STUDIES AND RESEARCH ON POLLUTION OF THE INDUSTRY ENERGY ON THE GREEN AREA OF THE CITY

STUDII ŞI CERCETĂRI PRIVIND POLUAREA INDUSTRIEI ENERGETICE ASUPRA ZONEI VERZI A LOCALITĂȚILOR

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Abstract. *The urban environment is heavily influenced by the pollution generated by thermo-power plants. Their work program and the fuels used generate intense pollution of urban green spaces. In the case of thermoelectric power plants on gaseous and liquid fuels (methane + fuel), the emissions of the gases (CO, NO, NO_2, SO_2), which by hydration produce acids, occur in the atmosphere. Acid rains work on green areas continuously over the dominant wind direction. The case study conducted in the Iasi area indicated the pollution area, the concentrations of the pollutants and the lengths of the noxious transport in the considered area. The study of the dispersion of noxes in the atmosphere is done by modeling the functional phenomena of the polluting sources.*
Key words: chemical pollutants, dispersion, dispersion model, impact

Rezumat. *Mediul urban este puternic influențat de poluarea realizată de centralele termo-energetice. Prin programul de lucru al acestora şi combustibili folosiți produc o poluare intensivă a spațiilor verzi urbane. În cazul centralelor termo-energetice pe combustibili gazoşi şi lichizi (gaz metan + păcură) se produce emisia în atmosferă a gazelor (CO, NO, NO_2, SO_2), care prin hidratare produc acizi. Ploile acide acționează asupra zonelor verzi în mod continuu pe direcția vântului dominant. Studiul de caz întocmit în zona oraşului Iaşi a indicat arealul de poluare, concentrațiile substanțelor poluante şi lungimile de transport a noxelor în zona considerată. Studiul dispersiei noxelor în atmosferă se realizează prin modelarea fenomenelor funcționale ale surselor poluante.*
Cuvinte cheie: poluanți chimici, dispersie, model de disperse, impact

INTRODUCTION

The city is made up of a complex of natural and artificial factors, which determine a number of facilities for the normal development of life. But some of the factors are harmful to human activity, depending on how they are organized and used by the community. At this stage, harmful artificial factors are multiplying more and more.

Pollution of the natural environment (soil, water, air) and human is made in a close dependency. An environmental pollution process has to be studied from the air circuit and continued with the water and soil circuit, then completed with the anthropic circuit (Hameed and Dignon, 1992; Luca, 1993). Most overground

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pollution sources distribute noxes (dusts, gases, vapours, aerosols, etc.) in the lower layer of the troposphere, at a height of about 0.5 to 2.0 km. The study of pollutant dispersion phenomena in the air must be carried out in this layer.

The study models used to analyze the phenomena of dispersion of pollutants are mathematical, physical and mixed. Physical models cover a field of research that is difficult to address by mathematical models, such as dispersion of pollutants in varied relief areas (including large cities) (Kenjeres *et al.*, 2006).

An important source of pollution of the atmosphere, soil, water and the human environment is represented by the energy industry that operates with solid and gaseous fuels. The objective of the paper is to analyze the phenomenon of dispersion of pollutants in the atmosphere and the impact on the urban and the external environment by the thermoelectric power plants (Hameed and Dignon, 1992).

MATERIAL AND METHOD

Studies and research have been carried out for a number of objectives in the power industry, such as the Thermoelectric Power Plants - CET. In the area of Moldova was analyzed CET Iasi, which is a producer of electricity, steam and hot water for the city of Iasi.

The wind direction in the study area has a NA - SE orientation as an annual average value and holds about 24% of the total annual. The wind in NE-SV direction accounts for 15% of the annual total. The predominant wind during the winter period is in the N-E direction. Average monthly hourly average speeds are recorded in March (3.60 m/s). Maximum daily average speeds are recorded in the NV - SE direction and reach values of 5.70 - 7.50 m/s. The maximum speeds recorded in the area reached 13 m/s and in gusts of 55 m/s (Luca, 2005).

The research method has gone through the following steps: a - studying the relief and climate characteristics of the pollutant source area and the pollutant dispersion area; b - analyzing the technical parameters of the pollutant; d - realization of the model of analysis of the pollution phenomenon; e - modeling the phenomenon of dispersion of pollutants into the atmosphere; f - data processing and interpretation, forecast of the pollution phenomenon.

RESULTS AND DISCUSSIONS

The research was carried out by a team of researchers from the Technical University "Gh. Asachi "Iasi in collaboration with specialists from research and design institutes. Research has been carried out over a long period of time, and the results have been harnessed when designing polluting targets. The objectives of the research were many, among which:

- the correct position of the polluting objects in the inhabited areas in order to limit their polluting effect;

- forecast of the pollution phenomenon on inhabited areas, urban green areas and extra-urban areas, by determining the polluted surfaces and the concentrations of pollutants at different source distances, etc.

The forecast of the greenhouse pollution phenomenon is imposed by the high degree of urban pollution in Romania in the current period, correlated with a decrease in the area occupied by parks and gardens. The research aims at determining the size of the polluted surfaces, the concentrations of pollutants at different distances from the pollutant source and the type of noxes transmitted in the territory.

The research is done by physical and / or numerical modelling of the phenomenon of pollution. Numerical modelling of the pollution phenomenon is done for ideal relief conditions (quasi-plan land) and with some restrictions on simulating the atmospheric boundary layer (Kenjeres *et al.,* 2006). Physical modelling is applicable to any type of relief (plain, hill and mountain), way of planning localities and various atmospheric conditions (Luca, 1993).

Physical modelling involves two working methods for the same pollutant objective: aerodynamic modelling and hydraulic modelling. Aerodynamic modelling was done in a specialized (Shiau and Chiou, 2006). Hydraulic modelling was carried out in a hydraulic channel with dimensions corresponding to the modelling ladders. In the aerodynamic tunnel / hydraulic channel were mounted models simulating the land surface with the location of the pollutant source and the research area considered.

The two phenomena present a perfect identity of the equations describing the physical process (Luca, 2005):

- equation of continuity ec. (1) and ec energy. (2),

(1), $$\frac{\partial V_i}{\partial x_i} = 0, \quad (2) \quad \frac{\partial \Delta\theta}{\partial t} + \frac{\partial \Delta\theta}{\partial x_i} V_i = a \frac{\partial^2 \Delta\theta}{\partial x_i\, x_j},$$

- preservation of the impulse ec (3),

(3) $$\frac{\partial V_i}{\partial t} + V_j \frac{\partial V_i}{\partial x_j} + 2\varepsilon_{i,j,k} V_k \Omega_j = -\frac{1}{\rho_0}\frac{\partial \Delta P}{\partial x_i} + \frac{g}{\theta_0}\Delta\theta\delta_{3i} + \frac{\nu \partial^2 V_i}{\partial x_k\, \partial x_k};$$

- the molecular diffusion of the gas emitted by the ec source (4),

(4) $$\frac{\partial c}{\partial t} + v_i \frac{\partial c}{\partial x_i} = \alpha \frac{\partial^2 c}{\partial x_i \partial x_i},$$

where t is the time; θ - the temperature; V- instantaneous speed; ΔP - pressure difference compared to neutral atmosphere; $\Delta\theta$ - temperature difference; Ω - the angular rotation speed of the Earth; ν - kinematic viscosity; a - thermal diffusivity; ρ_0 - density; c- instantaneous concentration; α - molecular diffusion coefficient; $\varepsilon_{i,j,k}$- the alternating tensor; $\delta_{i,j}$ - the size of Kronecker; t - time.

In the case of the pollutant sources of the thermoelectric power plants (CET Iaşi), the dispersal area and the concentration of the noxes in bound points were determined (fig.1). The boiler is equipped with three flue gases (methane + fuel) and four cooling towers (tab. 1). The pollutant source is surrounded by industrial and housing districts (60% constructions, 20% platforms, 20% roads + green spaces) in the direction of the dominant wind (fig. 2). The height of the buildings in the study area is 10 ... 40 m.

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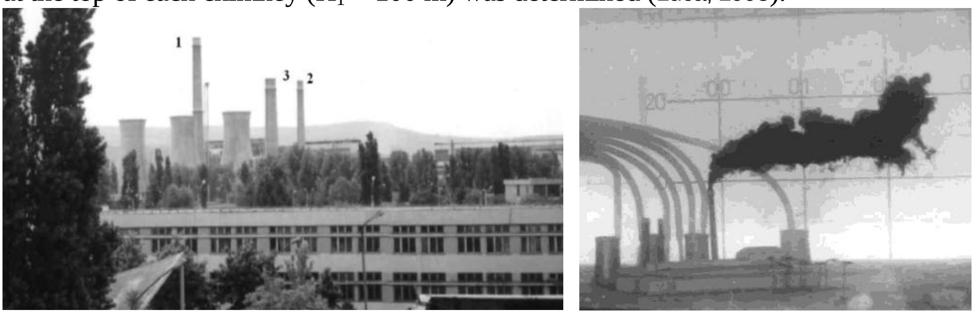

a b

Fig. 1 Thermoelectric power plant studied: general view (1, 2, 3 chimney); b - hydraulic simulation model.

Table 1

Smoke chimney parameters

Chimney	*H* (m)	*D* (m)	Q_g (m^3/h)	*T* (°C)	v_g (m/s)
Chimney 1	100	5.00	1,500,000	120-200	21.2
Chimney 2	70	3.50	734,000	120-200	21.2
Chimney 3	70	6.90	450,000	90-200	3.30
H-height; *D* - inner diameter at the top; Q_g - flue gas flow; *T*- gas temperature; v_g-velocity of the ejected gas					

In the direction of the dominant wind a 7,000 m long and 650 m wide terrain was shaped (fig. 2). The length at which NO is determined is 3.5 km. On the simulation model, the velocity profile in the atmospheric limit layer for various meteorological conditions was achieved (Luca, 1993). By simulation the contact distance Lc of the smoke plume with the ground for each chimney was determined and the values of the concentration of the pollutant in the dispersion zone. The length of contact with the terrain of the feather varies between 350 ... 900 m for the basket of 100 m high and 200 ... 700 m for the 70 m high chimneys. In model and reality, smoke moves under gusts and wind whirlwinds, so the point of contact with the land is not stable but variable.

The values of the concentration of pollutant in the dispersion area were determined for each basket operating individually and for all three in operation. Figure 3 presents the results of the Basket 1 research (Relative Concentrations, Cef / Cg) in the v_v/v_g = 4.5 ratio, where the model corresponded to vg = 56.7 cm/s and v_v = 12.8 cm/s.

The pollutants emitted in the air by a chimney are gaseous, liquid and solid. Their deposition starts near the chimney (solid particles) and extends over large and very large distances (2.0-2000 km) depending on the specific gravity of each and the value of the transport vector (wind).

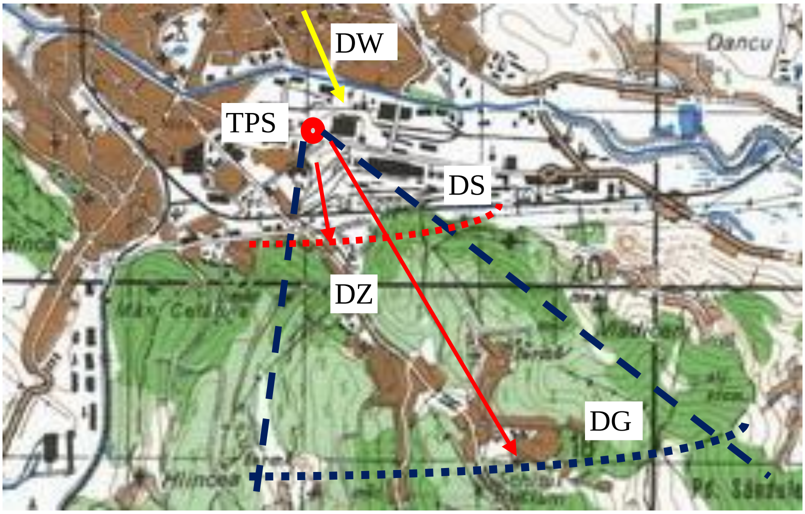

Fig. 2 Forecast of the pollutant dispersion area in the dominant wind direction: TPS - thermoelectric power station, DW - the dominant direction of the wind; DZ - dispersion area; DS - solid particle dispersion area; DG - gas dispersion area

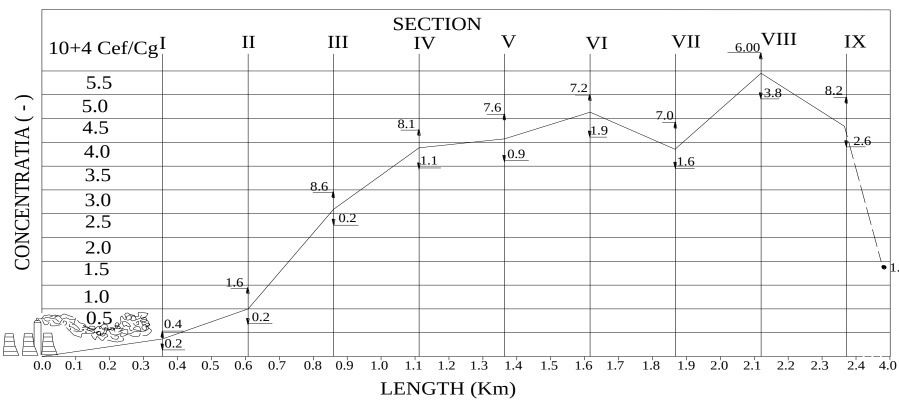

Fig. 3 The variation in the concentration of noxes emitted by the chimney 1 in the dispersion zone

The main gaseous substances in a thermoelectric plant operating on methane gas with the addition of fuel oil are: monoxide and carbon dioxide (CO, CO_2), monoxide and nitrogen dioxide (NO, NO_2) and sulfur dioxide and trioxide (SO_2) SO_3). They are transported over long distances depending on the height of the chimney, the ascent of the smoke in the atmosphere, the type of relief, the value of the gradient wind velocity, etc. During transport, the monoxides and dioxides are hydrated into the atmosphere and converted into acids. For example, nitrogen dioxide (NO_2) by hydration is converted to nitric acid and then to nitric acid over the transport length. The transition from the gaseous phase to the liquid determines the quicker deposition of pollutants and their action on the environment.

Relief influences the evolution of the fume gas emitted by the chimney. An uneven relief will cause the occurrence of whirlwinds that will come close to ground smoke and will facilitate the deposition of pollutants. In the case study, an intersection of the smoke fume issued by CET Iasi with the Caprița and Balan hills in the Bucium area resulted. As can be seen from figures 2 and 3, the smoke emitted by the chimney 1 will reach the ground after about 3.5-4.0 km.

Pollutant emissions from the thermoelectric power plant affect urban green areas located south of it (the Bularga and Socola charters), but also the Bucium hills, depending on the ground level. The relative value of the soil pollutant concentration varies from the C_{ef}/C_g deposition area = 1.0 to 600 m, up to C_{ef}/C_g = 6.0 at 2100 m, and at a distance of 4100 m to C_{ef}/C_g = 1.80.

CONCLUSIONS

1. Pollution from thermal power plants has a particularly negative impact on urban areas through the complex content of solid, liquid and gaseous substances of aggressive nature over green areas.

2. For a field with a varied relief, the experimental investigation of the pollution phenomenon in order to obtain the location of the polluting objects, of the affected areas and the prognosis in the territory of the pollutant concentrations is indicated.

3. Green areas are affected by pollutants with a chemical acid character, a situation specific to the thermoelectric power plants with oxides and nitrogen and sulfur dioxide emissions on burning of methane gas and fuel oil.

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