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DEPENDENCE OF GENERAL ALLERGIC RHINITS INCIDENCE OF THE POPULATION ON THE PERFORMANCE OF THE INCINERATION PLANT

Allergic rhinitis incidence may be caused by the pollution of the environment, in particular, by flue gases of the incineration plants, this gas is a mixture of 27 components. Determination of the regression dependence of general allergic rhinitis incidence of the population on the performance of the incineration plant is a relevant scientific engineering problem as it can be used for the prediction of such incidence rate.

Objective of the research is the construction by means of regressive analysis the regressional dependence of general allergic rhinitis incidence rate of the population on the performance of the incineration plant, this dependence can be used for the prediction of the incidence rate. In the process of studies the method of regression analysis of the results of single-factor experiments and other paired dependences with the selection of the most adequate type of function from sixteen most widely used variants by the criterion of maximum values of the correlation coefficient was used. Regression was performed on the base of the linearized transformations, which enable to reduce non-linear dependence to linear one. Determination of the coefficients of the regression equations was performed, applying the method of the least squares by means of the developed computer program "RegAnaliz".

Regression dependence of the allergic rhinitis prevalence rate on the performance of the incineration plant was obtained, it can be used for the prediction of the incidence rate of the disease. Graphic dependence of the allergic rhinitis prevalence rate of the population on the performance of the incineration plant was constructed, it enables to illustrate the dependence and show the sufficient coincidence of the theoretical results with actual data. It is established that the allergic rhinitis prevalence rate of the population increases with the growth of the incineration plant performance in power dependence.

Key words: *incineration plant, solid municipal waste, incidence rate, allergic rhinitis, regression analysis.*

Introduction

Solid municipal waste constitute danger for the security of the natural environment and human health [1]. Annual volume of SMW formation is more than 54 mil. m^3 , greater part of solid municipal waste is buried on the territory of 6107 landfills and dumps, their total area is almost 7700 ha, small part of waste is recycled or disposed at the incineration plants (2 %), unlike highly developed countries, where modern technologies of recycling and disposal are widely used [2]. As the price of organic fuel, especially natural gas, increased the problem of using SMW as energy fuel becomes urgent. In such developed countries as Denmark, Netherlands the share of waste burning is 54.3 % and 36.6 %, correspondingly [3]. Only during the period of 1995 – 2014 the share of SMW burning in the countries of EU increased almost 2 times [4]. Along with this it is expedient to dispose waste at the available municipal power plants of generation capacity of 12 MW, these power plants can operate on energy fuel (mixture of SMW, dehydrated to 20 % of relative humidity and coal with mass fraction of 16 %) with calculated low calorific value of 10.99 MJ/kg [5]. Nowadays thermal methods of SMW disposal are assessed ambiguously in the world practice, as the technological process of any incineration plant is accompanied by complex pollution of the atmospheric environment. Flue gases of the incineration plants are complex multicomponent mixture, where 27 components are identified and quantitively determined [6], they can cause the disease of the respiratory system [7], in particular allergic rhinitis.

Problem set-up

According to the text of the Resolution of the Cabinet of Ministers of Ukraine № 265 organization of control over the operating and closed SMW landfills is among the priority directions of solid municipal waste management in Ukraine to avoid harmful impact on the environment and human health [8]. That is why, determination of the regression dependence of the general allergic rhinitis incidence rate of the population on the performance of the incineration plant, which can be used for the prediction of the incidence rate of the disease is relevant scientific-engineering problem.

Analysis of the latest studies and publications

Regression models of such methods of SMW management occurrence as waste disposal and burning are suggested in the materials of the paper [8]. According to the data, published in the research [5], lower calorific value of SMW is 6.285...8.38 MJ/kg, and on condition of decreasing the humidity of SMW from 43 % to 20 % lower calorific value of SMW is 9.14 MJ/kg, calculated lower calorific value of the mixture of coal and SMW – 10.99 MJ/kg. In the study [9] by means of the suggested moisture meter [10] the study of the dehydration processes of SMW using the screw press was performed by means of experiment planning of the second order, the study enabled to determine the adequate quadratic regression model of the dehydration indices on the basic impact parameters. In the paper [11] the scheme of dehydration hydraulic drive and SMW compaction in the process of waste loading into the dustcart is patented.

Study of SMW combustion properties in fixed bed [12] determined that the decrease of the average size of particles from 30 to 10 mm leads to the increase of the flame propagation speed from 0.6 cm/min to 0.8 cm/min. This, in its turn, greatly increases SMW burning speed and controls maximum carrying capacity of the waste at achieving the complete combustion.

In the paper [13] the dependence of SMW combustion with utilization of energy in the developed countries on such factors of impact as population density, value of gross domestic product (GDP) per capita, human development index, average geographic latitude has been studied. Paper [14] contains statistical data regarding the occurrence of SMW combustion methods in Ukraine in 2012 – 2019.

Authors of the study [15] established that the greatest impact on the number of incineration plants has the value of gross domestic product (GDP) and average geographical latitude has the least impact, human development index influences indirectly by means of the effect of interaction of factors. Adequate regression dependence of the number of the incineration plants in different countries in the form of quadratic regression in logarithmic coordinates with the interaction effects of the first order has been obtained, it can be used in the process of the development of the strategy, complex of machines and equipment for SMW handling.

The trend to decreasing the morbidity indices both of the adult population on the whole and working age population on cerebral strokes has been revealed in the paper [16]. In the study [17] the regression dependence of the working age population cerebral stroke morbidity on the incineration plant performance has been determined. Regression power dependences of different diseases prevalence among the adult population of the settlements, adjacent to place of SMW disposal on the distance to the landfill have been determined, these dependences are used for the determination of the safe distance of landfills of SMW location from the settlements by the indices of prevailing the respiratory organs pathologies and blood circulation organs diseases [18].

Author of the paper [19] notes that among the diseases of the respiratory organs special attention should be paid to the indicator pathology of high degree of dependence on the factors of the environment, in particular, allergic diseases (allergic rhinitis, bronchial asthma). In the paper [20] studies, aimed at determining the characteristic features of the chronic rhinitis course on the background of action of the unfavorable factors of the environmental pollution, are described. Strong direct correlation connection between the degree of air pollution with dust and general level of the adult morbidity of the bronchial asthma (R = 0.88), blood circulation system (R = 0.91), coronary artery disease (R = 0.89), allergic rhinitis (R = 0.72) has been determined in the research, presented in the

paper [21].

Materials of the study [22], contain the indices of general morbidity of the population in different years on allergic rhinitis in Darnytsia administrative district of Kyiv, where the incineration plant "Energy" is located. However, the authors did not reveal, as a result of the analysis of the known publications, any mathematical dependences of the indices of general morbidity of the population on the allergic rhinitis on the performance of the incineration plant.

Objective and task of the paper

Objective of the paper is the construction by means of the regression analysis the dependence of general incidence of the population of allergic rhinitis on the performance of the incineration plant, these dependences can be used for the prediction of the morbidity indices.

Method and materials

The following methods were used for the determination of the regression dependence of the general incidence of the population of the allergic rhinitis on the performance of the incineration plant: regression analysis of the results of single factor experiments and other paired dependences, computer modeling.

Results of the research

On the base of the indices of general morbidity of the population in different years of the allergic rhinitis in Darnytsia administrative district of Kyiv, on the territory of which the incineration plant "Energy" is located, determined by the authors of the study [22], it was planned to obtain paired regression of the indices of general morbidity of the population of the allergic rhinitis on the performance of the incineration plant.

Regression was carried out on the base of linearized transformations, which enable to reduce non linear dependence to linear one. Determination of the coefficients of the regression equations was performed, applying the method of least squares [23] by means of the developed computer program "RegAnaliz" [24], protected by the Certificate of the State Registration of the rights to the copyright object and is described in details in the work [25, 26].

Program "RegAnaliz" enables to carry out regression analysis of the results of single-factor experiments and other paired dependences with the selection of the most adequate type of function from sixteen most widely-used variants by the criterion of maximum correlation coefficient, saving the results in the format MS Excel and Bitmap.

Results of the regression analysis are presented in the Table 1, where grey color indicates the cell with maximum value of the correlation coefficient *R*.

Table 1

Results of the regression analysis of the dependence of general morbidity of the population of the allergic rhinitis on the performance of the incineration plant

№	Type of regression	Correlation coefficient R	№	Type of regression	Correlation coefficient R
1	$y = a + bx$	0.99428	9	$y = ax^b$	0.98794
2	$y = 1 / (a + bx)$	0.99719	10	$y = a + b \cdot \lg x$	0.98518
3	$y = a + b / x$	0.97169	11	$y = a + b \cdot \ln x$	0.98518
4	$y = x / (a + bx)$	0.99722	12	$y = a / (b + x)$	0.99719
5	$y = ab^x$	0.99587	13	$y = ax / (b + x)$	0.97920
6	$y = ae^{bx}$	0.99587	14	$y = ae^{b / x}$	0.97556
7	$y = a \cdot 10^{bx}$	0.99587	15	$y = a \cdot 10^{b / x}$	0.97556
8	$y = 1 / (a + be^{-x})$	0.84788	16	$y = a + bx^n$	0.99896

Thus, according to the results of regression analysis on the base of the data from Table 1, the following regression dependence is taken as the most adequate

$$П_{AR} = 39.14 + 7.778 \cdot 10^{-6} m_{\text{bn.SMW}}^{2.5} \text{ [cases per 10 thousands of population]}, \quad (1)$$

where $П_{AR}$ – is the occurrence of general morbidity of the population of the allergic rhinitis, cases per 10 thousands of population; $m_{\text{bn.SMW}}$ – is annual mass of the burnt SMW, thousands of tons.

Fig. 1 shows actual and theoretical graphical dependence of general morbidity of the population on allergic rhinitis occurrence on the performance of the incineration plant.

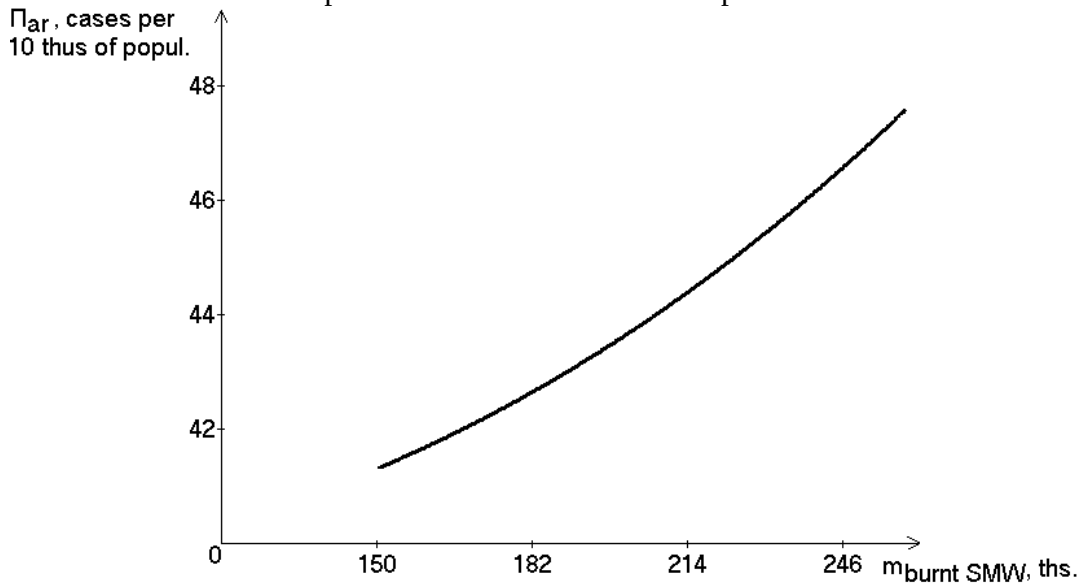

Fig. 1. Dependence of general morbidity of the population of allergic rhinitis on the performance of the incineration plant

Comparison of actual and theoretical data showed that theoretical occurrence of general morbidity of the population dependence on the performance of the incineration plant, calculated by means of regression equation (1), does not differ greatly from the data, presented in [22], this proves the sufficient accuracy of the obtained dependence.

Analysis of graphic dependence in Fig. 1 showed that the occurrence of general morbidity of the population grows with the increase of the incineration plant performance according to power dependence.

Conclusions

Regression dependence of general morbidity of the population of allergic rhinitis on the performance of the incineration plant has been determined, it can be used for the prediction of such morbidity indices.

Graphic dependence of general morbidity of the population of allergic rhinitis occurrence on the performance of the incineration plant has been constructed, it enables to illustrate this dependence and show the sufficient convergence of theoretical and actual results.

It has been established that the occurrence of general morbidity of the population of the allergic rhinitis grows with the enhancement of the incineration plant performance according to power dependence.

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