency of 25%, in 2014 as well as in 2015, each year ,in three months out of 12 have been recorded values above the admitted limit.

In year 2014 the highest quantity of settled powders has been measured in October, and it has been with 64.5% above the maximum admitted concentration , and the lowest quantity has been recorded in January and it represented 74.4% of the limit. For year 2015, the highest value has been recorded in June but it was only 12% above the allowed limit.

The minimum concentration has been measured in May, but it was right under half of the maximum admitted concentration. The sum of settled powders concentrations in 2014 was almost 25% higher than 2015. The next sampling location, S5, is located in the influence area of the coal deposit at a distance of about 150 m. In 2014, out of a total of 12 measurements conducted, only one was above the maximum value, which means a exceeding frequency of 8.3%. In was recorded in November and the calculated value was 22.6% above the limit. In the other months of the year, the concentrations had close values.

During 2015 there has been recorded an exceeding frequency four times higher (33.3%) than the one in 2014. The highest quantity of settled powders was recorded in January and it was 60% above the legal limit, other exceeding having close values. The smallest value of settled powders has been recorded in October, being 45.6% of the maximum limit. Even if the numbers of samples that exceed the legal limit in 2015 is higher than in 2014, the sum of the concentrations in the two years are very close, in 2015 it was 11% higher than in the year before.

In the sampling location S6, located in the south-eastern limit of the quarry, from out of a total of 12 measurements conducted in 2014, 50% were above the maximum concentration limit. The highest concentration of settled powders has been measured in February and it had a value of 94.3% above the allowed limit. The lowest value has been recorded in December and it represented only 27.3% of the max allowed concentration , and this was the smallest concentration that has been recorded in 2014 from all the seven sampling points.

During 2015, the exceeding frequency has been 33.3% higher than in 2014, four measurements were above the admitted limit. The highest value has been recorded also in February and it represented an exceed of about 26% of the admitted limit, the lowest

being recorded in December and it represented 42.5% of the maximum allowed concentration. The sampling point S7 is located also at the south-eastern limit of the quarry, but at a distance of about 300 m south towards S6.

In the study year of 2014, the exceeding frequency in this location was just 16.6%, which means that out of a total of 12 measurements, two were above the maximum allowed concentration. The highest value has been recorded in February and it was 8.8% above the allowed limit. The lowest concentration has been measured in November and it represented 30.5% of the allowed limit.

During year 2015 in this sampling location no value exceeded the maximum allowed concentration. The highest concentration has been measured also in February and it represented almost 76% of the max allowed concentration and the lowest was recorded in January and in represented 29% of the legal limit.

Both in 2014 and 2015 the sum of concentrations in this sampling location had the lowest values compared to the other locations.

However, an analysis that has been conducted considering the number of values that were above the admitted limit during the two years of studies, which is represented in Figure 3, pointed the fact that the fewest exceeding took place during the winter season, and most of them took place in the autumn season.

The lowest values were obtained mostly in the winter season, meaning at the beginning and also at the end of the year, this can be can be attributed to the fact that during this period the excavation, transport and storing activities of the mining mass are interrupted for a period of time, the activity being resumed in the middle of January and it comes back to normal in February.

In another order of thoughts, the huge concentrations of settled powders from the autumn season, represented by the big number of exceeding, may happed due to the meteorological conditions of this period, when the numbers of rainfalls is lower, and the economical agent does not apply the required measures that are needed to reduce the emissions of powders in such situations.

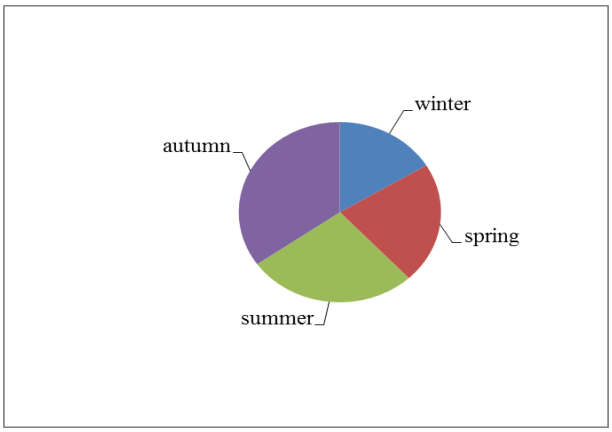

Figure 3. The distribution of settled powders breaches during the seasons from 2014-2015.

While the activity of coal exploitation through excavating has a great impact itself on the ground and also on the underground water, the transport and coal storing activities got a significant impact on the air in the area through emissions of powders and noise.

4. CONCLUSIONS

- The environmental factor is affected especially by the transport and coal storing activities, which take place on surface, and it's less affected by the excavation of the mining masses, which take place under the natural terrain level.
- From all the activities related to the extraction of the lignite through exploiting, the storing, loading and transport ones got major impact on the environment, especially because of the huge quantities of powders that result from them.
- The highest value of settled powders during the two years of studies has been recorded in the Rosia Quarry, sampling point S3, in the area of the coal deposit whose concentration has been 2.7 times higher than the maximum allowed concentration and it represented over 15% of the sum of concentrations in this location.

- So, for Rosia Quarry, in 2013 from out of a total of 84 measurements conducted, 25 were above the admitted limit, which means over 30%, and in 2014, 21 exceeded the maximum admitted concentration, representing 25%.
- Lower quantities of settled powders, as well as a lower exceeding numbers were recorded during the cold season rather than in the other seasons, but this aspect is attributed to the reduced activity in this period, rather than other causes.
- The higher concentrations recorded in the summer and autumn seasons are attributed, not just to less favourable weather conditions (fewer rainfalls), but rather due to the lack of anti-pollution measures that should have been applied by the economic agent, in such situations.

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