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DEPENDENCE OF THE CELEBRAL APOPLEXY MOBIDITY RATE OF THE PRODUCTIVE AGE POPULATION ON THE PERFORMANCE OF THE WASTE INCINERATION PLANT

Flue gases of the incineration plants is a complex multicomponent mixture of 27 components, which may cause the diseases of respiratory system and blood circulation, in particular, cerebral apoplexy. Determination of the regression dependence of the cerebral apoplexy morbidity rate of the population of the productive age on the performance of incineration plant, which can be used for the prediction of such morbidity rate is an important scientific-engineering task.

Aim of the research is the construction by means of the regression analysis the regressional dependence of the cerebral apoplexy morbidity rate indices of the working age population on the performance of the incineration plant, these dependences can be used for the prediction of the morbidity indices. In the process of the study the method of regressional analysis of the results of single-factor experiments and other paired dependences with the selection of the most adequate type of function from the sixteen most widely used variants by the criterion of maximum value of the correlation coefficient was used. Regression was carried out on the base of the linearized transformations, which allow to reduce nonlinear dependence to linear dependence. 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".

Regressional dependence of the disease prevalence among the population of the productive age on the performance of the incineration plant was obtained, the dependence can be used for the prediction of the morbidity indices. Graphic dependence of the cerebral apoplexy morbidity prevalence of the working age population on the performance of the incineration plant was constructed, this dependence allows to illustrate the sufficient coincidence of theoretical results with actual results. It is established that the cerebral apoplexy prevalence of the working age population increases with the performance growth of the incineration plant by exponential law.

Key words: *incineration plant, solid municipal waste, morbidity rate, cerebral apoplexy, regressional analysis.*

Introduction

Solid municipal waste (SMW) present serious danger for the environment and people`s health [1]. Annually more than 54 mil. m^3 of SMW are formed on the territory of Ukraine, greater part of the waste is buried at 6107 landfills and dump sites, their total area is almost 7700 ha and only part of waste is recycled or disposed at incineration plants (2%) unlike highly developed countries, where modern technologies of solid municipal waste recycling and disposal are widely introduced [2]. Due to price increase for organic fuel, especially natural gas, the problem of using SMW as energy fuel, becomes actual in Ukraine. That is why, in such developed countries as Denmark and the Netherlands the proliferation of incineration technology is 54.3% and 36.6%, correspondingly [3]. Only in the period of 1995 – 2014 the proliferation of SMW incineration increased almost two times [4]. It is expedient to dispose SMW at the available municipal co-generation plants with generation capacity of 12 MW, which can operate on energy fuel (mixture of SMW dehydrated to 20 % of the relative humidity and coal with the particle mass 16 %) with calculated low combustion value of 10.99 MJ/kg [5]. At the same time thermal methods of SMW recycling now have controversial evaluation in world practice. Operation 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 ingredients are identified and quantitively determined [6], they can cause the diseases of the respiratory system and blood circulation, particular, cerebral apoplexy.

Problem set up

According to the Decree of the Cabinet of Ministers of Ukraine № 265 provision of the control over the functioning and closed SMW landfills to prevent harmful impact on the environment and human health is one of the priority directions of SMW management in Ukraine [8]. That is why, determination of the regressional dependence of cerebral apoplexy morbidity rate of the productive age population on the performance of the incineration plant, which can be used for the prediction of the morbidity indices, is an important scientific-engineering problem.

Analysis of the recent research and publications

The paper [7] contains the regressional models of usage of such methods of SMW management as burial and burning. Lower combustion value of SMW is 6.285...8.38 MJ/kg and on the condition of the reduction of SMW humidity from 43 % to 20 % lower combustion value of SMW is 9.14 MJ/kg, calculated lower combustion value of the mixture of coal and SMW is 10.99 MJ/kg [5]. In the paper [8] by means of the suggested humidity meter [9] the study of SMW dehydration processes by means of the worm press, using the experiment planning of the second order was carried out, that enabled to determine adequate quadratic regression models of the dehydration indices dependence on the main impact parameters. In the research [10] the hydraulic drive dehydration and compaction scheme of SMW in the dust-cart during waste loading is suggested. Determination of the SMW combustion properties in a fixed layer [11] established the following dependence of the combustion speed on the size of particles: decrease of the average size of particles from 30 to 10 mm leads to the speed increase of fire spreading from 0.6 cm/min to 0.8 cm/min, that in its turn greatly increases the speed of SMW combustion, and, hence, controls maximum carrying capacity of the waste at reaching the complete combustion. Dependence of SMW combustion spreading with energy utilization in the developed countries on the factors of impact (density of the population, value of GDP per capita, human development index, average geographic latitude of the country) is studied in the paper [12]. The research [13] contains statistical data regarding the methods of SMW burning in Ukraine in the period of 2012 – 2019. In the paper [14] it is established that GDP per capita influences most the quantity of the incineration plants and average geographical latitude influences the least and human development index influence non-directly by means of the effects of factors interaction. Adequate regressional dependence of the number of incineration plants in different countries in the form of quadratic regression in the logarithmic coordinates with the interaction effects of the 1st order is obtained, the given regression can be used in the process of the strategy development, complex of machines and equipment for solid municipal waste management. In the study [15] the trend to the reduction of the cerebral apoplexy morbidity rate both of the adult population on the whole and productive age population is determined. Paper [16] is devoted to the determination of the regressional power dependences of the diseases prevalence among the adult population of the settlements, adjacent to the place of SMW deposition on the distance to the landfill, which are used for the determination of the safe distance of SMW landfills location from the settlements by the indices of the prevalence of the pathologies of the respiratory organs and blood circulation system. However, specific mathematical dependences of the cerebral apoplexy morbidity indices of the working age population on the performance of the incineration plant as a result of the analysis of the known publications, the authors did not reveal.

Aim and tasks of the paper

Aim of the paper is the construction by means of the regressional analysis the regression

dependence of the cerebral apoplexy morbidity indices of the productive age population on the performance of the incineration plant, these dependences can be used for the prediction of the indices of such morbidity.

Methods and materials

For the determination of the regression dependence of the cerebral apoplexy morbidity indices of the productive age population on the performance of the incineration plant, the following methods are used: regressional analysis of the results of single factor experiments and other paired dependences, computer modeling.

Results of the research

Table 1 contains the indices of the cerebral apoplexy morbidity of the productive age population in Darnytsia District of Kyiv, on the territory of this district incineration plant "Energy" is located. Indices are determined by the authors of the research [15], depending on the performance of the incineration plant.

Table 1

Indices of the cerebral apoplexy morbidity rate of the productive age population depending on the performance of the incineration plant [15]

Year	2015	2016	2017	2018
SMW burnt, ths. t. [13]	256.4	259.3	245.6	206.5
Cerebral apoplexy prevalence per 100.000 of population	116.2	125.4	88.5	58.1

On the base of the Table 1 data it was planned to obtain paired regressional dependence of the indices of cerebral apoplexy morbidity rate of the productive age population on the performance of the incineration plant.

Regression was carried out on the base of the linearized transformations which enable to reduce the non-linear dependence to linear one. Determination of the coefficients of the regression equation was performed, applying the method of the least squares [17] by means of the developed computer program "RegAnaliz" [18], the program is protected by the Certificate of the state registration of the rights to the copyright object and is describing details in [19, 20].

Program "RegAnaliz" allows to perform regressional analysis of the results of single-factor experiments and other paired dependences with the selection of the most adequate type of function from 16 most widely spread variants by the criterion of maximum correlation coefficient, storing the results in MS Excel and Bitmap.

Results of the regressional analysis are presented in Table 2, cell with the maximum value of the correlation coefficient R is marked with grey color.

Thus, by the results of the regressional analysis on the base of the data from Table 1 the following regressional dependence is accepted as the most adequate

$$P_{CA} = 54,85 - 1,054 \cdot 10^{-31} m_{b.smw}^{13,6} \text{ [cases . per 100 000.of population .]}, \tag{1}$$

where P_{CA} − prevalence of the cerebral apoplexies, cases per 100.000 of the population; $m_{b.SMW}$ − annual mass of the burnt SMW, thousand of tons.

Fig. 1 shows actual and theoretical graphic dependences of the cerebral apoplexy prevalence among the productive age population on the performance of the incineration plant.

Table 2

Results of the regressional analysis of the dependence of the cerebral apoplexy prevalence among the productive age population on the performance of the incineration plant

№	Type of the regression	Correlation coefficient R	№	Type of the regression	Correlation coefficient R
1	$y = a + bx$	0.95557	9	$y = ax^b$	0.97562
2	$y = 1 / (a + bx)$	0.99449	10	$y = a + b \cdot \lg x$	0.94918
3	$y = a + b / x$	0.94270	11	$y = a + b \cdot \ln x$	0.94918
4	$y = x / (a + bx)$	0.97461	12	$y = a / (b + x)$	0.99449
5	$y = ab^x$	0.98000	13	$y = ax / (b + x)$	0.98940
6	$y = ae^{bx}$	0.98000	14	$y = ae^{b / x}$	0.97103
7	$y = a \cdot 10^{bx}$	0.98000	15	$y = a \cdot 10^{b / x}$	0.97103
8	$y = 1 / (a + be^{-x})$	0.93963	16	$y = a + bx^n$	0.99992

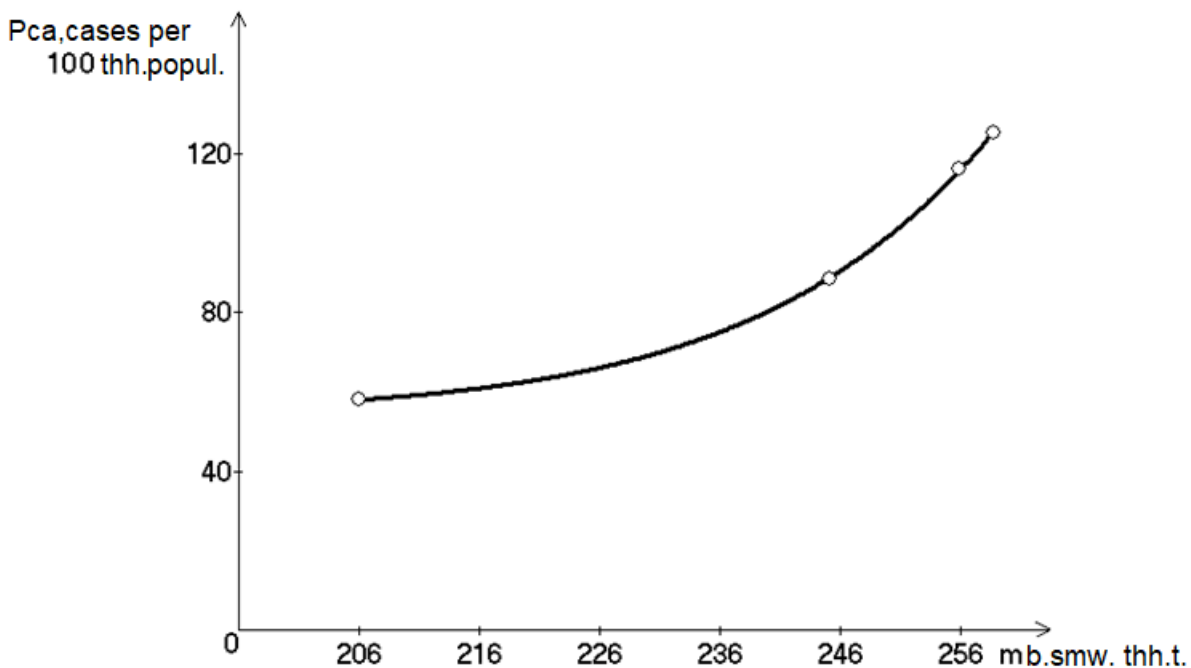
Fig. 1. Dependence of the cerebral apoplexy prevalence among the productive age population on the performance of the incineration plant: actual ○, theoretical —

Comparison of the actual and theoretical data showed that theoretical prevalence of the cerebral apoplexy morbidity of the productive age population on the performance of the incineration plant, calculated by means of regression equation (1) does not differ greatly from the data, presented in the paper [15], that proves the sufficient accuracy of the dependence, obtained well before .

Analysis of the graphical dependence in Fig. 1 showed that cerebral apoplexy prevalence among the productive age population increases with the performance growth of the incineration plant by exponential law.

Conclusions

Regressional dependence of the cerebral apoplexy prevalence among the productive age population on the performance of the incineration plant is determined; the dependence can be used for the prediction of the morbidity indices.

Graphic dependence of the cerebral apoplexy prevalence among the productive age population on the performance of the incineration plant is constructed, it allows to illustrate this dependence and show the sufficient coincidence of the theoretical results with actual results.

It is established that the prevalence of the cerebral apoplexy among the productive age population

increases with the growth of the performance of the incineration plant by the exponential law.

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