

SECTION 13. THEORETICAL MEDICINE

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13.1 The dependences determination of the incidence indicators of separate respiratory diseases on the productivity of a waste incineration plant

According to the World Health Organization, emissions of municipal solid waste (MSW) are constantly increasing, reaching huge levels that significantly affect the environment. Only about 2% of Ukrainian solid waste is disposed of at waste incineration plants [377-381], the rest is buried in landfills and landfills [382, 383] or subject to composting [384]. Thanks to the increase in the price of organic fuel, especially natural gas [385-390], the problem of using MSW as an energy fuel is becoming more urgent in Ukraine. In developed EU countries, the prevalence of waste incineration reaches significant values: in Denmark 54.3%, in the Netherlands 36.6% [391]. Only during 1995-2014, the prevalence of MSW incineration in EU countries almost doubled [392]. At the same time, it is expedient to dispose of MSW at existing communal thermal power plants with a generating capacity of 12 MW. They can work on energy fuel (mixtures of MSW dehydrated to 20% relative humidity and hard coal with a mass fraction of 16%) with an estimated lower calorific value of 10.99 MJ/kg [393]. At the same time, thermal methods of solid waste disposal have currently received an ambiguous assessment in world practice, since the technological process of any waste incineration plant is definitely accompanied by complex pollution of the environment [394-397], in particular atmospheric pollution. The flue gases of waste incineration plants are a complex multicomponent mixture, in which 27 components have been identified and quantified [398], which can lead to diseases of the respiratory system, human blood circulation, etc. [399]. In addition, large amounts of smoke and toxic gases such as nitrogen oxides and sulfur oxides are produced when MSW is burned in landfills or waste treatment plants. These substances, entering the atmosphere, form smog and other harmful aerosols that can cause various diseases of the respiratory tract and cardiovascular system. In addition, large particles of solid waste that disintegrate into fine dust under the influence of wind and other factors can

be inhaled by humans, which leads to various respiratory diseases and allergic reactions.

Regression dependences that describe the prevalence of landfilling and incineration of solid waste are published in the article [400]. In work [401], regression dependencies were determined that describe the dynamics of the prevalence of solid waste incineration methods in Ukraine and allowed to predict that in Ukraine in 2031, among the methods of solid waste incineration, the prevalence of incineration for the purpose of obtaining energy under appropriate conditions may amount to 99.66%, and without energy recovery – 0.34%. The lower heat of combustion of solid waste is 6.285...8.38 MJ/kg, and when the moisture content of solid waste is reduced from 43% to 20%, the lower heat of combustion of solid waste is 9.14 MJ/kg, the estimated lower heat of combustion of a mixture of coal and solid waste is 10.99 MJ/kg [393]. In work [402], with the help of the proposed moisture meter [403], controlled by the program [404], a study of the processes of solid waste dehydration by a screw press was carried out using the planning of the second-order experiment [405] with the help of the program [406], which made it possible to determine adequate quadratic regression models indicators of dehydration from the main parameters of influence. In work [407], the regression logarithmic dependence of the calorific value of MSW on their moisture content was determined, and it was also established that dehydration of MSW before burning will significantly increase their calorific value to the level required for burning MSW in existing thermal power plants, which, in turn, will reduce consumption fossil fuels. The work [408] proposed a hydraulic drive scheme for dewatering and compacting solid waste in a garbage truck during their loading, which made it possible to increase the efficiency of the process [409]. In the article [410], an experimental study of the processes of compaction of pre-compacted and dehydrated solid waste was carried out using the planning of the experiment, which made it possible to determine adequate regression models of the compression characteristics of solid waste in the garbage truck, taking into account their relative humidity. According to the Student's criterion, it was determined that, among the investigated influencing factors, the pressing pressure of solid waste is most affected by their relative deformation, and the

least by the relative humidity of pre-compacted and dehydrated solid waste; the density of the final compacted and dehydrated MSW is most affected by the density of pre-compacted and dehydrated MSW, and the least by the relative humidity of pre-compacted and dehydrated MSW; the relative humidity of final compacted and dehydrated MSW is most affected by the pressing pressure of MSW, and the least – by the relative humidity of pre-compacted and dehydrated MSW.

The conducted study of solid waste combustion properties in a stationary layer [411] allowed establishing the following dependence of the burning speed on the particle size: a decrease in the average particle size from 30 to 10 mm leads to an increase in the flame propagation speed from 0.6 cm/min to 0.8 cm /min, which, in turn, significantly increases the MSW burning rate and, therefore, controls the maximum throughput of waste when complete combustion is achieved. This made it possible to formulate requirements for the moisture content of solid waste during loading into a garbage truck [412].

In the materials of the article [413], the dependence of the prevalence of solid waste incineration with energy utilization in developed countries on such influencing factors as the country's population density, the value of the gross domestic product per capita, the index of human potential development, and the average geographical latitude of the country was investigated. The materials of the work [414] provide statistical data on the prevalence of MSW incineration methods in Ukraine in the period 2012-2019.

In the scientific article [415], the dynamics of the specific amount of solid waste incinerated in the EU countries was studied. It has been established that the specific amount of MSW incinerated in the EU countries increases annually according to the indicator dependence.

In the materials of the article [416], it was found that the number of waste incineration plants in different countries is most affected by GDP per capita, and the least by the average geographical latitude, and the index of human potential development is affected only indirectly by means of the effects of the interaction of factors. An adequate regression dependence of the number of waste incineration plants

in different countries was also obtained in the form of a quadratic regression in logarithmic coordinates with the effects of 1st order interactions, which can be used during the development of a strategy, a complex of machines and equipment for solid waste management.

In the scientific publication [417], a tendency towards a decrease in the incidence of cerebral strokes, both in the adult population as a whole and in the population of working age, was revealed, and in the article [418], the regression dependence of the incidence of cerebral stroke in the working-age population on the productivity of the waste incineration plant was determined. The work [419] is devoted to the determination of the regression power dependences of the prevalence of diseases of various classes in the adult population of settlements adjacent to the MSW disposal site and the distance to the landfill. The resulting dependencies were used to determine the safe distance of landfill sites from settlements based on the prevalence of respiratory diseases and diseases of the circulatory system.

In the table 1 shows the indicators of the general morbidity of the population in the years 2011-2018 for certain diseases of the respiratory organs in the Darnytskyi administrative district of Kyiv, on the territory of which the waste incineration plant "Energia" is located, determined by the authors of the scientific work [420], depending on the productivity of the waste incineration plant.

The regression data were performed on the basis of linearization transformations, which allow to reduce the non-linear dependence to a linear one. The coefficients of the regression equations were determined by the method of least squares using the developed computer program "RegAnalyz", which is protected by a certificate of copyright registration for the work [421], and is described in detail in the works [422, 423].

Table 1

Indicators of the general morbidity of the population for individual diseases of the respiratory organs depending on the productivity of the waste incineration plant [420]

Year		2011	2012	2013	2014	2015	2016	2017	2018
MSW burned, thousand tons [414]		252.5	228.5	150.5	152.8	256.4	259.3	245.6	206.5
Prevalence of total morbidity per 10 thousand population	allergic rhinitis	–	–	41.3	–	47.5	47.4	–	43.9
	bronchial asthma	80.2	–	79.6	79	80.7	80.9	80.8	–

The computer program "RegAnalyz" allows you to carry out regression analysis of the results of univariate experiments and other pairwise dependencies with the selection of the best type of function from the 16 most common options according to the criterion of the maximum correlation coefficient with saving the results in MS Excel and Bitmap format.

The results of the regression analysis are shown in the table. 2, where cells with the maximum value of the correlation coefficient R are marked in gray.

Table 2

The results of the regression analysis of the dependence of the prevalence of certain diseases of the respiratory organs on the productivity of the waste incineration plant

No.	Type of regression	Correlation coefficient R	
		$P_{AR} = f(m_{inc.MSW})$	$P_{BA} = f(m_{inc.MSW})$
1	$y = a + bx$	0.99428	0.95730
2	$y = 1 / (a + bx)$	0.99719	0.95767
3	$y = a + b / x$	0.97169	0.94135
4	$y = x / (a + bx)$	0.99722	0.99992
5	$y = ab^x$	0.99587	0.95749
6	$y = ae^{bx}$	0.99587	0.95749
7	$y = a \cdot 10^{bx}$	0.99587	0.95749
8	$y = 1 / (a + be^{-x})$	0.84788	0.53370
9	$y = ax^b$	0.98794	0.95489
10	$y = a + b \cdot \lg x$	0.98518	0.95442
11	$y = a + b \cdot \ln x$	0.98518	0.95442
12	$y = a / (b + x)$	0.99719	0.95767
13	$y = ax / (b + x)$	0.97920	0.94289
14	$y = ae^{b/x}$	0.97556	0.94213
15	$y = a \cdot 10^{b/x}$	0.97556	0.94213
16	$y = a + bx^n$	0.99896	0.95313

So, according to the results of the regression analysis based on the data in the

table. 1, the following regression dependencies [426, 427] were finally accepted as the most adequate:

$$P_{AR} = 39.14 + 7.778 \cdot 10^{-6} m_{inc.MSW}^{2.5} \text{ [cases per 10,000 people];} \quad (1)$$

$$P_{BA} = \frac{m_{inc.MSW}}{0.07256 + 0.01212 m_{inc.MSW}} \text{ [cases per 10,000 people],} \quad (2)$$

where P_{AR} , P_{BA} – the prevalence of general morbidity in the population, allergic rhinitis and bronchial asthma, respectively, cases per 10,000 people;

$m_{inc.MSW}$ – annual mass of incinerated solid waste, thousand tons.

Figure 1 shows the actual and theoretical graphical dependences of the prevalence of the general morbidity of the population on individual diseases of the respiratory organs on the productivity of the waste incineration plant.

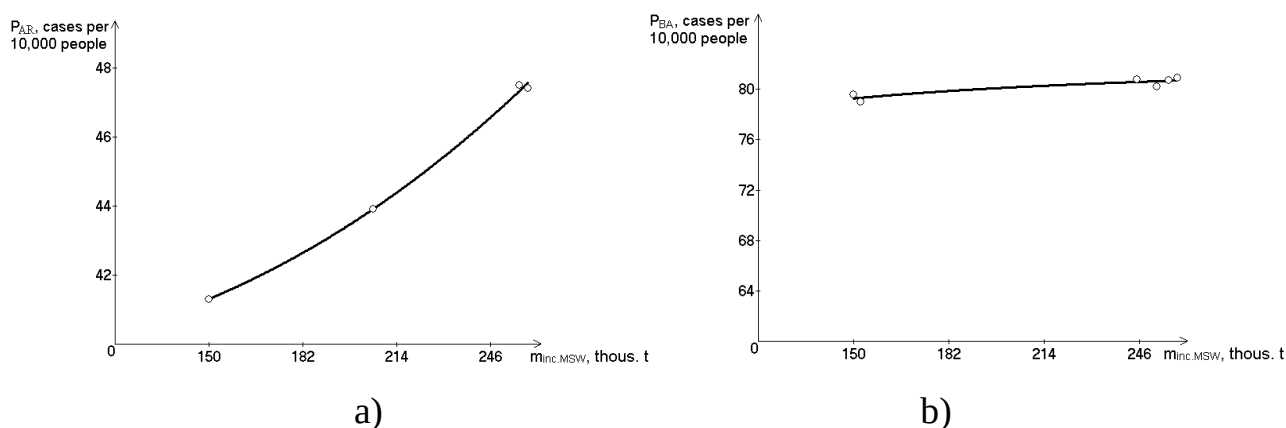


Figure 1. Dependencies of the prevalence of general disease in the population on the productivity of the waste incineration plant: actual $\circ$, theoretical — a) allergic rhinitis, b) bronchial asthma

A comparison of actual and theoretical data showed that the theoretical prevalence of the general morbidity of the population for individual diseases of the respiratory organs, calculated using the obtained regression equations (1, 2), differ insignificantly from the data given in the work [420], which confirms the previously determined sufficient accuracy of the obtained dependencies

So, the regression dependences of the prevalence of general morbidity of the population on the productivity of the waste incineration plant for the following diseases of the respiratory organs: allergic rhinitis and bronchial asthma, which can be used to predict indicators of such morbidity, have been determined.