

Measurements of PM10 particles made in the Roşia of Jiu quarry as a result of the use of Komatsu PC4000-11 hydraulic excavator

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Abstract. This paper studies the Roşia Jiu quarry area in Romania. This research highlights the working method of hydraulic excavators and the values of particles released into the atmosphere by them. Improving technological equipment not only helps build a better world, but also restores and preserves the environment. The measurements were made during 2020, using DSM501A sensors, which were located at four points in the quarry, namely in the north, southeast and west of the quarry.

1 Introduction

Between the villages of Zatreana and Mosneni, there is the largest mining quarry, namely the Roşia quarry. In 1973 - with only a few dozen workers, the 2000-01 excavator and a unloading line were put into operation, with which, in over 1000 hours, more than 1.4 million cubic meters of material covering the layers of coal were dug and excavated. Thus, the opening of the quarry was executed, creating the conditions for carrying out the water capture and evacuation works as well as for the introduction in the production circuit. Starting with the following year, other technological lines were launched, constantly setting the goal of a large production capacity of the Rovinari mining basin.[10]

Over time, due to the development of society and human industry, the equipment used in the country has been constantly changing, thus wanting to increase efficiency in operation and a low cost of maintenance. Today, one of the new machines used in the quarry is a hydraulic mining excavator called Komatsu. It is produced by Komatsu Germany[10].

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Fig. 1 Komatsu PC4000-11 hydraulic excavator

The PC4000-11 excavator is the most modern on the market, and the functions such as the simplified system, safety such as the 45 ° access system, additional railings, the rescue hatch and the unmatched emergency exit staircase are the results of continuous process improvements. of Komatsu engineering. It has been combined with the latest maintenance functions, resulting in higher production, huge safety results, less maintenance and performance monitoring.

This paper studies the operation of the Komatsu PC4000-11 hydraulic excavator found in the Rosia quarry and how their activity affects the environment.[9]

2 Materials and Methods

For this work I chose the Komatsu PC4000-11 hydraulic excavator. It has a 16-cylinder SDA16V160E-3 engine with a power of 1400 kW, which is still the central component of the PC4000-11.

The engine, which is turbocharged in one stage and subsequently cooled. It has been enhanced with new settings to meet all relevant requirements of the final EPA Tier 4 regulations and to be part of the complete exhaust aftertreatment system. The engine can run 24 hours without interruption thus combining reliability with durability for allow efficient production.



Fig. 2 Komatsu engine

With the new engine settings, Komatsu could reduce the number of particles (PM). This reduction in PM is just one step in PC4000-11's new Tier 4 final machine concept. The other step is the control of nitrogen oxides (NOx) through an improved selective catalytic reduction (SCR) system. By thus replacing the shock absorber of the excavator exhaust system, no additional space is required for the SCR. By injecting diesel exhaust fluid (DEF) into the exhaust stream, the SCR system converts harmful NOx into nitrogen and harmless steam to protect the environment. [8]

Komtrax Plus 2 is the development of the well-proven and optional Komtrax Plus monitoring system from Komatsu with years of experience. The system provides real-time machine data to the operator and maintenance crew. Error messages are monitored, stored and alarmed as standard by audible and visual alarms. Added to this Komtrax Plus 2, it offers a reduction in service time through easy maintenance analysis. As well as a comprehensive reporting function for mine management.

Safety is the major issue in the mining industry. KomVision helps reduce accidents at work and gives operators a better feeling. KomVision is one of our key security features. Helps protect the operator from hazards. Several rooms are mounted on and around the excavator to provide the best safety conditions. The selected areas around the excavators

mark the safety zone, the work area and the evacuation area. The operator recognizes any movement of foreign objects in his work area and can react. All devices in the seven implemented cameras are available for a single view to provide a detailed picture of the surroundings.

The access system has been newly designed to provide the operator with the best security conditions. The access and exit system is designed to meet the highest standards of comfort and safety. The 45 ° stair system allows the operator and maintenance staff comfortable and safe access to the machine house and the cab. The main features are the system of stairs with steps made of non-slip grids and an additional non-slip edge. The reduction of PM and NOx is the major requirement to fully complete the final level 4 regulation. Environmental pollution will be significantly reduced. NOx reduction could be reduced tenfold and even PM pollution could be reduced almost 14 times compared to level 1 regulation. Due to the implementation of all features, we comply with all environmental regulations.

Compared to the level 1 version, the NoX reduction of the final level 4 version is significantly low. In addition, the particulate matter emission of a level 1 machine is consistent with 14 final level 4 machines. The DEF tank is located on the roof of the excavator and is injected into the exhaust pipe, where it connects to the PM to reduce the emissions as you can see below. [8]

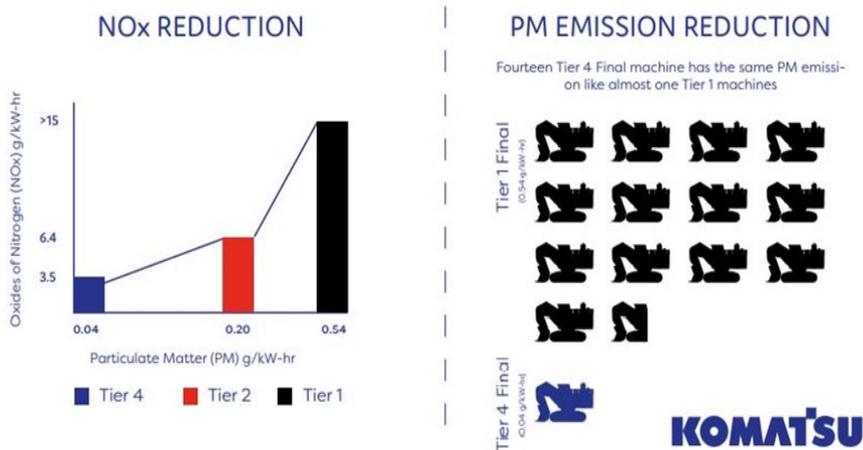


Fig. 3 X reduction of the Tier

The measurements were made using DSM501a sensors, which were connected to an arduino board. The measurements are made over a period of one year, namely the year 2020 in the cardinal points of the quarry, in order to see if the change of equipment really achieves a lower production of suspended particles, particles that affect the environment and human society. The dust sensor module DSM501A is a compact size for a particle density sensor with it is used to quantitative particle (> 1 micron) measurement with the principle of particle counter. The measurements performed are presented below.

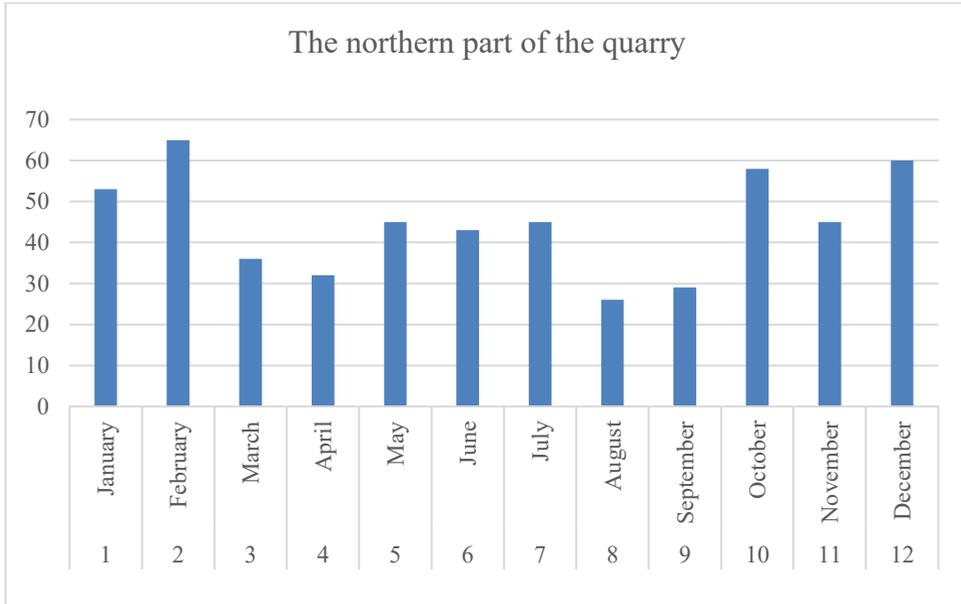


Fig. 4 PM 10 suspended particle value [$\mu\text{g}/\text{m}^3$].

As we can see in the graph above, the daily limit values in the northern part of the quarry have exceeded, so their increases can be observed, especially in the winter days, when the coal demand was much higher. Thus the months of February and December knew values exceeding $50\mu\text{g} / \text{m}^3$.

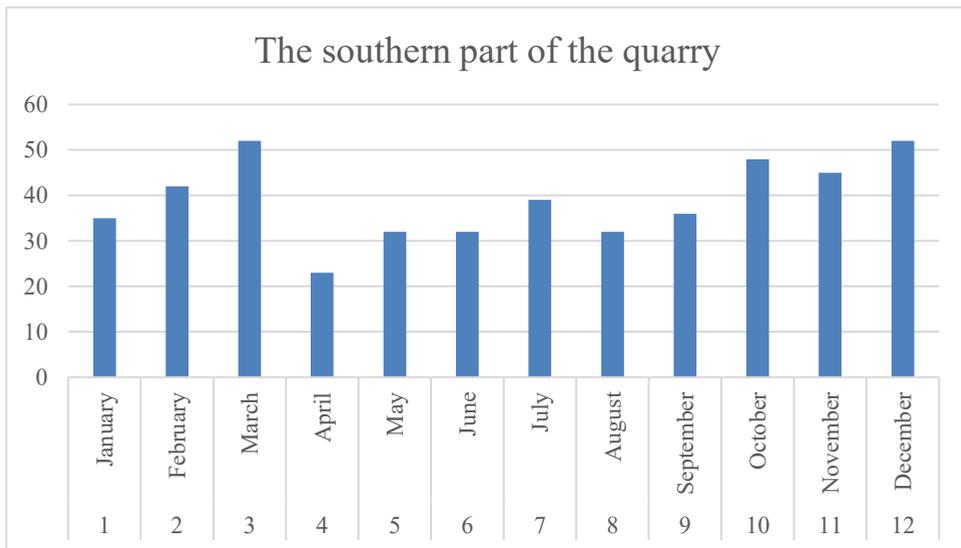


Fig. 5 PM 10 suspended particle value [$\mu\text{g}/\text{m}^3$].

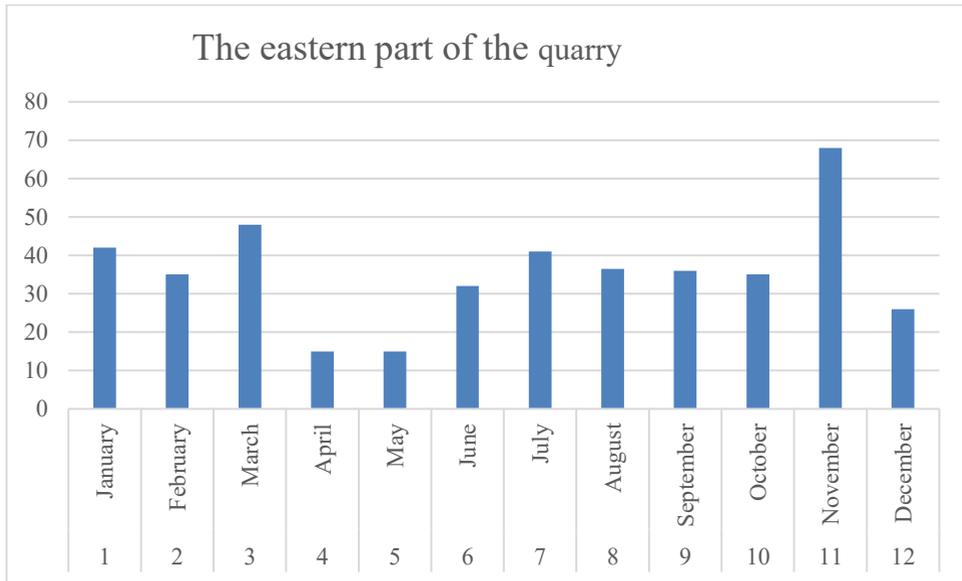


Fig. 6 PM 10 suspended particle value [$\mu\text{g}/\text{m}^3$].

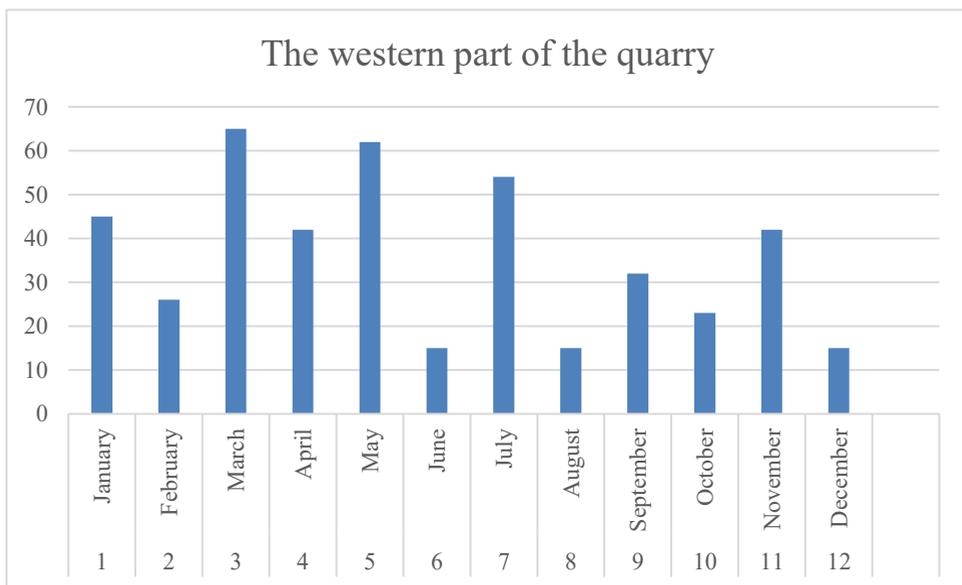


Fig. 7 PM 10 suspended particle value [$\mu\text{g}/\text{m}^3$].

As we can see in the graphs presented in figures 5,6 and 7, the measured values still record frequent values that exceed the limits established by law 104 of 2011, but we can say that the situation is much better than 10 years ago when the values exceeded these monthly limit. Because the large area of exploitation is not located near the houses, we point out that the eliminated particles do not directly affect the health of the population. And in the other parts of the quarry the most important values were measured in the winter months because then the recorded temperatures are very low which results in a high consumption of coal necessary for the production of electricity and heat.

3 Conclusions

Mining activity, regardless of how it is carried out, always produces long-term negative effects on the environment and human health.

As we can see, the areas around the perimeter of the coal dumps are not in a very marked state of degradation, but the pollution generated by the mining operations has produced and produces negative effects on the environment. Thus, the water around this deposit cannot be potable, the soil is not indicated for growing vegetables or plants, and pollution with suspended particles can endanger human health if the limit values are exceeded.

The role of this paper was to highlight how the refurbishment and acquisition of new technologies and operating equipment can have a positive influence on the environment. After we could observe in the measurements made during 2020, the air quality and the environment underwent an improvement compared to 10 years ago when the equipment used was outdated and in a poorly functioning state.

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