AIR QUALITY AND DISPERSION OF ATMOSPHERIC POLLUTANTS

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ABSTRACT: *The paper comprises a study of pollutant dispersion modelling at local and regional scale which would concentrate on the assessment of the impact on air quality generated by high combustion installations of Rovinari power plant. Due to its geographical position, the area of the locality of Rovinari is affected by the regional pollutant transport. This fact has been highlighted by the studies of air quality assessment through mathematical modelling at national level.*

KEY WORDS: *pollutant, particles, dispersion, air quality,emissions.*

1.INTRODUCTION

Particles are those tiny solid or liquid powders that are suspended in the air and which are usually invisible to the naked eye individually.
However, collectively, small particles often form a clouding limiting visibility.
Indeed, on many summer days the sky over the cities of North America and Europe is white in color instead of blue, due to the scattering of light by particles suspended in the air.
Particles suspended in a given mass of air are not all of the same size or shape, nor have the same chemical composition.

2.AIR QUALITY INDICES FOR PARTICULATE MATTER

When air quality is monitored, the most common measure a concentration of suspended particles is the PM index (Particulate Matter = substance in particulate form), which means the amount of the substance below particle form present in a given volume. Since the substance involved is usually inhomogeneous, its molar mass can not be used, and therefore the concentrations are given in terms of the mass of the particles and not the number of moles.

Usual units are micrograms of particulate matter per cubic meter of air ($\mu g / m^3$). Since smaller particles have a higher harmful effect on human health than the larger ones, usually only those with a certain diameter or less than that are collected and reported. This limit diameter, in µm, is listed as an index to the PM symbol.

A part of the harmful emissions from coal fired power plants and other sources are minute particles called PM10 and PM2.5.
These fine particles emitted from the power plants disperse over a wide area and are harmful to human beings as they enter the respiratory tract and cause many chronic health problems. Based on their size, they are known as PM_{10} and $PM_{2.5}$.
Pollution due to particulate matter in the air is one of the six criteria pollutants in the National Air Quality Standard by the US EPA and also by other regulatory authorities worldwide. Documented health hazards world-wide prompted regulators to specify special regulations to contain the emission of theses small particles into the atmosphere.
Due to the very small size, this finds its way into the respiratory tract of humans and is identified as a potential health hazard for the population exposed to it. These particles embedded in the respiratory tract can cause respiratory tract infections, asthmatic complaints, and chronic bronchitis.

Dust from power plants was one of the main emission problems of old coal fired power plants. Visibility and ophthalmic problems were the result of exposure to this dust content. Effects on respiratory diseases were not documented. Power plants then had only mechanical cyclones that separated around sixty to seventy percent of the ash.

As the power plant numbers and capacities increased regulations were in place limiting the dust emission from these plants. The advent of reliable Electrostatic Precipitators (ESP's) and reliable fabric filters helped in considerably reducing dust or particulate emission. Reduction of the earlier limits of 350 μg/m^3 to the current values of 150 μg/m^3 or below is to eliminate these health hazards. Together with regulations that require higher chimney stacks, dust fallout on ground level is predicted to be at acceptable levels.

Earlier standards specified only the total dust emission without considering the size of the particles. Considering the documented evidence of health hazards associated with very fine particles, particulate emission regulations are now made in two parts namely PM10, particulate matter less than 10 micrometers and PM2.5 particulate matter less than 2.5 micrometers. Particles greater than 10 microns settle to the ground with less chance of entering the respiratory tract.

The current National Ambient Air Quality Standards of US EPA identifies PM10 and PM2.5 as part of the six criteria pollutants. The limits of PM10 are 150 μg/m3 average on a 24 hour basis and PM2.5 is 15 μg/m3 on an annual average basis.

The particulate matter themselves can be divided into two as to their formation.

First is the primary particle that forms directly at the source like the ash formed during the combustion of the coal or dust formed during combustion.

The other category is the secondary particles formed due to chemical reactions from gaseous emissions from the primary source. Majority is from vehicular emissions.

Most of the particulate emissions from coal fired plants fall in the PM10 category.

The contribution to PM2.5 from power plants is the secondary particles formation due to the SO_X and NO_X emissions from the plant.

3. DISPERSION OF ATMOSPHERIC POLLUTANTS

The forecasting of ambient air pollution levels generated by all the sources of the studied objective was done by mathematical modeling of the concentration fields.

The assessment of the concentration levels was made by reference to the limit values provided by the regulations in force: QRD MAPM no. 592/2002 and STAS no. 12574/1987.

The limit values and alert and intervention threshold values are presented in Table 1.

Table 1. - limit values for air quality (μg / m^3)

Poluant	Valori (VL) limită	Marje de toleranță (MT) % din VL acceptate	Valori ghid OMS	UR Expunerea la conentrația de 1μg/m^3 OMS	Perioada de mediere	Nr.De depășiri ale VL acceptate	Limita pt protecția (recap-torilor)	Anul intrării în vigoare	Pragul de alertă
TSP	500	-	-	-	30 min	-	Populație	Actual	350
	150	-	-	-	24 h	-	Populație	Actual	175
	75	-	-	-	1an	-	Populație	Actual	52,5

Until the year in which the limit values enter into force, the accepted value is equal to the sum of the limit value and the margin of tolerance. The margin of tolerance decreases annually progressively, so that on 1 January of the entry into force of the limit values the margin of tolerance becomes zero.

Figure 1 shows the air quality mediation period compared to the threshold value under the current STAS and the alert threshold.

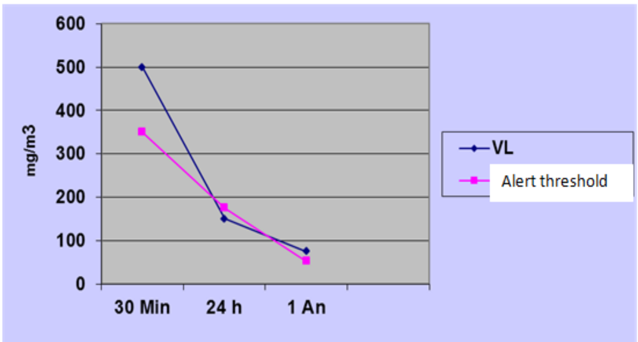

Figure 1 Air quality mediation period compared to the threshold value under the current STAS and the alert threshold

For the mathematical modeling of the concentration fields, the OML model was used.

4. MODEL DESCRIPTION - OML - DISPERSION MODEL FOR SURFACE POINT SOURCES

OML-multi is a local scale pollutant dispersion model developed by the National Environmental Research Institute - NERI (Denmark) in the 1980s. At the level of the 1990s, this model became operational, being widely used in Denmark for practical applications on the estimation of air quality in different areas and can be run both in urban areas and in rural areas up to 30 km.

Throughout the 1990s, the model has been improved both from the theoretical point of view and from the point of view of presenting and viewing the results.

OML-multi is a Gaussian multisource model. The model was designed to include in its theory the main physical phenomena that govern the dispersion into the atmosphere of pollutants from industrial sources or other sources. The model can include point sources as well as surface sources.

It has also been pursued:

• the best possible behavior of the model in most possible atmospheric conditions;

• avoiding discontinuities in describing the dispersion phenomenon;

• the possibility of its application for operational purposes;

Thus, compared to the Gaussian models developed to date, OML - many introduces:

• new methods for calculating the pollutant cant.

• modeling the penetration phenomenon of the boundary layer;

• New methods of handling horizontal dispersion at very low wind speeds or systematic wind direction changes;

• New methods for simulating building effects;

Initially, OML was designed to model the dispersion of pollutants in flat land in urban and rural areas. The new version of OML has several methods of including complex land. The final version of OML - multi is the result of a long process.

Since its first validation through experiments, the many new phenomena that have been introduced over time have required new and new experimental validations and validations.

Structural OML - many consists of:

• Meteorological Preprocessor - the computational method of the physical parameters necessary for the modeling of the dispersion processes, starting from meteorological measurements;

• The actual dispersion model - the copulative method of estimating the concentration fields in a predefined receiver system, based on the physical parameters and other input data required (emission data, field information).

The meteorological pre-processor requires time-based meteorological data inputs and two vertical temperature profiles performed daily by radios.

Output data are turbulent parameters:

• Heat sensitive flow;

• length Monin - Obukhov;

• Friction speed;

• Mixing height.

Input data are:

• weather data: generated in a specific format following the weather preprocessor run;

• Sources data: physical parameters of sources (point sources - baskets) or geometric dimensions - length - width - height for surface sources;

• data related to the receptor network: defining the receptor coordinates in a spherical or rectangular coordinate system.

Output data are the concentration fields in the defined receptor network nodes.

OML - multi generates average hourly concentrations, monthly, yearly, and other important statistical values in air quality assessment in all nodes of the receptor network.

The mathematical modeling of the concentration fields was performed for the main pollutants emitted by the related sources. Total particulate pollutant pollution has been considered, which has associated limit values for the protection of susceptible receptors likely to be affected (the population in the surrounding area).

The results of modeling, dust dispersion maps are shown in figures (2, 3, 4).

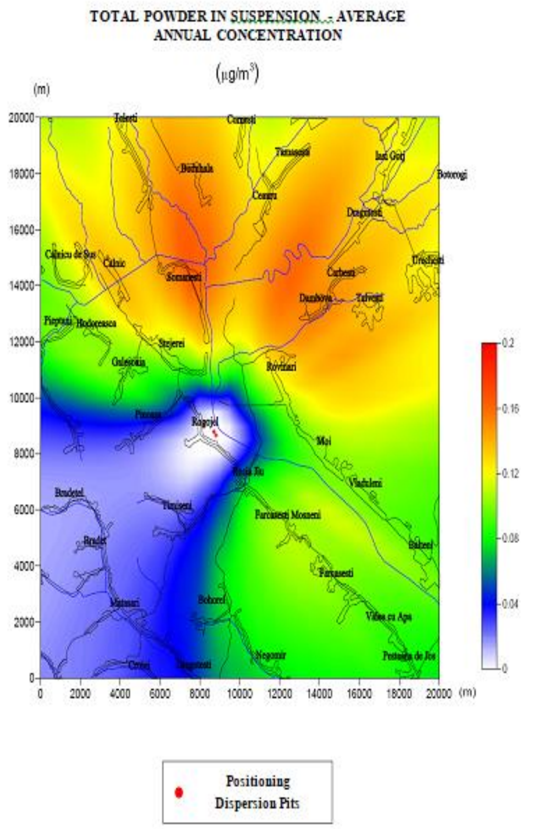

Figure 2 Powder dispersion map - annual average concentration

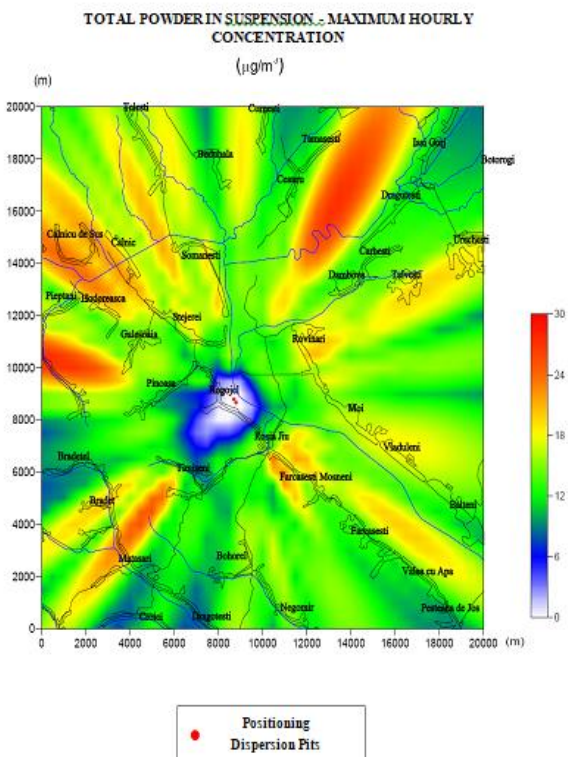

Figure 3 Powder dispersion map - maximum hourly concentration

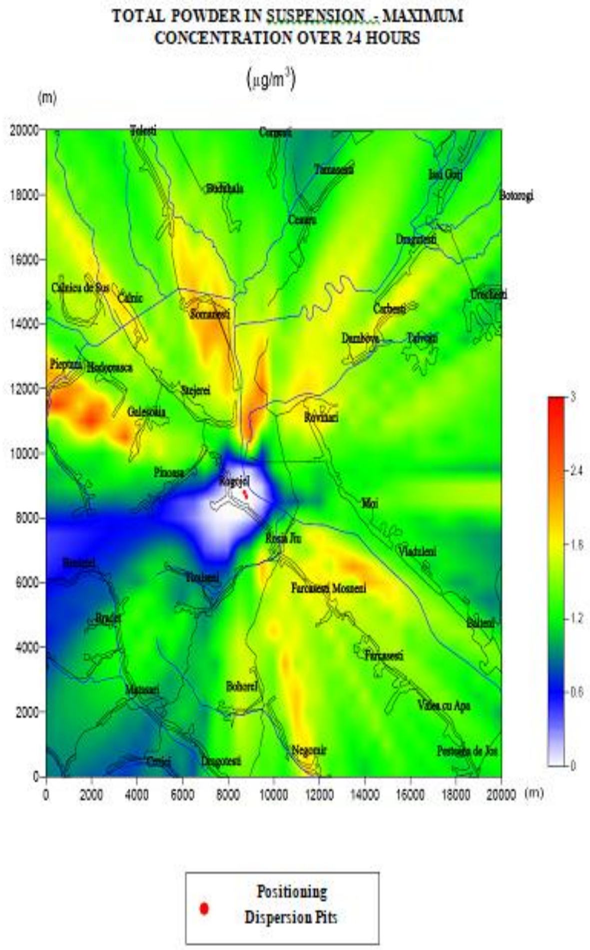

Figure 4 Powder dispersion map - maximum concentration over 24 hours

CONCLUSION

One factor in improving air quality has been the pollution-control technologies used by coal-fired power plants. Today's coal-fired electricity generating plants produce more power, with less emission of criteria pollutants, than ever before. Undoubtedly, air quality will continue to improve in the future because of improved technology.
Using this dispersion model OML it can be observed the impact on air quality both at regional and local level, which is very well presented in the dispersion maps.
Due to the pollution caused by these pollutants resulting from the combustion of coal, we are currently trying to reduce pollution by adopting new technologies capable of reducing ash far as possible their harmful effects.

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