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Scattering Aerosol Emissions of Industrial Enterprises in the Atmospheric Boundary Layer

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ABSTRACT

Results of studying of dispersion of an aerosol of the dioxide of sulfur released into the atmosphere by the chemical company for processing of phosphorites are presented. Influence of the direction and speed of wind on sulfur dioxide distribution in a ground layer of the atmosphere is studied and the points of the direction of wind leading to pollution of the atmosphere of the nearby city are allocated. The statistical analysis of environmental pollution is carried out by method of the correlation and regression analysis. The equations of dependence of amount of the sulfur dioxide released into the atmosphere on the volume released by the enterprise of production are defined.

Keywords: aerosol, dispersion, emissions, industrial enterprise, sulfur dioxide, circumterrestrial layer, atmosphere, statistical analysis, regression equation

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INTRODUCTION

In the last decades ecological systems will come under considerable influence natural and in particular, anthropogenous factors, changing in the direction, undesirable to mankind. Therefore, research of process of environmental pollution by emissions of waste of the industrial enterprises is an actual task [1-21].

Stability of an ecosystem, as we know, develops at interaction of two major factors: features of a local environment and resources, on the one hand, and sources of pollution of production and non-productive character and intensity of their education - with another. The Republic of Kazakhstan has no rather powerful natural factors for counteraction to pollution forces. Its biogeocenosis is insufficiently steady and differs in high vulnerability and vulnerability. In particular, it is poor in water resources and flora, the low-power soil cover is subject to influence of a wind and water erosion.

In this regard, studying of influence of the industrial enterprise for processing of phosphorites located the Republic of Kazakhstan at various weather conditions and mathematical modeling of environmental pollution is represented especially important.

The main pollutant of the atmosphere of the considered region are the enterprises of chemical industry for processing of phosphorites. It is necessary to notice that gaseous impurity are the most dangerous to environment.

Identification of tendencies of environmental pollution as at a given time, and during time, from sources of pollution of a ground layer of the atmosphere represents considerable interest at the solution of various problems concerning ecologo-hygienic safety [13].

MATERIALS AND METHODS

Research of distribution of an aerosol in a ground layer in most cases does not allow to make natural experiment. Therefore, the great value gets a possibility of carrying out computing experiment which requires creation of mathematical models, enough adequate investigated to natural processes and realized on modern computer facilities.

In this scattering of an aerosol of the dioxide of sulfur released into the atmosphere by the enterprise for processing of phosphorites is considered.

For the purpose of an assessment of environmental pollution determination of dependence of amount of the polluting substances on the volume released by the enterprise of production is necessary.

As initial statistical material for carrying out the analysis served selection of measurements in the mode of normal operation of the enterprise (measurements of concentration of the polluting substance in installation sites of control and measuring stations), meteorological parameters (speed of wind and its direction).

Every day the plant throws out a significant amount of the polluting substances. However, the increased ground concentration of these substances in the air environment of the city which is at distance of 15 km from the enterprise are observed not always. It is explained by impact of air streams on dispersion and ablation of emissions of the enterprise from the city aside.

Studying of an arrangement of sources of emissions of impurity in the atmosphere showed that pollution of the city has to happen generally at western and SZ the directions of wind.

RESULTS AND DISCUSSION

Dependences of concentration of dioxide of SO2 sulfur on the direction of wind are given in Figure 1.

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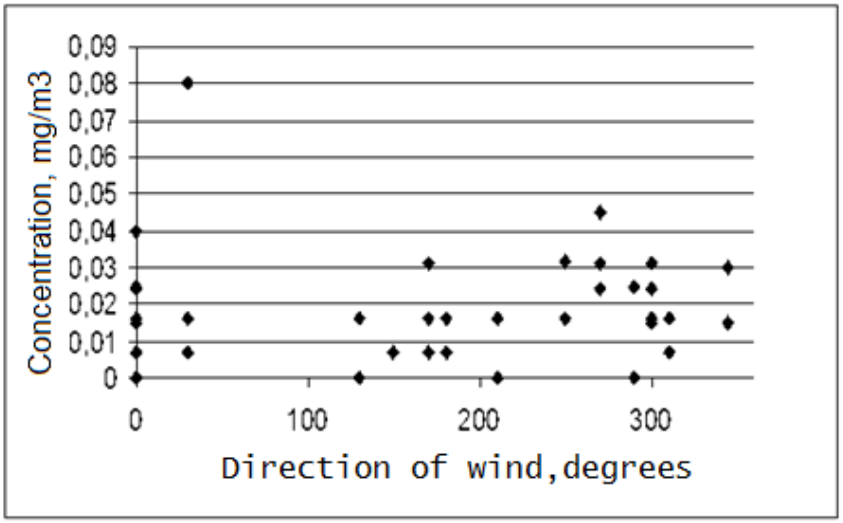

Figure 1: Dependence of pollution of the atmosphere sulfur dioxide from the direction of wind.

It is visible that points of the direction of wind when increase in concentration of dioxide of sulfur exceeds average daily values of the maximum-permissible concentration (MPC) are allocated. This excess of maximum concentration limit happens at the northern direction and makes 0.08 mg/m3 that there is more average daily maximum concentration limit by 1.6 times. A certain amount of dioxide of sulfur dissipates at the southern direction of wind and its concentration makes from 0.01 to 0.03 mg/m3. At northern and to SZ the direction of wind leading to air pollution of the city the increased maintenance of SO2 (0.004 - 0.045 mg/m3) close to maximum concentration limit (0.05 mg/m3) is observed.

On dispersion of harmful substances in a ground layer of the atmosphere the great influence is exerted by wind speed. Change of concentration of dioxide of sulfur within three days when the speed of wind changed ranging from a calm to 2 m/s is shown in Fig. 2.

From the data given on fig. 2 it is visible, that in at a calm there is the greatest pollution of the city and concentration of SO2 makes 0.04 mg/m3 whereas at a wind 1m/s speed the content of dioxide of sulfur decreases twice and makes 0.015-0.025 mg/m3. At a speed of wind of 2 m/s the maintenance of SO2 in point of supervision of the city is insignificant (0.007 mg/m3) whereas in an active zone of a kernel the maximum concentration makes 0.08 mg/m3.

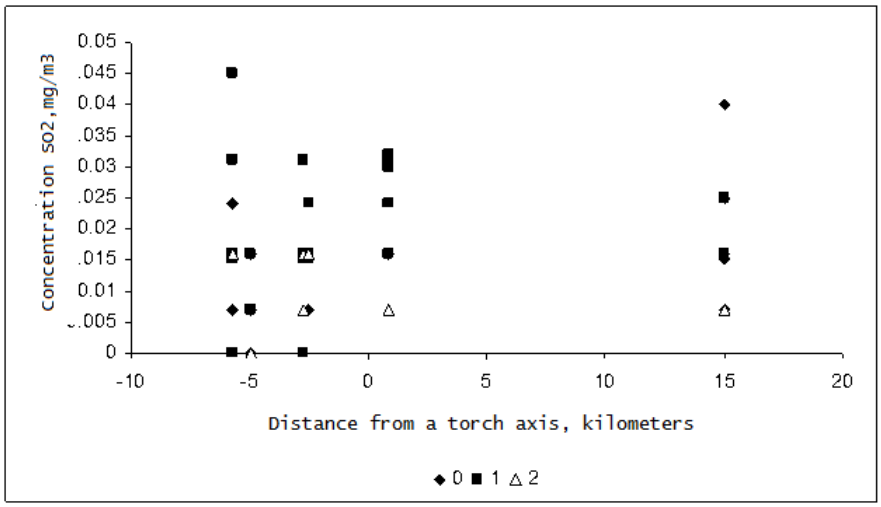

Figure 2: Dependence of distribution of concentration of emissions of sulphurous gas on distance to an emission source at various speeds of wind: 0 m/s, 1 m/s and 2 m/s.

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It was of interest to estimate diffusion of the polluting substances in the direction perpendicular to the direction of a flow of STARS according to supervision on stationary posts. For this purpose it is necessary to define distance from a torch axis to point of sampling. Previously distances from a conditional point of the center of gravity of organized sources to point of sampling of the polluting substances were determined by the card.

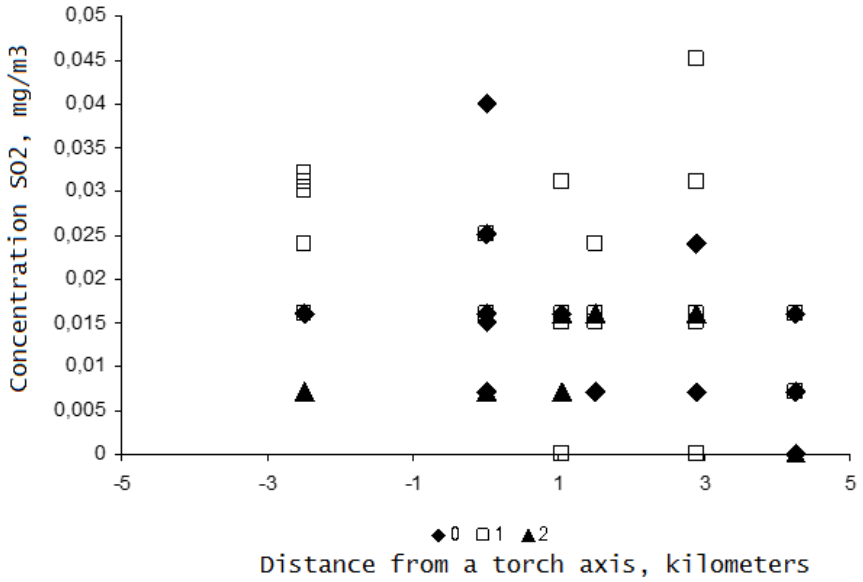

Figure 3: Concentration of SO_2 at various distances from a torch axis.

It is visible that the greatest pollution by dioxide of sulfur is observed in a kernel zone, in its active zone on which industrial constructions and objects of the enterprise are located. In an active subband the processes making direct impact on environment components proceed. Here the greatest specific loads of environment are observed. The border of a sanitary protection zone of the enterprise and a zone of an arrangement of stores of waste of productions (5-6 km) (fig. 3) is characterized, apparently from the schedule, by high concentration of dioxide of sulfur though specific loadings are lower here, than in an active subband. In this subband to the weakened activity and a peripheral subband processes of diffusion, evaporation, etc. are observed at a temperature and pressure of environment, but at the increased concentration of the polluting substances. The zone of indirect influence where the nearby city (15 km) is located, is affected by the polluting substances at their migration in mobile components of the environment. Here the average annual content of dioxide of sulfur makes 0.016 mg/m3.

Observed change of concentration of dioxide of sulfur from distance to an axis of a torch allows to estimate scales of cross turbulent diffusion.

The statistical analysis was carried out by a correlation and regression method [22, 23]. In Fig. 4 the correlation field of dependence of emission of dioxide of sulfur on volume of the phosphorus released by the enterprise is presented. The received results indicate existence between the number of emissions of sulphurous gas and output pronounced positive, close to linear functional, correlations. The view of the received field of correlation allowed to choose the equation of regression of a look:

$$y = b_0 + b_1 x,$$

where x - production of phosphorus; y - emission of the polluting substance.

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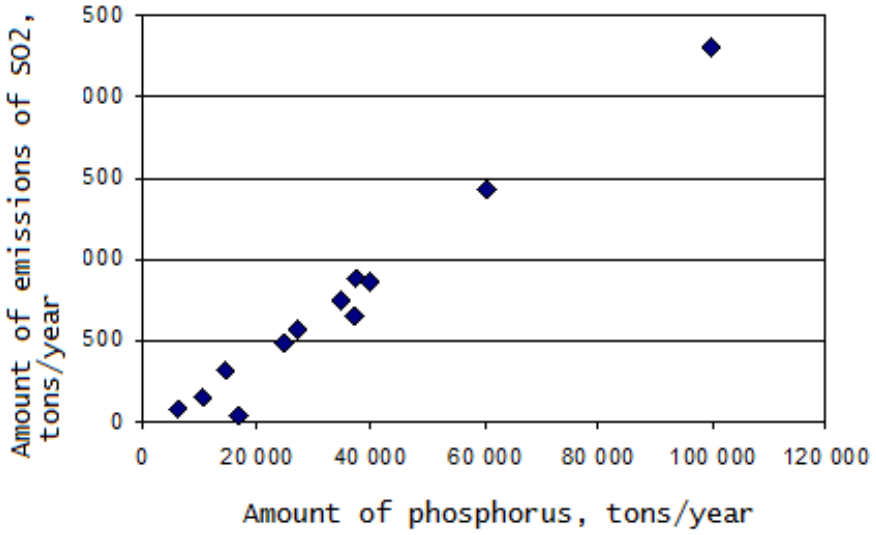

Figure 4: Correlation field of dependence of number of emissions of sulphurous gas on output.

Coefficients of the linear equation of regression are determined by a method of the smallest squares. After finding of the linear equation of regression the statistical analysis of results consisting in check of the importance of all coefficients in comparison with an error of reproducibility and adequacy of the equation is carried out. The assessment of the importance of coefficients is carried out in size of criterion of Styudent: tst = bj/Sbj, where bj- j-regression equation coefficient; Sbj - an average square deviation of j-g of coefficient. The results received by a statistical method are presented in Table 1.

It is visible that for sulfur dioxide emissions the amount of the let-out phosphorus, within an interval of the importance of 95%, is statistically significant (Styudent's criterion makes 20.39) whereas at the same intervals of confidence (95%) and number of degrees of freedom of f=11 the tabulated tst value. = 2.2. The equation coefficients determined by this method make: b0 = - 135.16; b1 = 0.025. The size R-square for emissions of SO2.

Table 1: Values of coefficients of correlation of emissions and criteria of their assessment

Name of emission	R_{sq}	Coefficients		t_{ct} Styudent's criterion	F, Fischer's criterion
		b_0	b_1		
Sulphurous gas	0.98	-135.16	0.0247	20.39	415.88

It is close to 1 (0.98) that testifies to linear nature of dependence between the number of emissions and volume of the phosphorus made by the enterprise. The size of criterion of Fischer makes 415.9 whereas at number of steppes of freedom f1 =11 and f2 =10 Ftabl value = 2.95 that indicates that the equation corresponds to experiment and has an appearance:

$$y = -135.16 + 0.025x,$$

where x - the volume of phosphorus, y - amount of dioxide of sulfur.
It is visible that for emissions of SO2 the amount of the let-out phosphorus is statistically significant.

CONCLUSIONS

1. Sulfur dioxide dispersion at various weather conditions is defined.

2. The method of the correlation and regression analysis defined the equations of environmental pollution by emissions of the chemical company in dependences of volume of the made phosphorus petro gas of condensate of the extracting regions.

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