THE POLLUTION LEVEL OF THE AIR IN THE AREA OF PINOASA MINING IN GORJ COUNTY, ROMANIA

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Abstract

The mining industry produces polluting substances for the air, either directly, through actual exploitation, or indirectly, by the stocking-preparing and processing installations of the useful mineral substances,. The paper presents the pollution level of the air in the area of Pinoasa mining in Gorj county. The perimeter of Pinoasa quarry is placed in the north-west of Rovinari coal basin, on the right shore in the south-west of Rovinari thermo-power station in Gorj county. For monitoring the sedimentary powders and the powders in suspension, four sampling points placed in the area of Pinoasa mining exploitation were established.

The determination of sedimentary powders was accomplished according to STAS 10195/75 and it consists of collecting the powders in the atmosphere in containers whose surface and gravimetric determination are known. The reference method for determining the fraction PM_{10} is described in the European Norm EN 12341/1998.

The measuring principle is based on sampling on a filter of the fractionPM_{10}, separated from particles in suspension from the air and their gravimetric determination.

The quality of the environmental factors in the influence area of Pinoasa quarry is affected by the over presence of the sedimentary powders and of the powders in suspension. Considering the 4 monitoring points of the sedimentary powders, none of them registered values below the maximum accepted concentration during the two study years. Regarding the powders in suspension, the highest concentrations were registered in the area of the coal deposit, following the distribution knots from a band section to another

Keywords: powders, sedimentary, powders, the fraction PM_{10}

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1. INTRODUCTION

The activity in the field of environmental protection should start from fully knowing the pollution sources and the methods to remove them and also the affected environmental factors, the organization way and the connections between its elements, for the final result to be a secure and efficient de-pollution of the environment.

One of the particularities of the current situation consists of the fact that the changes in the environment are much faster than the development time of the methods of controlling and forecasting its status, so the human sees the unfavourable ecological phenomena and he cannot prevent them.

When there are problems regarding the environment, the causes should often be looked for in the past, because when the environment is damaged, the effects show up after a certain lapse of time.

The mining industry significantly contributes to the pollution of environmental factors, both by means of the big quantities of waste it produces, and by their diversity.

The future development of this activity will increase even more, especially by extending the daily exploitation, in quarries, where we may obtain productivities incomparably higher than the ones obtained underground, a fact that will allow the exploitation of big deposits at reasonable prices.

The negative impact of the mining activities on the environment is direct, related strictly to the actual extraction of the deposits of useful mineral substances, and indirect, related to the activity of processing and using mining products (Fodor and Baican, 2001). These activities are usually concentrated in certain geographical perimeters, so the same area is influenced by the mining activity both directly and indirectly.

In all the mining basins in Romania, the exploitable lignite layers have a width of 1,0-8,0 m and they are presented as packages having layers of sterile intercalations, having aquifer formations with water having a free level or under pressure both in the bedding and in the roof.

The lignite deposits in Romania are installed in areas where the youngest geological formations mainly develop (the Dacian ones, the Levantine ones and the Quaternary ones), constituted of soft, cohesive and non-cohesive rocks such as clays, sand. The limits of the exploiting perimeter of Pinoasa quarry are presented in figure 1 and these are:

• at south- Timişeni village
• at north–Tismana quarry
• at east– the perimeter of Rogojelu mine and Rovinari Thermo-power station
• at west– the forest area–Tasa hill

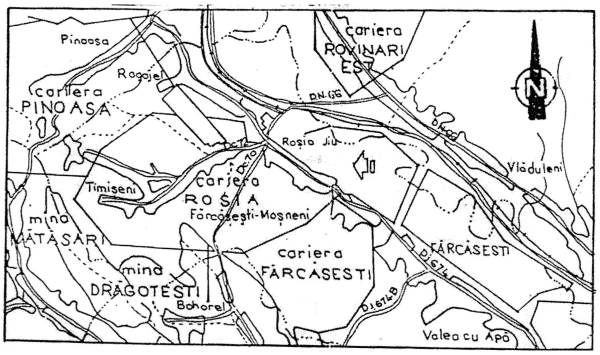

Figure1: The limits of the exploiting perimeter of PINOASA quarry in GORJ county, ROMANIA

Depending on the relief conditions and the vertical distance from the surface to the last exploitable layers, the depth of the quarries may have between 40 and 110 m in the meadow area and even 180 m in the hill areas, and the discopert report on the total mining field is contained between 2,5 and 8 m^3 sterile/ extracted lignite tone. The paper presents the pollution level of the air with sedimentary powders and powders in suspension in the area of PINOASA exploitation in GORJ county.

2. MATERIALS AND METHODS

The determination of the sedimentary powders was accomplished according to STAS 10195/75 (Căpăţînă and Simonescu, 2008; European Norm E.N. 12341, 1999).

For monitoring the sedimentary powders, five sampling points were established, all of them in the area of the houses of Timişeni village. These are placed on the eastern and south-eastern side of Pinoasa quarry. Their distribution from north to south is presented as follows:

• P1 – about 15 m away from the coal transporting band to Pinoasa deposit and close to the crossing from a band to another.
• P2 – about 60 m away from the coal transporting band
• P3 –about 150m away from the coal transporting band
• P4 – situated towards the south-east, 50 m away from the coal transporting band, and 170 m away from the inside sterile deposit

The monitoring of the powders in suspension in the influence area of Pinoasa quarry was accomplished by taking air samples from four points placed as follows.

• P1 – placed in the influence area of Timişeni coal deposit, belonging to Pinoasa quarry;
• P2 – placed close to a distribution knot;
• P3 – placed close to an inhabited area 700m towards the S – W away from Pinoasa quarry.
• P4 – placed in the influence area of the sterile deposit of Valea Negomirului .

Floated powders content (PM_{10} fraction)

The reference method for the sampling and measurement of the PM_{10} fraction is described in the European Norm EN 12341/1999 (European Norm E.N. 12341, 1999; Standard Collection of Enviroment Protection). The European Norm EN

12341/1999 specifies the performances of the sampling instruments for the PM_{10} fraction in view of the harmonizing of measurements systems, according to the provisions of the Directives of the European Union Council 96/62/EC for the evaluation and management of the environmental air quality.

The measuring principle is based on the filter sampling of the PM_{10} fraction separated from the air-floated particles and their gravimetric determination. In this case it was used a Low Volume System of the LVS-PM_{10} type (fig. 2).

The reference measurement method uses an aspiration system of PM_{10} directly coupled to a filter substrate and a control device of the aspiration flow rate, followed by a gravimetric determination of the PM_{10} mass collected on the filter. The sampling flow rate was adjusted to $2m^3/h$ (fig. 3).

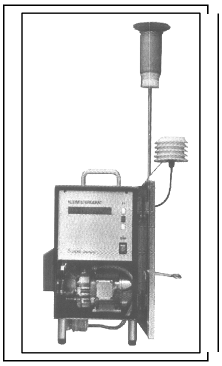

Figure 2: Sampling system for the LVS powders

The air flow is accelerated inside the aspiration compartment by an impactor with 8 impact nozzles and then directed by a pipe towards the impact surface. After that, the air flow is led by a line towards the filter support. This support is adjusted for the insertion of a circular filter with the diameter of 47 mm.

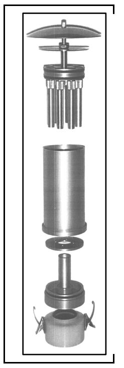

Figure 3: Powders sampling head

Before sampling, the filters are conditioned for 24 hours by drying in a desiccator with calcium chloride. It is weighted and the exposed for sampling for another 24 hours. After sampling, the filters are again weighted and used for determination of PM_{10} fraction.

3. RESULTS AND DISCUSSION

The results regarding the registered values for sedimentary powders across the two study years are presented in table 1 and in table 2. The values present the measurements accomplished in 2011 and 2012.

Table 1: Values of the sedimentary powders in the area of Pinoasa quarry in 2011

Year	Sampling point	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
2011	P_1	9,25	15,31	25,15	22,35	26,56	19,36	18,10	19,23	21,87	16,21	14,83	13,92
	P_2	6,21	4,28	25,43	19,29	19,78	21,72	28,94	26,46	17,81	17,41	12,78	9,28
	P_3	8,41	6,76	15,26	18,71	13,60	11,96	33,13	22,19	14,17	15,23	12,43	11,92
	P_4	10,44	18,27	20,94	22,33	24,13	22,24	21,67	15,11	17,28	21,73	18,92	18,72

Table 2: Values of the sedimentary powders in the area of Pinoasa quarry in 2012

Year	Sampling points	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
2012	P_1	11,49	38,48	20,33	13,17	21,37	27,59	30,17	18,66	23,95	-	-	-
	P_2	12,13	,10	16,94	24,28	18,92	27,36	28,47	28	20,57	-	-	-
	P_3	6,68	13,41	22,10	14,97	22,21	32,82	20,84	20,47	15,87	-	-	-
	P_4	13,91	23,33	18,93	24,15	24,17	22,76	25,41	13,92	21,84	-	-	-

The interpretation of the results for the sedimentary powders was accomplished accordingly to the stipulations of the standard 12574/87 (Standard Collection of Enviroment Protection). Air in the protected areas. Quality conditions. According to this standard, the maximum accepted quantity of sedimentary powders in the air of the protected areas is 17 g/m^2/month.

A first finding is the fact that, during the two study years, all the monitoring points registered at least an overflow of the maximum accepted concentration.

Thus, in P1 sampling point, placed 10 m away from the coal transporting band, across the year 2011, considering the 12 measurements accomplished, 7 of them registered overflows of the maximum accepted concentration, representing a frequency of overflows of about 58 %.

All the overflows were registered in May-September. The highest concentration of sedimentary powders was calculated in May, having 56.2% above the maximum accepted concentration. The lowest concentration across the year 2011 in this point was registered in January, representing only 54% of the maximum accepted concentration.

In 2012, the frequency of overflows in P1 point was even higher, namely 77,8 % . This time, the highest quantity of sedimentary powders was registered in February, having 126.35% above the maximum accepted concentration. The lowest quantity was also measured in January and it represented 67,6% of the maximum accepted concentration.

In the next point, P2, in 2011, considering the 12 measurements, 8 of them were above the maximum accepted concentration, representing a frequency of overflows of 67%.

The highest quantity was registered in July and it was above the maximum accepted concentration with 70.23%. The lowest concentration was registered in February and it represented only 25% of the maximum accepted concentration.

In 2012, the frequency of overflows was 67% of the total measurements accomplished, and 6 out of the 9 values overtook the maximum accepted concentration. The highest concentration was also registered in July and it had 67.5% above the accepted limit. The lowest quantity was registered in the same lapse of time as in 2011, but it represented 335.8% of the maximum accepted concentration.

In P3 sampling point, considering the 12 measurements accomplished in 2011, only 3 of them registered overflows, namely 25%. The highest concentration of sedimentary powders measured in this point in 2011 was registered in July and it had 94.9% above the imposed limit.

The lowest value was measured in February and it represented 40% of the maximum accepted concentration.

In 2012, there was a frequency of overflows of 33%, meaning that 3 out of 9 measurements accomplished overtook the maximum accepted concentration. The highest value was registered in June and it had 93% above the accepted limit, and the lowest one represented 39,3 % of the maximum accepted concentration and it was measured in January.

P4 measuring point presented a frequency of overflows of 83 % in 2011, and in 2012 of 22.2% registering values above the maximum accepted concentration.

In 2011 the highest quantity of powders was measured in May, having 42% above the maximum accepted concentration, and the lowest was registered in January and it represented 661.31% of the accepted limit.

In 2012, the highest value was registered in July, having 49.5% above the accepted limit, and the lowest one was in January and it represented 82% of the maximum accepted concentration.

The PM10 content is calculated by means of the relation:

$$\text{PM10} = \frac{m_1 - m_2}{V} \quad (\mu g / m^3) \quad (1)$$

Where:
m1 = filter mass after the exposure;
m2 = filter mass before exposure;
V = volume of aspired air.

The interpretation of the results for PM10 fraction was accomplished according to the stipulations of MAPM Order no. 592 /20O2 for approving the Normative regarding the establishment of the limit value, the maximum value and the criteria and methods of evaluation of the sulphur dioxide, the nitrogen dioxide and the nitrogen oxides, the powders in suspension (PM10 and PM 2,5), the slug, the benzene, the carbon monoxide and the ozone in the environmental air.

For PM10 the limit value for protecting human health is considered as the daily limit (for 24 hours) and it was established at 50 $\mu g/m^3$.

Taking the air samples was accomplished by a LVS (LOW VOLUME SYSTEM) sampling system for powders, having a sampling head for PM10. The debit of air sampling was adjusted at 2 m^3/h.

The values with concentrations of powders in suspension in the influence area of Pinoasa quarry are presented in table 3

Based on the obtained results, we may evaluate the contribution of different activities developed in the framework of Pinoasa quarry on the air pollution with powders in suspension.

Table3: Values of the PM10 in the area of Pinoasa quarry

Sampling point	Measured value ($\mu g/m^3$)	Limit value ($\mu g/m^3$)
P1	281,37	50
P2	129,22	
P3	58,35	
P4	73,04	

Therefore, in the point placed in the area of Timişeni coal deposit, 400-500 m away from the closest house, the PM10 concentration registered the highest value. The concentration of powders in suspension in this point was 5.62 times higher than the limit value. This increased value of powders in suspension is caused by the fact that, by falling off the transporting band in the deposit, the mining mass generates big quantities of dust. The increased quantity of powders in the environmental air may be influenced by the reduced humidity of the mining mass, by the reduced atmospheric precipitations and by the height of the falling off the band in the deposit.

The next sampling point, P2, was placed close to another important source generating powders. A distribution knot provides the concentration of the production of several technological lines, a fact that increases the powder concentration.

In this case, the PM10 concentration registered a value 2.6 times higher than the limit value.

The sampling point placed in an inhabited area (P3), situated 700 m towards SW from Pinoasa quarry, registered the lowest value. The concentration of powders in suspension measured in this area within 24 hours, was a little bit above the limit value, having 17% above it.

The last sampling point (P4) was placed in the influence area of the sterile deposit of Valea Negomirului. The registered concentration of powders in suspension had 46% above the limit value.

Measures for protecting the air quality

All the technological processes involving the movement of the soil and of the coal, and also the exposure of the erodible surfaces to wind, generate a certain quantity of powders freely emitted in the atmosphere.

For diminishing the impact of the exploiting activities of the coal on the air, we may take several measures that could lead to the reduction of the quantities of emitted powders. The applied methods depend on the source generating powders or other types of polluters (Sun et al., 2006; Li et al., 2009; Popa et al., 2001; Mutlu et al., 2011; Colucci et al., 2006; Nisulescu et al., 2010; Standard Collection of Enviroment Protection).

- A method quite frequently used in all the daily exploitations consists of using certain mobile sources that could splash the areas of access and manipulations, especially during summer, when the powder concentration in the atmosphere may significantly increase.

- The accomplishment of certain fog curtains by spraying water under pressure (16 atm), accomplished especially in the work points where the high quantities of powders are generated and other technical solutions cannot be used.
- Capturing the dust at source by hulling the installations generating powders. This measure applies especially on the band sectors passing by protected areas (houses, social-cultural objectives etc.), at the distribution knots, at the charging places.
- For preventing the auto-burning, the movement of the coal stocks is used as a measure, especially during hot seasons.
- Hardening the coal during the pile formation, for removing the empty airs.
- Using covering protecting layers. For stopping the air access inside the coal pile, the surface and the embankments are covered with different materials such as: coal dust, cinder dust having a hardened width of 10 – 15 cm, anthracite having a width of maximum 3mm, splashed with fuel oil and hardened. We may also use clay bitumen paste (45% bitumen, 25% water and 30% clay), applied on the pile surface as liquid, in a 2 -3 mm layer. Using the clay bitumen paste as a protecting layer is possible only when the environmental temperature is above 0° C.
- Using the inhibitors in order to diminish the qualitative losses of coal. These create pellicles on the pile surface stopping the access of the air oxygen and its interaction with the coal. As mechanic inhibitors, the polishes, the paints, the macromolecular organic substances, the combinations with polymerization properties at oxidation and heat are very used. As chemical inhibitors, we use: chlorines ($CaCl_2$) adding clay and lime dust, the suspensions of hydrate of lime saturated with carbon dioxide – calcium bicarbonate, ammoniac, ammoniacal salts, mixtures of phenol – formaldehyde resins, polyacrylamide, shale, furnace cinder etc. .
- For stopping the auto-burning of the coal in layers that crop out, we do not discopert completely, leaving a sterile layer of about 10 - 15 cm.
- Checking the temperature by wells of steel pipes to the pile bottom, where thermometers are descended, measuring the temperature every 2 meters of depth; when overcrossing the temperature of 40 ^{0} C, the control is made every 12 h, and if the temperature overflows 60 ^{0} C, the coal is immediately consumed.
- Giving back the fields having no more technological tasks to the productive circuit for limiting the extension of the powders in the atmosphere by means of the wind.

4. CONCLUSION

Based on the presented facts and on the study regarding the pollution in the influence area of Pinoasa quarry, we may formulate certain conclusions regarding the impact produced by the activity of this quarry on the environment.

- The technological process of exploiting coal and sterile is composed of three phases: excavation, transport and depositing.
- The exploitation of the mining mass in Pinoasa quarry is accomplished by means of the rotor excavators having a high capacity, and the transport is accomplished by means of the transporting bands.
- The polluting sources of the air with particles are mainly represented by the distribution knots, the places where it is produced the crossing of the mining mass from a section to another, the coal deposits and the access ways for cars.
- Considering the 5 monitoring points of the sedimentary powders, none of them registered values below the maximum accepted concentration, across the two study years.
- The only lapse of time when the overflows of the maximum accepted concentration were not registered was in January, both in 2010 and in 2011. These values under the limit are

caused by the stopping of the activity of excavation and coal transport in this lapse of time, not by technical reasons.

- The lapse of time having the highest concentrations of sedimentary powders was June-July, and June 2011 was the only month within the two analysed years when the frequency of overflows was 100 %.
- Considering the 5 monitoring points, the highest concentrations of sedimentary powders were registered in P1, placed in the closest area of the coal transporting bands and of a crossing from a band to another.
- The lowest concentrations of sedimentary powders were registered in P5.
- During the two study years, higher concentrations of sedimentary powders were rather registered in summer than in the other seasons, and this fact is considered to occur because of the reduced humidity of the mining mass and of the air.
- Regarding the powders in suspension, the highest concentrations were registered in the area of the coal deposit, following the distribution knots or the crossing areas of the mining mass from a band section to another. This aspect was also found when accomplishing measurements for other quarries.
- In case of a daily mining exploitation, we should take protecting measures for the environment, both during exploitation and after stopping the exploitation activity.

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