SULPHUR REMOVAL IN COAL-FIRED POWER PLANTS. PART II: BEFORE AND AFTER IMPLEMENTATION

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ABSTRACT: This paper presents a cases study on implementation of a post-combustion sulphur removal system at Turceni coal-fired power plant. In order to assess the effectiveness of the sulphur removal system, a comparative study was conducted using emission data before and after implementation. It was found that: (1) before system implementation, the emission level for SO_2, NO_2 and particulate matter was much higher than the limit values; (2) after system implementation, the emission level reduced significantly, below the limit values.

Key-Words: - emission factor, coal-fired boiler, sulphur oxides

1. INTRODUCTION

According to the implementation plan for Directive 2001/80 / EC on the limitation of emissions of certain pollutants into the air from large combustion plants, in Western Europe, the level of 50 mg / m^3N of dust in dusty gases is widespread [1].
Faced with a significant reduction in emissions of pollutants from IMA, Romania had a choice between complying with the emission limit values for sulfur dioxide, nitrogen oxides and dust by each existing IMA, or to develop a Plan National Reduction of Emissions from existing IMA [1, 2].

2. GENERAL CALCULATION METHOD

The Strategy and Economic Development Division of Termoelectrica has developed the calculation methodology in accordance with the standards in force and is applied within the units operating on solid, liquid and gaseous fuel or whenever necessary [3].
The correct determination of pollutant emissions is made based on measurements performed with specialized equipment. If this equipment is not available, for post-assessments for different periods of time, including for the preparation of inventories and statistical reports for verification of compliance with regulations and for the preparation of forecasts, emissions assessment is based on a calculation [4].
The calculation method is based on fuel consumption and emission factors.
The emission factor "e" represents the amount of pollutant released into the atmosphere, relative to the unit of heat introduced with the fuel in the boiler [5].
The amount of pollutant discharged into the atmosphere (emission) is determined by the relationship:

$$E = B\, H^i_i\, e \quad [kg] \qquad (1)$$

in which:
E - the amount of pollutant released into the atmosphere over a period of time, in kg;
B - the amount of fuel consumed in that period, in kg;

H_i^i - lower calorific value of the fuel, in kJ/kg;
e - emission factor, in kg/kJ.
By reporting the amount of pollutant is determined using the equation (1), the length of time corresponding to the emission flow rate can be calculated, expressed generally in mg /s or kg / h.
For various pollutants, the emission factors are determined experimentally. They depend on the characteristics of the fuels used, on the constructive type of the combustion installations (boiler and ancillary installations) and on their thermal power. Emission factors can be corrected depending on changes in fuel composition and combustion technologies [6].
The calculation model takes into account the situation in the thermal power plants in Romania, where classic combustion processes are applied and there are no installations for the retention of gaseous pollutants [7].
Once the boilers are equipped with noxious emission reduction installations, the necessary amendments will be introduced in the calculation of the emission factors. The quantities of fuel and the related calorific values will be determined on fuel lots.
In the calculation, when burning coals, the amount of fuel will be corrected by excluding the content of unburned slag and ash. In the case of using several types of fuel, the total amount of pollutant is determined by summing the emissions related to each of them [8].
In the forecast calculations, the mass concentration of Cm pollutants, expressed in mg / m^3N, can be determined from the relation:

$$C_m = \frac{e}{F_v} [mg/m^3_N] \quad (2)$$

in which:
e - emission factor, in mg/GJ;
F_v - the volume factor, defined as the ratio between the total volume of resulting flue gases and the amount of heat related to the fuel introduced into the boiler, in m^3_N/GJ.

3. DETERMINATION OF THE POLLUTION WEIGHT OF S.E. TURCENI

To determine the share of pollution in the Turceni area by the analyzed objective, the average values / Turceni area were compared taking into account the influence of other fixed sources in Gorj County with the average values on different mediation times generated by the dispersion program for S.E. Turceni in the situation operation without desulphurization installations - table 1.

Table 1. Average concentrations on different mediation intervals

Pollutant	Averaging period	Turceni area C_{medie} [µg/m^3]	Turceni area C_{medie} [µg/m^3]	Contribution of S.E.Tuceni in the area [%]	Alarm value [µg/m^3]	Limit value [µg/m^3]
Particulate matter	year	7,60	4,80	63	-	40
	24h	8,90	8,20	92	-	50
NO_2	year	18,95	17,40	92	-	40
	1h	100,10	77,50	77	400	200
SO_2	year	60,20	42,50	70	-	20
	24h	160,40	120,0	75	-	125
	1h	230,10	210,80	92	500	350

4. COMPARISON BETWEEN THE OPERATING SITUATION S.E. TURCENI WITHOUT DESULFURATION INSTALLATIONS / WITH DESULFURATION INSTALLATIONS

The average concentrations of pollutants in the ambient air at ground level, determined in the case of energy blocks operation, by mathematical modeling of the dispersion with the perspective situation through which four desulfurization plants will be located are presented in table 2, and in figures 1-7 the graphical representations.

Table 2 Average concentrations of pollutants in ambient air at ground level in the case of S.E. Turceni without / with desulphurisation plants

Pollutant	Averaging period	S.E. Turceni without sulphur removal system C_{medie} [µg/m^3]	S.E. Turceni With sulphur removal system C_{medie} [µg/m^3]	Pollution reduction [%]	Limit values (V.L.) [µg/m^3]
Particulate matter	year	4,80	2,0	58	20
	24h	8,20	5,4	34	50
NO_2	year	17,40	22,0	-	40
	1h	77,50	70,0	9,7	200
SO_2	year	42,50	10,0	76	20
	24h	120,0	15,0	87,5	125
	1h	210,80	28,0	86,7	350

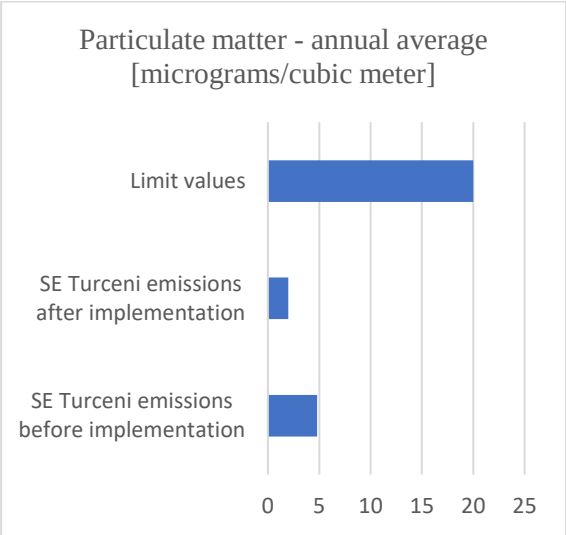


Figure1

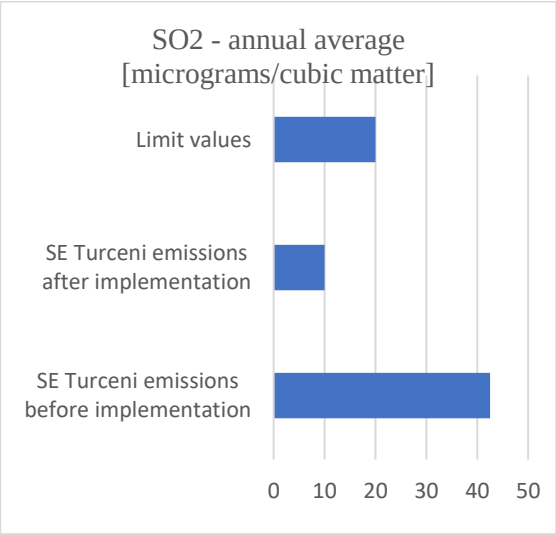
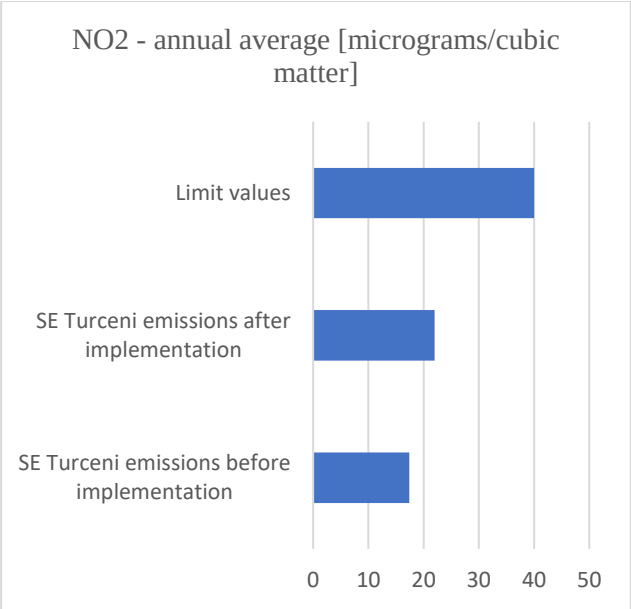


Figure 2



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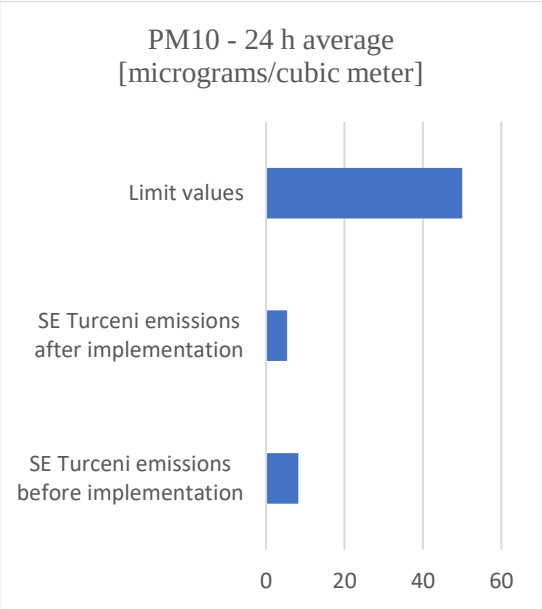

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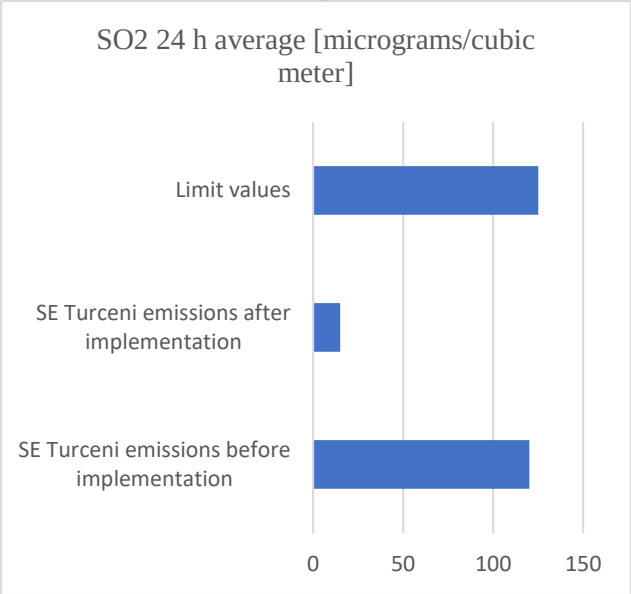

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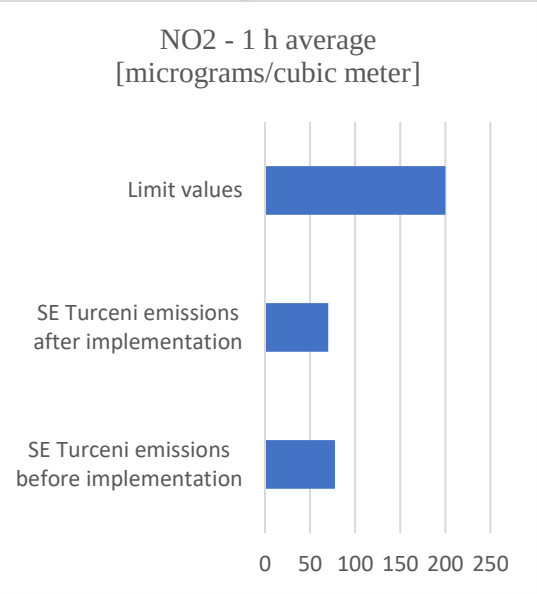

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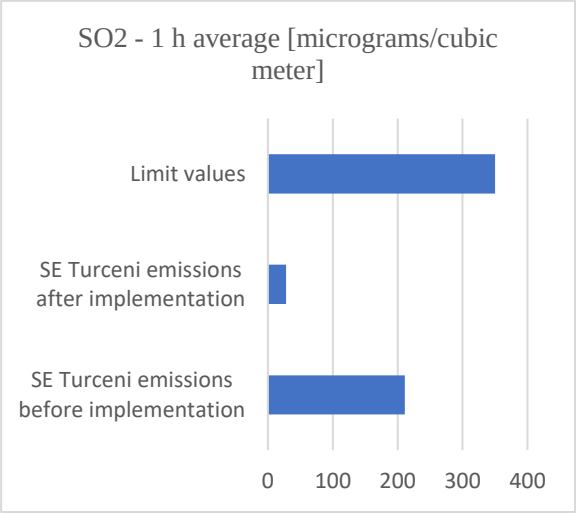

Figure 7

5.CONCLUSIONS

The study of dispersion of emissions from fixed sources revealed the following:

a. At the regional level, (Gorj county):

- maximum / average pollutant concentrations at different mediation intervals are found in most cases near the main emission sources;
- unfavorable meteorological conditions (persistent atmospheric calm and low wind speed, as well as the relative uniformity of winds on the main cardinal

directions do not allow a rapid movement of pollutants from the areas where they are emitted;
- the high values of SO_2 concentrations in the Rovinari and Turceni area are due to the operation of S.E. Rovinari and S.E. Turceni without desulphurisation plants.

b. At zonal level (Turceni area):

- the share of S.E. Turceni in the Turceni area for the operation of energy blocks without desulfurization installations:
  - minimum 63% for powders;
  - minimum 77% for NO_2;
  - minimum 70% for SO_2;
- reduction of pollution in the Turceni area in the situation of S.E. Turceni with 4 desulfurization plants is estimated as follows:
  - by 34 ÷ 58% for powders;
  - by 76 ÷ 87.5% for SO_2;
  - by 9.7% for NO_2 at mediation times of 1h. The average annual NO_2 concentration will have higher average values than in the case of S.E. Turceni without desulfurization facilities, due to the increase of approx. 10% of the volumetric flow of exhaust gases.

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