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DISPERSION OF POLLUTANTS AT ROVINARI POWER PLANT

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Abstract

The accelerated development of the global industry has led to the increase of pollutant emission in the atmosphere, which has a negative effect on fauna and flora. The phenomenon has highly increased after 1970, which alerted the governments.

It seems that the environmental pollution through the uncontrolled human activity reaches the "critical threshold" exceeding the limits of nature defence, thus endangering the existence of life on Terra.

In this paper, we have carried out a study of dispersion of pollutants resulted from solid fuel combustion at the power plant Rovinari. We study the spatial distribution of pollutants for different cases of the functioning of energetic groups.

Keywords: pollution, dispersion, model, desulphurisation, coal, case.

INTRODUCTION

The current stage of pollution at Rovinari CTE depends on the modernisations made to the thermo energetic equipment used, to the exploitation staff, to the quality and characteristics of the fuel used.

In this moment, at Rovinari the energetic groups no. 3 and 6 are modernised, being implemented desulphurisation installations of combustion gases, and the energetic groups no. 4 and 5 are going to be modernised.

Pollutant dispersion does not depend only on the activity of thermoelectric power plants, but also on the auxiliary activities, since they are sources of pollutants, namely: the quarries pertaining to the Company Complex Energetic Oltenia S.A., fuel administration, evacuation and deposition of slag and ash.

In order to meet the technical requirements for assessing pollutant transport at regional scale an Euler numerical model called TAPM (The Air Pollution Model) was used, being a combined mode of meteorology-dispersion.

With this application five cases of pollutant dispersion have been studied, namely: without desulphurisation installation, with a desulphurisation installation, with two desulphurisation installations, with three desulphurisation installations and with four desulphurisation installations.

An efficiency of the use of desulphurisation installation of combustion gases can be observed gradually after this study.

Pollution particles adversely affect the whole environment.

The large quantities of particles [6] must be dispersed on a surface as extended as possible, because particles have negative effects on flora and fauna. The higher the concentration is, the more significant the negative effects are.

The particles with dimensions exceeding 10 μm are retained in the superior airways and are eliminated fast.

The particles with inferior dimensions to the sedimentary ones are extremely important from a meteorological point of view, since they constitute water vapour condensation nuclei. The particles with a diameter smaller than 10 μm remain suspended in the atmosphere and from a qualitative point of view, the individual

particles are classified into *coarse* and *fine* particles, depending on their diameter, if it is bigger or smaller than 2,5 μm. The particles smaller than 10 μm are called “breathable aerosols” and can reach during respiration up to the level of pulmonary alveoli, having a high noxious potential.
There are many common terms for atmospheric particles: “dust” and “soot” refer to solid particles, “fog” and “mist” refer to liquid particles, the latter designating a high concentration of water drops.
When air quality is monitored, the most common measure of suspended particle concentration is the index **PM** (Particulate Matter = substance under the form of particles) [5], designating the quantity of substance under the form of particles present in a certain volume.
The usual units are micrograms of substance in particles per cubic metre of air ($\mu g/m^3$).
In the last years, the government agencies of many countries have monitored PM10, namely total concentration of particles with diameters smaller than 10 μm, which corresponds to all fields of fine particles, plus the smallest classes of coarse particles, all these being called particles that can be inhaled. A PM10-type value in an urban settlement is of 30 $\mu g/m^3$.
The index PM2,5 is highly used, which comprised all fine particles with a diameter below 2,5 μm, called also *breathable* particles.
The new term of *superfine* is used for particles with very small diameters, usually smaller than 0,05μm (50 nm), although various scientists use different values. In the past, instead of PM index the total suspended particles (TSP) were reported, representing the concentration of all substances under the form of air particles.

THE DISPERSION OF ATMOSPHERIC POLLUTANTS

The forecasting levels of environmental air generated by all the sources corresponding to the studied objective were made through the mathematical modelling of concentration fields.
By the year in which the limit values enter in force, the accepted value is equal with the sum of the limit value and the margin of tolerance. The margin of tolerance is decreasing annually, so that beginning with 1 January of the year in which the limit value enters into force, the tolerance margin becomes zero [1].
The role of pollutant dispersion modelling in the process of air quality assessment is very important, representing an important instrument in the development of action plans for the improvement of air quality, which represents the final aim and objective environmental public authorities.
The modelling improves the efficiency of air quality management. By modelling, the contribution of different categories of sources to the limit value exceedance can be identified.
Another major advantage of using pollutant modelling in the air in managing and assessing air quality is the improvement of the capacity to represent the distribution of pollutant concentration spatially, with application from regional scale. Furthermore, the modelling will contribute to the establishment of the compliance or non-compliance to the quality objectives laid down by the legislation in force, laid down by the legislation in force helping in the same time to the identification of regions which could contain areas where the limit values are exceeded.
With this regard, 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 CTE, namely: two large combustion installations type I, with a thermal power higher than 500 MWt formed of 4 energetic groups which comprise a tower boiler of 1035 t/h, steam turbine FIC type with condensation, electric generator of 330 MW and

transformer of 400 MVA, 24/400 kV.

The forecasting of air pollution – mathematical modelling of pollutant dispersion in the environmental air and the elaboration of dispersion maps were performed for the following situations:

- the functioning of all four energetic blocks without desulphurisation installations of combustion gases;
- the functioning of three energetic blocks without desulphurisation installations of combustion gases and of an energetic block with a desulphurisation installation of combustion gases;
- the functioning of two energetic blocks without desulphurisation installations of combustion gases and of two energetic blocks with a desulphurisation installation of combustion gases;
- the functioning of an energetic block without a desulphurisation installation of combustion gases and of three energetic blocks with desulphurisation installations of combustion gases;
- the functioning of all four energetic blocks with desulphurisation installations of combustion gases.

Apart from the functioning of energetic blocks corresponding to desulphurisation installations [2], there were taken into account the modernisation of the existent filters of every group and the mounting of burners with reduced NOx.

The dispersion study [4] will take into account the values of regional fund concentrations induced by the pollutant transport from mesoscale to regional scale.

Only the combustion installations within Rovinari CTE have been taken into consideration as emission sources, represented by 3, 4, 5 and 6 energetic blocks, considering their functioning in 5 different cases, corresponding to different implementation stages of the new measures emissions reduction for each energetic block [3] – represented by the functioning of the desulphurisation installations of combustion gases, the modernisation of existent filters and the installation of burners with reduced NOx – as follows:

Case "1" – before the desulphurisation installation starts functioning:

- the functioning of 3, 4, 5 and 6 energetic blocks without desulphurisation installations;

Case „2" – after the first desulphurisation installation starts functioning, to the 3 energetic block ;

- the functioning of the 3 energetic block with desulphurisation installation, with the evacuation of combustion gases through the new FGD chimney no. 3;
- the functioning of the 4, 5 and 6 energetic block without desulphurisation installation, with the evacuation of combustion gases through the existent chimney no. 1;

Case „3" – after the second desulphurisation installation starts functioning, to the 6 energetic block:

- the functioning of the 3 and 6 energetic block with desulphurisation installation;
- the functioning of the 4 and 5 without desulphurisation installation;

Case „4" – after the third desulphurisation installation starts functioning, to the 4 energetic block:

- the functioning of the 3, 4 and 6 energetic block with desulphurisation installation;
- the functioning of the 5 energetic block without desulphurisation installation;

Case „5" – after the fourth desulphurisation installation starts functioning, to the 5 energetic block:

- the functioning of the 3, 4, 5 and 6 energetic block with desulphurisation installation.

DISPERSION MODEL USED

The mode used is called TAPM (The Air Pollution Model) and is a combined model of meteorology –

dispersion.
In order to meet these technical requirements for the assessment of pollutant transport, an Euler numerical model.
The meteorological compound of TAPM is a forecast, incompressible, non-hydrostatic model, of primitive equation solved in coordinates which monitor topography.
The dispersion Euler model consists of telescopic solution (the model can roll in "nest" mode) of the concentration Euler equation representing advection, diffusion and chemical reactions.

Processes of dry and moist deposition are also included.

The concentration forecast equation is similar with that used for the potential virtual temperature and the specific humidity variables from the meteorological model.
Entry data are formed of the meteorological data and the data related to the field.
Output data are represented by the concentration fields from the defined cells of the calculation grills. TAPM generated in all the cells of calculation grills, hour average concentrations, means on 8 hours, daily means, as well as annual means, percentiles and other statistical values important in the assessment of air quality.

Table 1 *Maximum concentrations obtained by modeling the different averaging intervals on grid computing*

Pollutant	Averaging time	Limit values (VL) [μg /m^3]	Maximum concentrations [μg /m^3]					% din VL				
			Whitout IDG	Whit 1 IDG	Whit 2 IDG	Whit 3 IDG	Whit 4 IDG	Whitout IDG	Whit 1 IDG	Whit 2 IDG	Whit 3 IDG	Whit 4 IDG
NO_2	1 h	200	84,97	107,20	138.40	147,59	183,35	42,49	53,60	69.20	73,80	91,68
	year	40	5,13	8,71	13.65	16,21	21,02	12,85	21,80	34.13	40,53	52,56
NOx	year	30	7,70	13,07	20,48	24,31	31,53	25,69	43,59	68,27	81,06	105,12
SO_2	1 h	350	1011,07	835,05	716,48	436,48	212,79	288,88	238,59	204,71	124,71	60,80
	24 h	125	348,54	298,41	271,48	147,46	75,18	278,83	238,73	217,19	117,97	60,15
	year	20	64,27	58,89	53,84	38,65	26,32	321,38	294,49	269,23	193,27	131,61
PM_{10}	24 h	50	2,04	2,06	1,77	1,46	0,02	4,10	4,13	3,56	2,93	0,05
	year	40	0,79	0,80	0,67	0,56	0,01	1,98	2,00	1,69	1,42	0,03

*IDG - installation of flue gas desulphurisation

Analysing the measurement results it is observed that after the introduction of the desulphurisation installations of combustion gases (IDG) at the four energetic blocks the SO_2 percentage decreases from 262,95% to 131,61%, in exchange the NO_x percentage increases from 21,02% when IDG are not mounted to 105,12% when IDG are mounted at all energetic groups.
Spatial distribution of daily maximum concentration measures is based on comparative dispersion maps.

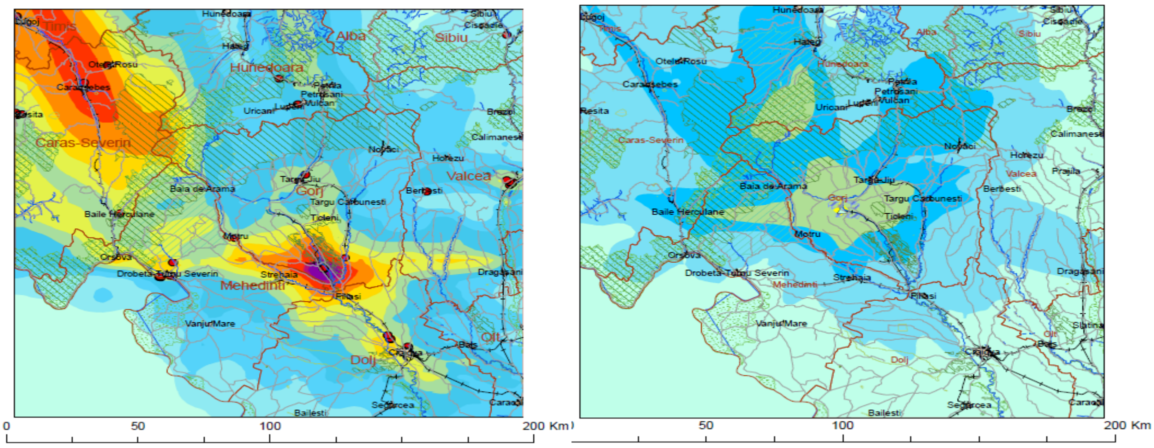

Figure 1*. Spatial distribution of maximum daily SO_2 concentration in case 1 and case 5 (without IDG and with 4 IDG) - impact on a regional scale*

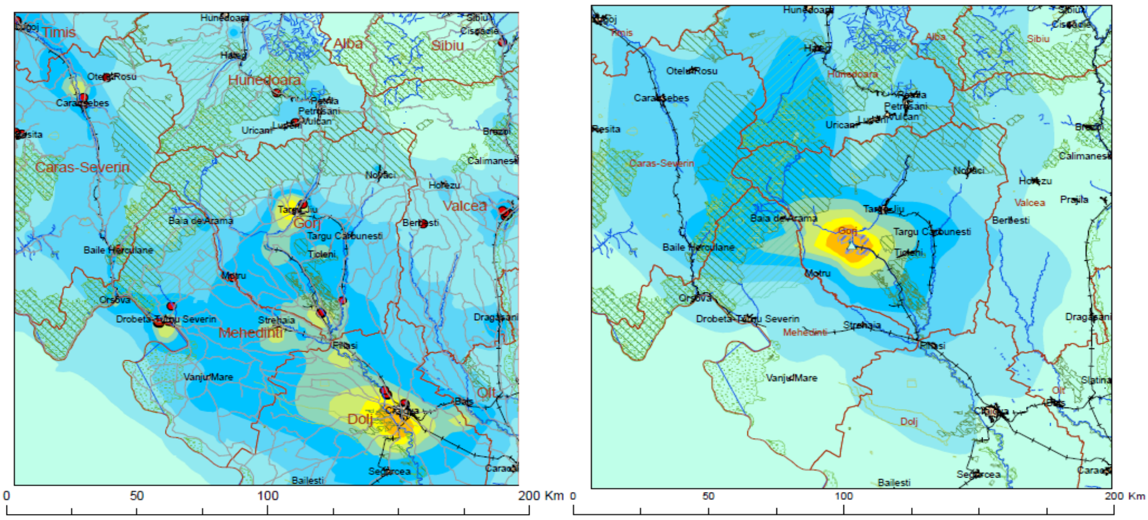

Figure 2*. Spatial distribution of maximum daily NO_2 concentration in case 1 and case 5 (without IDG and with 4 IDG) -impact on a regional scale*

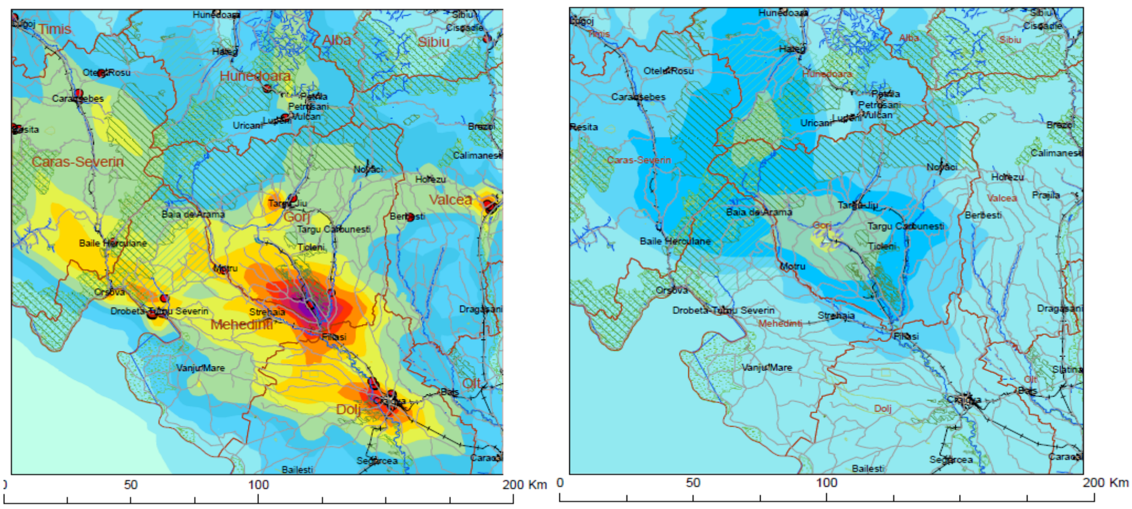

Figure 3. *Spatial distribution of maximum daily PM10 concentration in case 1 and case 5 (without IDG and with 4 IDG) - impact on a regional scale*

CONCLUSION

Analysing the measurement results it is observed that after the introduction of the desulphurisation installations of combustion gases (IDG) at the four energetic blocks the SO_2 percentage decreases, in exchange the NO_x percentage increases. The conclusion is that the measures for reducing SO_2 lead to the modification of NO_x content. The same situation is encountered in the other measurement areas of pollutant concentrations. In order to reduce pollutant emissions is mandatory to reduce NO_x through corresponding methods.

Taking into account these aspects, it can be stated that compared to the real possible functioning situations, in the analysed scenarios the levels of pollution generated by IMA operation within Rovinari CTE through an exclusive impact have been overestimated.

Case 1 represents the most unfavourable as possible, related to the impact of the functioning of large combustion installations of Rovinari CTE on the environmental air quality[6], since it treats the simultaneous functioning of all the 4 energetic blocks of the power plant, without any improvement brought to the systems of emission reduction/control (equipment of energetic blocks with desulphurisation installation, burners with reduced NOx and modernisation of electrofilters).

The same hypotheses regarding boiler's load, number of functioning hours per year and participation of fuel used have been made for the scenarios 1, 2, 3 and 4. In addition, it is specified that, until the functioning of all four energetic blocks with the new systems of emission reduction/control, the analysed situations within 1, 2, 3 and 4 scenarios will have a slight occurrence probability, because for the gradual mounting, for every energetic block of these systems, one block of 4 will be always in crucial repairs with modernisation, being not functional, and in these conditions the impact on air quality is due to the input of only three blocks of four.

The theoretical and experimental researches in the paper prove that pollutant formation is a complex process which depends on the following factors: thermo energetic equipment, exploitation staff, used fuel and its quality, as well as series of economic factors.

The polluting emission cannot be totally eliminated, but there are efforts to reduce them within the limits required by the regulations on environmental protection, through a continuous research, modernisation and increase of the efficiency of thermo energetic installations.

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