

SECTION 15. THEORETICAL MEDICINE

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15.1 The productivity influence of the waste incinerator plant on indicators of the population general disease

Every year in Ukraine, only about 2% of municipal solid waste (MSW) is disposed of in incineration plants [644-648], the rest is buried in landfills and landfills [649, 650] or subject to composting [651]. Due to the increase in the price of organic fuel, especially natural gas [652-657], the problem of using MSW as an energy fuel is becoming more urgent in Ukraine. In the developed countries of the EU, the prevalence of waste incineration reaches significant values: in Denmark 54.3%, in the Netherlands 36.6% [658]. Only during the period of time during 1995-2014, the prevalence of MSW incineration in the EU countries increased almost twice [659]. 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 [660]. At the same time, thermal methods of MSW disposal have currently received an ambiguous assessment in world practice, since the technological process of any waste incineration plant is definitely accompanied by complex environmental pollution [18-21], in particular atmospheric pollution. Flue gases of waste incineration plants are a complex multicomponent mixture, in which 27 components have been identified and quantified [665], which can lead to diseases of the respiratory system, human blood circulation, etc. [666].

Regression models that describe the prevalence of such methods of MSW management as burial and incineration are published in the article [667]. In work [668], regression dependencies were determined that describe the dynamics of the prevalence of MSW incineration methods in Ukraine and allowed to predict that in Ukraine in 2031, among the methods of MSW 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 MSW 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 MSW is 9.14 MJ/kg, the estimated lower heat of combustion of a mixture of coal and solid waste is 10.99 MJ/kg [660]. In work [669], with the help of the proposed moisture meter [670], controlled by the program [671], a study of the processes of solid waste dehydration by a screw press was carried out using the planning of a second-order experiment [672] with the help of the program [673], which made it possible to determine adequate quadratic regression models indicators of dehydration from the main parameters of influence. In work [674], 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 paper [675] 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 [676]. In the article [677], 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 final compacted and dehydrated solid waste is most affected by the density of pre-compacted and dehydrated solid waste, and the least is the relative humidity of pre-compacted and dehydrated solid waste; 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 study of the combustion properties of MSW in a stationary layer [678] made it possible to establish 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 rate of solid waste burning 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 [679].

The article [680] investigated the dependence of the prevalence of MSW 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. The materials of the work [681] provide statistical data on the prevalence of MSW incineration methods in Ukraine in the period 2012-2019.

The article [682] examines the dynamics of the specific amount of MSW incinerated in EU countries. It has been established that the specific amount of MSW incinerated in the EU countries increases annually according to the indicator dependence.

In the article [683], 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 human potential development index affects it only indirectly through 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.

The work [684] revealed a tendency to decrease the incidence of cerebral strokes, both in the adult population as a whole and in the population of working age, and in article [685] 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 [686] 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 obtained 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 materials of the work [687], in particular, indicators of the general morbidity of the population in 2012-2018 for various diseases in the Darnytskyi administrative district of Kyiv, on the territory of which the waste incineration plant "Energia" is located, are given.

In the table 1 shows the indicators of the general morbidity of the population in the years 2012-2018 for various diseases 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 works [684, 687], depending on the productivity of the waste incineration plant.

Table 1

Indicators of general morbidity of the population for various diseases depending on
the productivity of the waste incineration plant [684, 687]

Year		2012	2013	2015	2016	2017	2018
MSW burned, thousand tons [681]		228.5	150.5	256.4	259.3	245.6	206.5
Prevalence of total morbidity per 10 thousand population	respiratory diseases	5526.6	–	5744	5931.5	5827.4	5682.8
	allergic rhinitis	–	41.3	47.5	47.4	–	43.9
Prevalence per 100 thousand population	cerebral strokes	–	–	116.2	125.4	88.5	58.1
	transient ischemic attacks	–	–	90.2	91.6	91.7	62.8

Regressions were performed on the basis of linearizing 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 [688], and is detail described in the works [689, 690].

The "RegAnalyz" program allows you to perform a 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 diseases on the productivity of the waste incineration plant

No.	Type of regression	Correlation coefficient R			
		$\Pi_{no\partial} = f(m_{\text{chl.tib}})$	$\Pi_{yi} = f(m_{\text{chl.tib}})$	$\Pi_{mia} = f(m_{\text{chl.tib}})$	$\Pi_{ap} = f(m_{\text{chl.tib}})$
1	$y = a + bx$	0.64472	0.95557	0.96480	0.99428
2	$y = 1 / (a + bx)$	0.63904	0.99449	0.96673	0.99719
3	$y = a + b / x$	0.61231	0.94270	0.97451	0.97169
4	$y = x / (a + bx)$	0.86327	0.97461	0.86379	0.99722
5	$y = ab^x$	0.64194	0.98000	0.96585	0.99587
6	$y = ae^{bx}$	0.64194	0.98000	0.96585	0.99587
7	$y = a \cdot 10^{bx}$	0.64194	0.98000	0.96585	0.99587
8	$y = 1 / (a + be^{-x})$	0.20751	0.93963	0.99944	0.84788
9	$y = ax^b$	0.62606	0.97562	0.97097	0.98794
10	$y = a + b \cdot \lg x$	0.62895	0.94918	0.96997	0.98518
11	$y = a + b \cdot \ln x$	0.62895	0.94918	0.96997	0.98518
12	$y = a / (b + x)$	0.63904	0.99449	0.96673	0.99719
13	$y = ax / (b + x)$	0.60617	0.98940	0.97625	0.97920
14	$y = ae^{b/x}$	0.60931	0.97103	0.97546	0.97556
15	$y = a \cdot 10^{b/x}$	0.60931	0.97103	0.97546	0.97556
16	$y = a + bx^n$	0.95166	0.99992	0.95897	0.99896

So, according to the results of the regression analysis based on the data in the table 1, the following regression dependencies were finally accepted as the most adequate [685, 691-693]:

$$P_{RD} = 5608 + 1.69 \cdot 10^{-34} m_{inc.MSW}^{15} \text{ [cases per 10,000 people]}, \quad (1)$$

$$P_{CS} = 54.85 + 1.054 \cdot 10^{-31} m_{inc.MSW}^{13.6} \text{ [cases per 100,000 people];} \quad (2)$$

$$P_{TLA} = \frac{1}{0.01097 + 2.381 \cdot 10^{87} e^{-m_{inc.MSW}}} \text{ [cases per 100,000 people];} \quad (3)$$

$$P_{AR} = 39.14 + 7.778 \cdot 10^{-6} m_{inc.MSW}^{2.5} \text{ [cases per 10,000 people]}, \quad (4)$$

where P_{RD} , P_{AR} – the prevalence of general morbidity of population for respiratory

diseases and allergic rhinitis, respectively, cases per 10,000 people;

P_{CS} , P_{TIA} – the prevalence of cerebral strokes and transient ischemic attacks, respectively, cases. per 100,000 people;

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

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

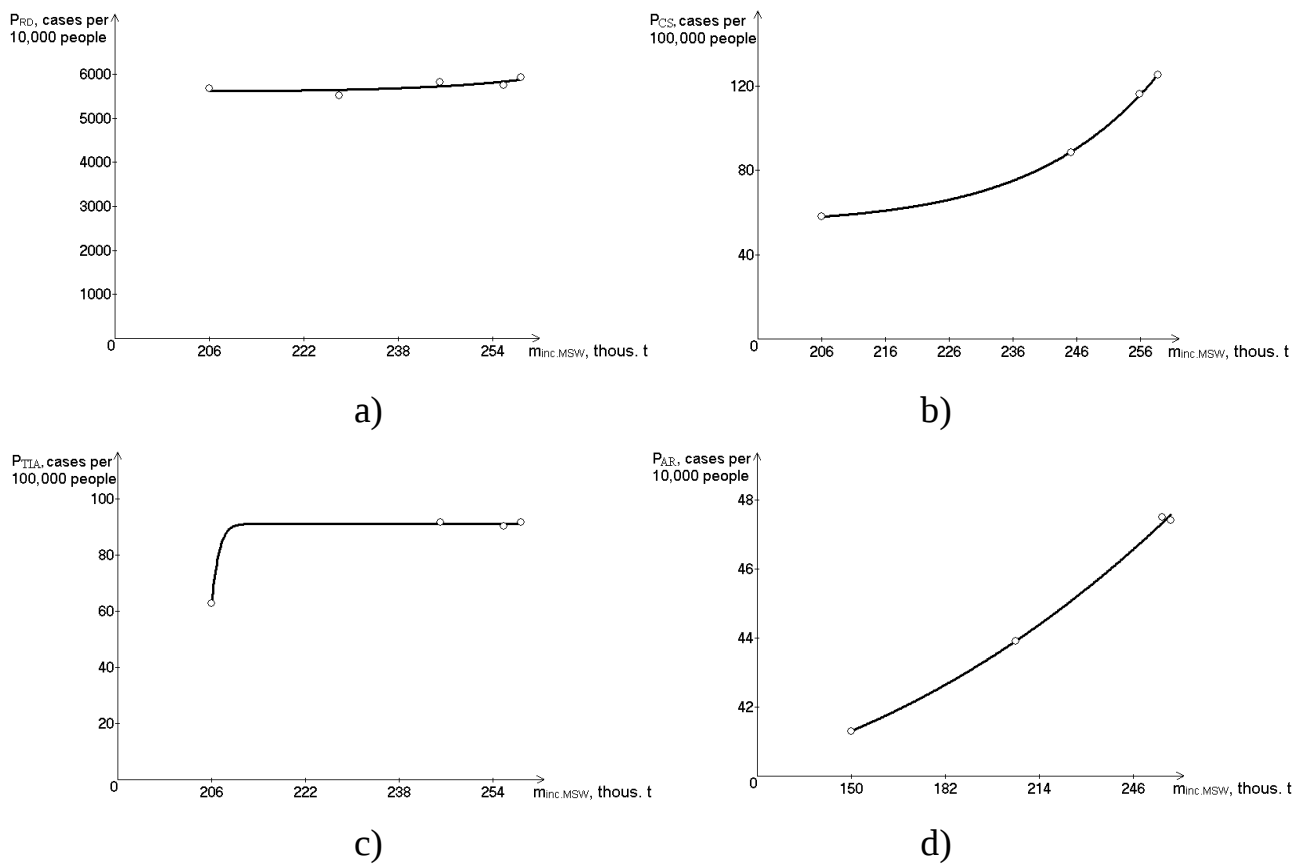


Figure 1. Dependencies of the prevalence of general morbidity in the population on the productivity of the waste incineration plant: actual $\circ$, theoretical — a) respiratory diseases, b) cerebral stroke, c) transient ischemic attacks, d) allergic rhinitis

A comparison of actual and theoretical data showed that the theoretical prevalence of the general population incidence of various diseases, calculated using the obtained regression equations (1-4), differ insignificantly from the data given in the works [684, 687], which confirms the previously determined sufficient accuracy of the

obtained dependencies

So, the regression dependences of population general morbidity prevalence on the productivity of the waste incineration plant for the following diseases: respiratory diseases, cerebral stroke, transient ischemic attacks, allergic rhinitis, which can be used to predict indicators of such morbidity, have been determined.