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RESEARCH OF ENVIRONMENTAL STATUS ROADSIDE STRIP IN WINTER, ON THE BASIS MATHEMATICAL MODELING

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ДОСЛІДЖЕННЯ ЕКОЛОГІЧНОГО СТАНУ ПРИДОРОЖНЬОЇ СМУГИ В ЗИМОВИЙ ПЕРІОД РОКУ НА ОСНОВІ МАТЕМАТИЧНОГО МОДЕЛЮВАННЯ

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ИССЛЕДОВАНИЕ ЭКОЛОГИЧЕСКОГО СОСТОЯНИЯ ПРИДОРОЖНОЙ ПОЛОСЫ В ЗИМНИЙ ПЕРИОД ГОДА НА ОСНОВАНИИ МАТЕМАТИЧЕСКОГО МОДЕЛИРОВАНИЯ

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Intro

Intensive development of motorization around the world, the expansion and improvement of road network, increase capacity and speed of the vehicle and cause a toxic gain vibroacoustic pollution, causing the urgency of solving the problems of ecological safety and reduce vehicle action on the environment of human existence.

Analysis of research and publications

Today, there are quite a number of works, which are various methods of determining the level of contaminants in the atmosphere and their distribution patterns. Great contribution to the study of air pollution have M.E. Berlyand, N.S. Burenin, G.P. Kirillov, N.A. Ryabikov, V.F. Skorchenko, I. Kolpakov, T.I. Cherv'yakova, V.V. Filipov and other domestic and foreign authors [1-7].

To determine the CO of the carriageway highways proposed various empirical dependence, major road setting where there are traffic (Table 1).

Table 1 - Dependence to determine the level of CO carriageway roads

The authors	Empirical equations
Aramyan P. A.	$CO=0{,}49\cdot10^{-5}\cdot N^2+0{,}06904\cdot N-2{,}043063$
Kirillov G. P.	$CO=3{,}85+0{,}0185\cdot N+\Sigma A_i$
Manusajyants G.	$CO=22{,}4\cdot B\cdot M_г\cdot d\cdot N_\alpha\cdot(1+0{,}0125\cdot h)$
Sidorenko V. F.	$CO=7{,}38+0{,}026\cdot N+\Sigma A_i$
Ornatsky N. P.	$CO=(7{,}33+0{,}026\ N_\alpha)\cdot K_1\ K_2\cdot K_3$ In the absence of wind: $C_x=0{,}5CO-0{,}1X$
Silyanov V.	$C=CO=0{,}006\ N_1-9\cdot lgV-0{,}3U+17$
Boveb L., Siebenberg S.	$CO=1{,}53\cdot N^{0{,}368}$
Cassidy M.	$CO=1{,}1\cdot(7+0{,}0025\cdot N)$
Toyce F., William S., Sohnson D.	$CO=1{,}1\cdot(0{,}006\cdot N-9\cdot lgV-0{,}3\cdot U+17)$

Where N is the intensity of the movement, ed./day; T – CO in shares of MPC; – coefficient taking into account the impact of the development; μ is the concentration of ozone in the air, mg/m3; h is the building height, m; ΣAi – coefficient taking into account the change in the composition of traffic flow, speed and longitudinal pahili; Mg – the volume of exhaust gases conditional car, m3; d is the amount of carbon monoxide in the exhaust gas, %; V – speed of movement, km/h; α – specific gravity, g/m3; U – wind speed, m/s; K1, K2, K3 are coefficients which depend on the composition of traffic flow, the effect of longitudinal slope, the degree of toxicity of emissions from motor vehicles.

However, given in table. 1 dependence has not received wide practical application because it does not always adequately reflect the actual distribution and the level of air pollution, and does not take into account the influence of other, equally important, factors.

Today in environmental research are most often used two methods of calculating the concentration of harmful impurities in the atmosphere.

One of the first to have substantially implemented the results into practice, was Sutton S. G. He described the impurity concentration near the source of pollution Gaussi distribution law [8]:

$$\theta_x = \frac{1}{\sigma_X \sqrt{2\pi}} \exp\left(\frac{x^2}{2\sigma_x^2}\right). \quad (1)$$

In the case of linear source, which is the roadbed, oriented along the axis *OY*, the distribution can be seen only in the direction *OX*, and then setting σ_x the law will look like:

$$\sigma_x^2 = \frac{1}{2} C_x^2 \left(\vec{u}t\right)^{2-n}, \quad (2)$$

where σ_x – variance distribution of impurities in the direction of the axis *OX*; C_x – virtual diffusion coefficient; $\vec{u}$ – Average wind speed, м/с; n – the dimensionless parameter.

The second method of calculation of the concentration of contaminants is to solve the turbulent diffusion equation to account for possible changes of air temperature, wind speed, of the exchange ratio in the surface layer of air. This method is more universal and allows to solve problems with different characteristics of the external environment and boundary conditions. Under the assumption of the constancy of the nature of the studied process and the linearity of the source of contamination of the equations of the steady-state diffusion takes the form:

$$-\frac{\partial}{\partial x} k_x \frac{\partial z_C}{\partial x} - \upsilon_x \frac{\partial z_C}{\partial x} - \beta z_C = F_u . \quad (3)$$

Solving the equation of atmospheric diffusion is performed by numerical methods using modern computer technology and provides a functional dependence of the concentration of the main active factors.

In addition, much work has been devoted to experimental research and development of mathematical models of distribution of various pollutants in roadside strip. However, all the work was no comprehensive approach to environmental assessment roadside strips and was not considered seasonal changes in the level of contamination considering weather and climatic factors (FSC). The most favorable traffic occurs in standard weather conditions [9], which can be also considered more favorable to the dispersion of pollutants in the roadside strip. During the winter season there are particularly significant differences from standard traffic conditions.

In addition, the level of pollution of roadside strip in winter largely determined by the characteristics of technology road maintenance. Application antiglaze chloride salts are the most effective way to melt the ice layer and improve safety, but it should take into account their negative effect on the National Assembly, activation of atmospheric corrosion.

Thus, the assessment of pollution roadside strip in the winter season as the most diverse and intense in terms of load it is very relevant issue today.

A mathematical model for evaluating contamination roadside strip in the winter season Given that the level of pollution of roadside strips depends on road and off road factors, to assess its ecological condition necessary to analyze the interaction between subsystems "road - vehicle - environment" (D - A - PS) and "environment - road "(PS - D). These subsystems are part of the overall Vadso ("driver - vehicle - road - environment"), which is the theoretical basis for solving the operation of highways.

Scheme of interaction subsystems shown in Figure 1.

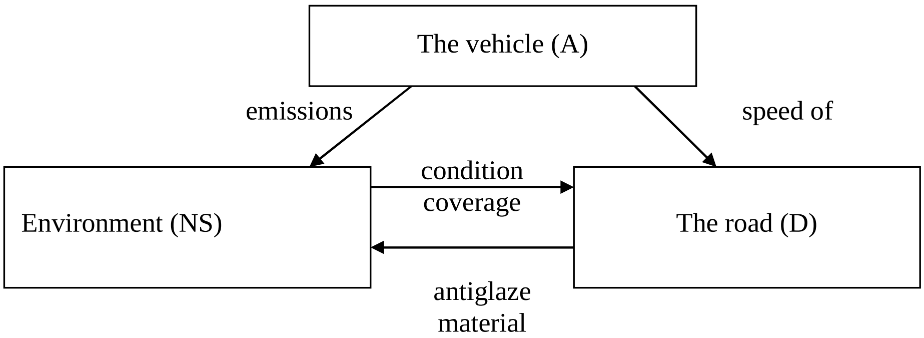


Figure 1 - Scheme of interaction subsystems NA - D and D - A - NA

An analysis of the results of research of many authors, as a factor for solving environmental problems of road can be chosen speed. In winter it is defined as the road surface. To assess the state of road surface use the mathematical model developed to study the conditions of formation of winter slipperiness on road surfaces [10].

In accordance with the general theory of complex systems, subsystems functioning law D - NS present generalized operator FS, which converts a set of internal parameters independent subsystems (road and meteorological factors) in external dependent - road surface condition:

$$\overline{y(t)} = F_S\left[\overline{\upsilon(t)}, \overline{h(t)}, t\right], \quad (4)$$

where $\overline{y(t)} = \{y_1(t), y_2(t), ..., y_n(t)\}$ – state vector coating roads in winter; $\overline{\upsilon(t)} = \{\upsilon_1(t), \upsilon_2(t), ..., \upsilon_m(t)\}$ – vector of the external environment (weather and climatic parameters); F_S – law of the system; $\overline{h(t)} = \{h_1(t), h_2(t), ..., h_k(t)\}$ – own vector system parameters (road and transport parameters); t – time.

In assessing the environmental situation in a roadside strip covering state vector will have its own parameters setup D - A - NA, which determines the level of contamination. The law operation of the subsystem similarly present some generalized operator F_y, which converts a set of internal parameters independent subsystems (road and meteorological factors) in external, dependent for Environmental Assessment in a roadside strip:

$$e(t) = F_y\left[\overline{\upsilon(t)}, \overline{h(t)}, \overline{y(t)}, t\right], \quad (5)$$

where $\overline{e(t)}$ – vector external dependent parameters used for the Environmental Assessment; F_y – law operation subsystem D - A - NA.

In assessing the environmental situation in the state vector roadside strip of pavement $\overline{y(t)}$ will be one of its own road system parameters which influences like all others, the level of pollution in the winter. In (5), he singled out as the result of simulation.

To assess the environmental situation in winter will consider the following options:$H_i(t)$ – pollution of roadside territory antiglaze material (POM)$Q_i(t)$ – concentration of major emissions of gaseous pollutants by vehicles in *i*-th condition of pavement.

Thus, the vector of external parameters becomes:

$$\overline{e(t)} = \left\{\overline{H(t)}, \overline{Q(t)}\right\}. \quad (6)$$

Equation (4), (5) are dynamic mathematical models that reflect the behavior of the system over time. Operators F_S i F_y can be represented as a system of equations, logical relationships, existing empirical and analytical relations linking the input and output parameters subsystem D - A - PSD verbal description of conformity and t. e. [11].

As an external (source) Parameter subsystem NA - D take the road surface condition in winter. To assess the ecological condition of roadside strip in the winter these states take cover, which alter his grip and therefore modes of traffic flows [10].

In calculating state coverage will be represented as a vector

$\overline{y(t)}$, in which all components are zero except the one corresponding possible in the given time condition coverage. Thus, a sign of a certain state coverage is component serial number other than zero and equal to one adopted. The components of the state vector at each step of the calculation time will be determined by weather and road factors.

As an external (input) subsystem parameter D - A - NA take-emissions vehicles under various road surface conditions and the number of SIDs necessary to eliminate winter slipperiness and present it as a vector $\overline{e(t)}$. The components of the vector corresponding to the level of pollution, formed under various road surface conditions. Duration relevant environmental contamination roadside strip of determined time coverage in a given state, dangerous from an environmental point of view.

As the output parameter subsystem D - A - NA take-emissions vehicles under various road surface conditions and the number of SIDs necessary to eliminate winter slipperiness and present it as a vector $\overline{e(t)}$. The components of the vector corresponding to the level of pollution, formed under various road surface conditions.

The internal parameters of the subsystem D - A - NA affecting the state coverage and level of pollution assign its own parameters subsystems that divide into fixed and variable road and transport factors.

The list of personal preferences subsystem is given in Table 2.

Table 2 - Own System Settings

The components of the vector	parameter	marking
	Constant road options	
$h_1(t)$	longitudinal sloping	I
$h_2(t)$	The radius of the curve in terms of	RK
$h_3(t)$	Operating mark (embankment, excavation)	h
$h_4(t)$	The direction of the road	ND
	Variable road options	
$h_5(t)$	The temperature of the road surface	T_n
$h_6(t)$	Condition of road surface	SP
$h_7(t)$	The width of the roadway	$B_{п.ч.}$
$h_8(t)$	Width cutter	$B_{узб}$
$h_9(t)$	visibility	$L_{вид}$
$h_{10}(t)$	Equal coverage	S
$h_{11}(t)$	roughness coverage	φ
	Options traffic	
$h_{12}(t)$	traffic	N
$h_{13}(t)$	The composition of traffic (number of vehicles with petrol and diesel engines)	N_k N_d

Continued Table 2

$h_{14}(t)$	speed of movement	V
$h_{15}(t)$	Power issue	G
$h_{16}(t)$	Fuel consumption for cars with different engine type	G_k G_d
	Захисні фактори	
$h_{17}(t)$	Availability buildings	*З*
$h_{18}(t)$	belts	LS
$h_{19}(t)$	Snow barrier structures	SZ

To the parameters of the influence of the external environment include $\overline{\upsilon(t)}$, which have an impact on the coverage, speed and emissions of vehicles. Components of a vector the influence of the environment is presented in table 3.

Table 3 - Parameters of the external environment

The components of the vector	The name of the parameter	Denote
$v_1(t)$	The air temperature	T_n
$v_2(t)$	Atmospheric pressure	P
$v_3(t)$	Relative humidity	W
$v_4(t)$	Precipitation (presence, type, state)	OP
$v_5(t)$	The amount of precipitation	K_{on}
$v_6(t)$	Clouds	$N_{xм}$
$v_7(t)$	The wind speed	U
$v_8(t)$	The direction of the vector	$Rumb$
$v_9(t)$	The changes in atmospheric pressure	ΔP

The laws of functioning of subsystems D – NA and D – A – NS – a set of analytical and empirical dependencies for the quantitative assessment of the above environmental parameters. In the calculation of air pollution most often used method Gaussa distribution of impurities in the atmosphere at low altitudes [12]. The method of calculation based on the gradual definition of emission of exhaust gas, the concentration of air pollution these gases at varying distances from the road and the data will be compared with MPC:

$$C = \frac{2q}{\sqrt{2\pi}\sigma_z u \sin\varphi} + F \,, \qquad (7)$$

where is the pollutant concentration, g/m3; – power emission, g/s•m; standard deviation Gaussa dispersion in the vertical direction; – wind speed, m/s; – the angle formed between the wind direction and the alignment of the road; – the background concentration of pollutants, mg/m3.

Power emission from all types of vehicles is determined by the formula [12]:

$$q = 2{,}06 \cdot 10^{-4} m \left[\sum_{1}^{i} C_{ik} N_{ik} k_k + \sum_{1}^{j} C_{jd} N_{jd} k_d \right], \qquad (8)$$

where is the correction factor that takes into account relative and absolute dependence of emissions per unit time, average speed of traffic flow; G_{jk}

– average fuel consumption for gasoline cars of the i-th brand, l/km; G_{id}

– the same as for diesel vehicles, l/km; N_{ik}, N_{id} – the traffic intensity of the i-th marks under gasoline and diesel vehicles;

k_k, k_d – dimensionless coefficients taken for the required hazardous component emissions respectively for gasoline and diesel engine types.

Option m depends on the speed of movement of vehicles and represented in the normative literature graphically [12]. For calculations you can use the data taken from the chart and presented in tabular form.

Thus, to assess the ecological status of the roadside strip in the winter proposed a mathematical model that will allow us to quantitatively predict the changes of parameters of functioning of the system from the various actions to solve specific engineering and environmental problems.

The study of the ecological state roadside Sumy in winter, on the basis of the mathematical model

To confirm the adequacy of the mathematical model, a series of numerical experiments to compare the calculation results with experimentality data and obtained their satisfactory coincidence.

The next stage in the work was a series of numerical experiments, in particular on the study of the influence of various conditions of the road surface on the road-side pollution. Were considered the 5 most common conditions road surface: dry, wet, loose snow, snow reel ,ice. The results of the calculations are presented in figure 2.

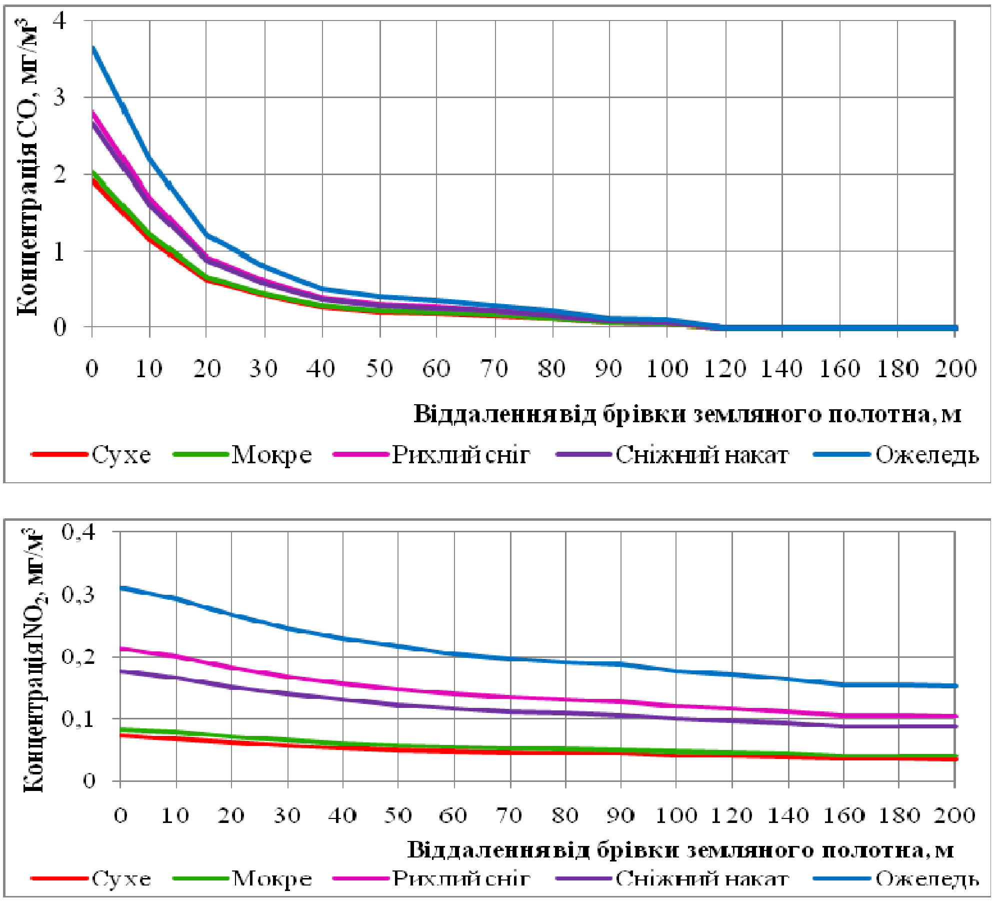
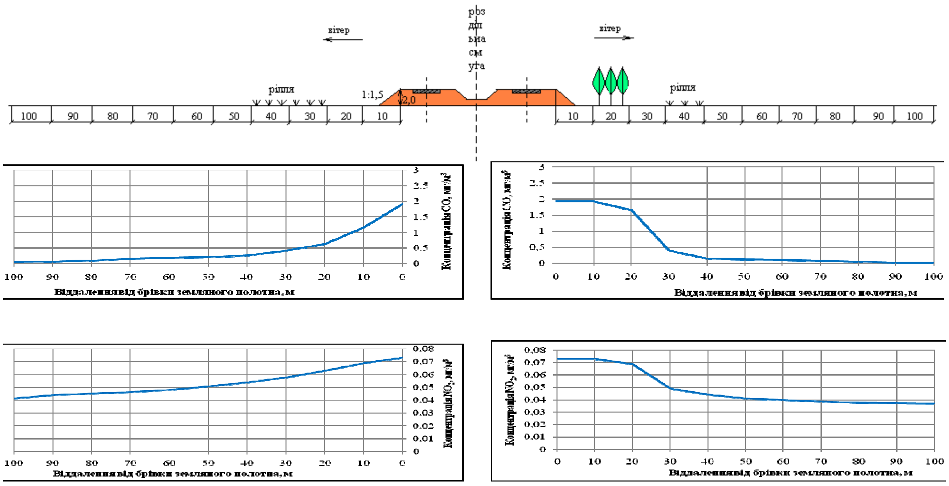


Figure 2 – Graphs of the distribution of concentrations of CO and NO2 in a roadside strip in various States of road surface

The analysis of calculation results showed that the contamination of roadside strips maximum at ice, the minimum – in the dry coating. In addition, regardless of the state of the coating is observed a decrease in the concentration of CO and NO2 with distance from the edge of the subgrade.

A study was conducted of the influence of forest belts on the dispersion of pollutants in the air roadside.

The results are shown in figure

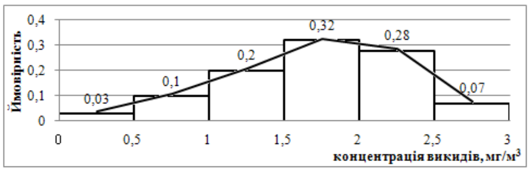


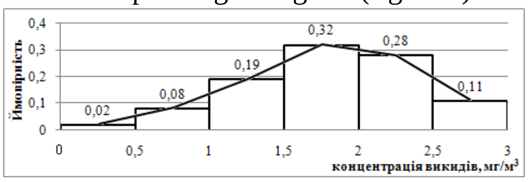
3.

Figure 3 – Graphs of the distribution of concentrations of CO and NO2 in the air roadside strips with and without considering the influence of forest belts

The analysis of calculation results showed that forest belts reduce the intensity of dispersion of pollutants by 40-50% and contribute to the accumulation of them in a roadside strip. This necessitates a device breaks between forest strips for better airing of the roads. For shelterbelts the level of gas, on average, does not exceed the MPC.

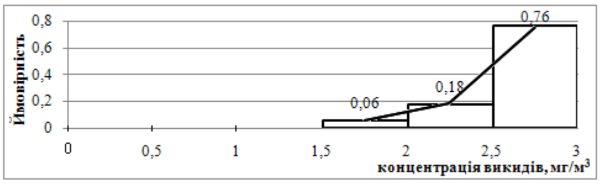
On the basis of the carried out calculations and analysis of experimental data set the distributions of CO and NO2 in the air roadside. For this purpose they built the corresponding histogram (figure 4).

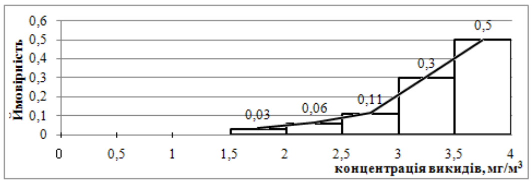




(a) the emissions of CO in the dry coating

b) emissions FROM wet floors





c) emissions of CO in loose snow

d) CO emissions at ice

Figure 4 – Histogram of the distribution of emissions WITH simulation results

Analysis of histograms allows us to conclude that the investigated random variable emissions FROM the dry and the wet roads are normally distributed and described by the dependence:

$$f(x)=\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{(x-\bar{x})^2}{2\sigma^2}}, \qquad (9)$$

where x – random variable (speed); $\bar{x}$ – the expectation values of speed of movement; σ – standard deviation.

The distribution of CO emission in the presence of a coating on the loose snow, snow traction and ice is carried out with the exponential law. Validation of the hypotheses was conducted by the goodness-of-fit Chi-square Pearson and Romanowski and is not rejected at the significance level of 0.1. The probability density is exponential law can be described by the dependence:

$$f(x)=\mu\cdot e^{-\mu x}=\frac{1}{M(x)}e^{-\frac{t}{M(x)}}, \qquad (10)$$

where μ – parameter exponential law; $M(t)=\frac{1}{\mu}$ – mathematics expectations.

The results of statistical processing of the emissions of CO are presented in table. 3.

Table 3 – Results of statistical processing of the concentration of CO emissions for different road surface conditions in winter

The condition of the coating	The law of distribution of concentration of emissions of CO	The parameters of the law	The concentration of CO emissions, mg/m3			
			The average value	Confidence interval of variation of the average value for a confidence level		
				0,85	0,90	0,95
Dry	Normal	$\bar{x}$=1,740 σ=0,795	1,740	0,717+2,763	0,576+2,904	0,350+3,132
Wet	Normal	$\bar{x}$=1,835 σ=0,816	1,835	0,756+2,914	0,607+3,063	0,367+3,303
Snow reel	Parisnicole	μ=0,413	2,420	0,997+3,843	0,800+4,040	0,484+4,356
Oiled	Parisnicole	μ=0,301	3,320	1,368+5,272	1,096+5,544	0,662+5,978
Loose snow	Parisnicole	μ=0,392	2,550	1,050+4,050	0,843+4,256	0,512+4,588

Similar calculations were performed for NO2. Analytical results are given in table (table 4)

Table 4 – Results of statistical processing of the concentration of NO2 emissions under different road surface conditions in winter

The condition of the coating	The law of distribution of concentration of emissions of CO	The parameters of the law	The concentration of CO emissions, mg/m3			
			The average value	Confidence interval of variation of the average value for a confidence level		
				0,85	0,90	0,95
Dry	Parisnicole	μ=16,97	0,050	0,021+0,079	0,017+0,083	0,010+0,090
Wet	Parisnicole	μ=17,54	0,057	0,024+0,090	0,019+0,095	0,012+0,103
Snow reel	Normal	$\bar{x}$=0,138 σ=0,063	0,138	0,057+0,219	0,046+0,230	0,028+0,248
Oiled	Parisnicole	μ=4,12	0,243	0,100+0,386	0,081+0,405	0,049+0,437
Loose snow	Normal	$\bar{x}$=0,166 σ=0,076	0,166	0,068+0,263	0,055+0,277	0,033+0,299

The results of statistical processing of the emissions of CO are presented in table III. 3 show that all the conditions of coverage than the ice, the average levels of emissions do not exceed the maximum permissible concentration=3 mg/m3. However, the upper value of the confidence intervals for p = 0.95 in all cases are outside the MPC.

The results of statistical processing of emissions of NO2 are presented in table III. 4, allow us to conclude that their average values and upper values of the confidence intervals for a confidence probability of 0.85, 0.90 and 0.95 at all States coverage exceed the maximum permissible concentration=0.04 mg/m3.

Conclusions

1. Road transport sector is one of the most significant environmental contaminants, hence the need to address problems of environmental safety and reducing the impact of transport on the human environment.

2. On the formation and transport of contamination of roadside strip is influenced by three groups of factors: traffic, climatic and transport.

3. In this approach, a mathematical model is proposed to assess the ecological status of the roadside strip in the winter.

4. The highest levels of roadside pollution stripes in winter, there is ice, the lowest – in the dry coating.

5. The presence of shelterbelts along roads increases the accumulation of CO and NO2 at the roadside strip by 40-50%.

6. Based on the statistical analysis of established laws of distribution of the concentrations of CO and NO2 in a roadside strip the various States of the coating.

REFERENCES

1. Berlyand ME Modern problems of atmospheric diffusion and air pollution. L. 1975 . 448.

2. Burenin NS Study of air pollution vehicle exhausts . Author. Ph.D. Chap. Exercise . Hydrometeorological Service under the USSR Council of Ministers , Ch. Geophysical Observatory . Voeikova . L., 1977. 18 .

3. Kirillov GP Prediction of pollution residential areas exhaust gases of motor transport and urban development activities to reduce it . Author. Ph.D. Volgograd, 1973. 31 p.

4. Ryabikov NA Score influences driving conditions on air pollution by exhaust gases of gasoline engines : Author. for Ph.D. SoyuzdorNII. Moscow. 1984. 188 p.

5. Skorchenko VF Investigation of the influence of traffic conditions on pollution cars: Author. Ph.D. KADI, K., 1980, 229 p.

6. VV Filippov Environmental calculations when designing roads. Roads, 1990, № 5. With. 20.
7. Cherv'yakova T.I. Vdoskonalennya dorozhnih minds on osnovi ekologichnoї otsinki povitryanogo communal swimming pool on primagistralnih teritoriyah : Author. Ph.D. KADI, K., 1988, 347 p.
8. Setton SG Micrometeorology (translated from English). L., 1958. 35.
9. AP Vasilyev Road design and impact of climate on traffic conditions. M., 1986. 248.
10 . Samodurova TV Organization to combat icy roads on the roads according to the forecast : Author. Ph.D. MADI, Moscow, 1992, 235 p.
11. BJ tips , Yakovlev SA Modeling systems. M., 1990. 86 p. (ref. to benefit SNIP)
12. Guidance on accounting requirements for the protection of the environment in the design of roads and bridges . Sost. GiprodorNII , SoyuzdorNII , MADI , Federal Highway Department . M., 1995. 123c.

ПЕРЕЛІК ПОСИЛАНЬ

1. Берлянд М.Е. Современные проблемы атмосферной диффузии и загрязнения атмосферы. – Л.; 1975. – 448 с.
2. Буренин Н.С. Исследование загрязнения атмосферы выхлопными газами автотранспорта. Автореф. к.т.н. Гл. упр. Гидрометеорологической службы при Совмине СССР, Гл. Геофизическая обсерватория им. Воейкова. – Л., 1977. – 18 с.
3. Кириллов Г.П. Прогнозирование загрязнения жилых территорий выхлопными газами автомобильного транспорта и градостроительные мероприятия по его уменьшению. Автореф. к.т.н. / Волгоград, 1973 – 31 с.
4. Рябиков Н.А. Оценка влияний условий движения автомобилей на загрязнение воздуха отработавшими газами бензиновых двигателей: Автореф. на к.т.н. / СоюздорНИИ, М., 1984, 188 с.
5. Скорченко В.Ф. Дослідження впливів дорожніх умов на забруднення навколишнього середовища автомобілями: Автореф. к.т.н. / КАДІ, К., 1980, 229 с.
6. Филиппов В.В. Экологические расчеты при проектировании дорог // Автомобильные дороги, 1990, №5. - с. 20.
7. Черв'якова Т.І. Вдосконалення дорожніх умов на основі екологічної оцінки повітряного басейну на примагістральних територіях: Автореф. к.т.н. / КАДІ, К., 1988, 347 с.
8. Сеттон С.Г. Микрометеорология (пер. с англ.). – Л.; 1958. – 35 с.
9. Васильев А.П. Проектирование дорог и влияние климата на условия движения. – М.; 1986. – 248 с.
10. Самодурова Т.В. Организация борьбы с зимней скользкостью на автомобильных дорогах по данным прогноза: Автореф. к.т.н. / МАДИ, М., 1992, 235 с.
11. Советов Б.Я., Яковлев С.А. Моделирование систем. – М.; 1990. – 86 с. (справ. пособие к СНиП)
12. Рекомендации по учету требований по охране окружающей среды при проектировании автомобильных дорог и мостовых переходов. Сост. ГипродорНИИ, СоюздорНИИ, МАДИ, Федеральный дорожный департамент. – М.; 1995. – 123с.

REFERENCES

Bondarenko L. P. Study of the ecological state of the roadside in winter, based on mathematical modelling. Management of projects, system analysis and logistics. Science journal: In Part 2. Part 1: Series: "Technical sciences" - Kyiv: NTU, 2014. - Vol. 13.

This paper investigated the ecological state of the roadside during the winter period, which is the most challenging and stressful for the road maintenance organizations.

Object of study: system "road - vehicle - environment"

Purpose - to investigate the influence of various factors on the roadside pollution in winter.

As part of the analyzed internal and external parameters affecting the ecological state of the roadside; proposed mathematical model , the numerical experiment on the effect of coating condition and the presence of windbreaks on the ecological condition of roadside; established relations of distribution of surface concentrations of impurities in the roadside .

Analysis of the results of the calculations showed that the pollution of the roadside icy maximum and minimum - in the dry coating. In addition, the presence of belts reduces the intensity of dispersion of pollutants and contribute to their accumulation in the roadside .

On the basis of calculations and analysis of experimental data histograms of the concentration distribution of carbon monoxide and nitrogen dioxide in the air roadside at various states of the pavement . Determined the normal distribution of concentrations of carbon monoxide in dry and wet surfaces and demonstration - with snowy reel, loose snow and ice . For nitrogen dioxide inherent exponential law distribution of concentrations under dry and wet conditions coverage , as well as ice and normal - when fresh snow and snow reel .

The results are obtained and scientific - practical conclusions will allow to make informed engineering decisions aimed at reducing the negative impact of road - transport complex on the environmental situation.

KEYWORDS: ROADSIDE curb , ecological condition , mathematical modeling, numerical experiments

РЕФЕРАТ

Бондаренко Л.П. Дослідження екологічного стану придорожньої смуги в зимовий період року на основі математичного моделювання / Л.П. Бондаренко // Управління проектами, системний аналіз і логістика. Науковий журнал: в 2 ч. Ч. 1: Серія: „Технічні науки” – К. : НТУ, 2014. – Вип. 13.

В статті проведено дослідження екологічного стану придорожньої смуги у зимовий період року, який є найбільш складним і напруженим в роботі дорожно-експлуатаційних організацій.

Обєкт дослідження: система „дорога-автомобіль-навколишнє середовище”

Мета роботи – дослідити вплив різних факторів на формування забруднення придорожньої смуги в зимовий період року.

В рамках роботи проаналізовано зовнішні і внутрішні параметри, що впливають на екологічний стан придорожньої смуги; запропоновано відповідну математичну модель; проведено числовий експеримент з дослідження впливу стану покриття і наявності лісосмуг на екологічний стан придорожньої смуги; встановлено закони розподілу приземних концентрацій домішок в придорожній смузі.

Аналіз результатів розрахунків показав, що забруднення придорожньої смуги максимальне при ожеледі, мінімальне – при сухому покритті. Крім того, наявність лісосмуг зменшує інтенсивність розсіювання домішок і сприяють накопиченню їх в придорожній смузі.

На основі проведених розрахунків та аналізу експериментальних даних побудовано гістограми розподілу концентрацій оксиду вуглецю та діоксиду азоту у повітрі придорожньої смуги при різних станах дорожнього покриття. Встановлено, що оксид вуглецю підпорядковується нормальному закону розподілу концентрацій при сухому та мокрому покритті і показниковому – при сніжному накаті, рихлому снігові та ожеледі. Для діоксиду азоту притаманний показниковий розподіл концернтрацій при сухому та мокромустанах покриття,а також при ожеледі та нормальний – при рихлому снігові та сніжному накаті.

Отримані в роботі результати та науково-практичні висновки, дозволять приймати обгрунтовані інженерні рішення, направлені на зниження негативного впливу дорожньо-транспортного комплексу на екологічний стан довкілля.

КЛЮЧОВІ СЛОВА: ПРИДОРОЖНА ПОЛОСА, ЕКОЛОГІЧНИЙ СТАН, МАТЕМАТИЧНЕ МОДЕЛЮВАННЯ, ЧИСЛОВИЙ ЕКСПЕРИМЕНТ

РЕФЕРАТ

Бондаренко Л.П. Исследование экологического состояния придорожной полосы в зимний период года на основе математического моделирования / Л.П. Бондаренко / / Управление проектами, системный анализ и логистика. Научный журнал: в 2 ч. Ч. 1: Серия: „Технические науки” – К. : НТУ, 2014. – Вип. 13.

В статье проведено исследование экологического состояния придорожной полосы в зимний период года, который является наиболее сложным и напряженным в работе дорожно - эксплуатационных организаций.

Объект исследования: система "дорога -автомобиль -окружающая среда "

Цель работы – исследовать влияние различных факторов на формирование загрязнения придорожной полосы в зимний период года.

В рамках работы проанализированы внешние и внутренние параметры, влияющие на экологическое состояние придорожной полосы; предложена соответствующаю математическая модель; проведен численный эксперимент по исследованию влияния состояния покрытия и наличии лесополос на экологическое состояние придорожной полосы; установлены законы распределения приземных концентраций примесей в придорожной полосе.

Анализ результатов расчетов показал , что загрязнение придорожной полосы максимальное при гололеде, минимальное – при сухом покрытии. Кроме того, наличие лесополос уменьшает интенсивность рассеивания примесей и способствуют накоплению их в придорожной полосе .

На основе проведенных расчетов и анализа экспериментальных данных построены гистограммы распределения концентраций оксида углерода и диоксида азота в воздухе придорожной полосы при различных состояниях дорожного покрытия. Установлен нормальный закон распределения концентраций оксида углерода при сухом и мокром покрытии и показательный – при снежном накате, рыхлом снегу и гололеде . Для диоксида азота присущ показательный закон распределения концернтраций при сухом и мокром состояниях покрытия, а также при гололеде и нормальный – при рыхлом снегу и снежном накате .

Полученные в работе результаты и научно - практические выводы, позволят принимать обоснованные инженерные решения, направленные на снижение негативного воздействия дорожно - транспортного комплекса на экологическое состояние окружающей среды.

КЛЮЧЕВЫЕ СЛОВА: ПРИЛОРОЖНАЯ ПОЛОСА, ЭКОЛОГИЧЕСКОЕ СОСТОЯНИЕ, МАТЕМАТИЧЕСКОЕ МОДЕЛИРОВАНИЕ, ЧИСЛЕННЫЙ ЭКСПЕРИМЕНТ

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