ASSESSMENT OF ATMOSPHERIC AIR QUALITY IN THE CITY OF TERMEZ

Kamila Shipilova
PhD, Senior Lecturer,
National Research University
"Tashkent Institute of Irrigation
and Agricultural Mechanization Engineers",
Republic of Uzbekistan, Tashkent
E-mail: kamila-shipilova@mail.ru

Malokhat Abdukodyrova
PhD, docent,
National Research University
"Tashkent Institute of Irrigation
and Agricultural Mechanization Engineers",
Republic of Uzbekistan, Tashkent

Baxriniso Tilovova
Master's Degree Student,
"Termez Institute of Engineering and Technology",
Republic of Uzbekistan, Termez

ОЦЕНКА КАЧЕСТВА АТМОСФЕРНОГО ВОЗДУХА В ГОРОДЕ ТЕРМЕЗ

Шипилова Камила Бахтияровна
PhD, ст. преподаватель,
Национально-исследовательский университет
«Ташкентский институт инженеров ирригации
и механизации сельского хозяйства»,
Республика Узбекистан, г. Ташкент

Абдукодырова Малохат Нориджоновна
PhD, доцент,
Национально-исследовательский университет
«Ташкентский институт инженеров ирригации
и механизации сельского хозяйства»,
Республика Узбекистан, г. Ташкент

Тилавова Бахринисо Рузимурод кизи
магистр,
Термезский инженерно-технологический институт,
Республика Узбекистан, г. Термез

ABSTRACT

The article discusses the problems of assessment and the current state of air quality in the city of Termez. The issue of monitoring atmospheric air in the city, data on atmospheric air pollution in the Termeses are published daily on the website of Uzhydromet, indicating the detected cases of excess of the actual concentration over the MPC_{mo}. The issue of the influence of motor transport on the O_2 content in urban air was also studied by calculating the method of changing the concentration of O_2. It has been experimentally established that the intensity of the decrease in oxygen concentration is associated with the intensity of car traffic. For the possibility of rapid assessment of oxygen concentration, a modified Kitsenko equation is proposed, in which the authors determine the coefficients of uneven motion.

АННОТАЦИЯ

В статье рассматриваются проблемы оценки и современное состояние качества воздуха в городе Термез. Рассмотрен вопрос проведения мониторинга атмосферного воздуха в городе, данные о загрязнении атмосферного воздуха в Термезе публикуются ежедневно на сайте Узгидромета с указанием выявленных случаев превышения фактической концентрации над ПДКмр. Также изучен вопрос влияния автомобильного транспорта на содержание O_2 в городском воздухе, путем расчета методикой изменения концентрации O_2. Экспериментально установлено, что интенсивность снижения концентрации кислорода связана с интенсивностью движения автомобилей. Для возможности проведения экспресс-оценки концентрации кислорода предлагается модифицированное уравнение Киценко, в которое авторами определены коэффициенты неравномерности движения в городе Термез.

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Ключевые слова: качество воздуха, индекс загрязнения, мониторинг, твердые частицы.

The steady growth of the Earth's population and the development of economic activity leads to an increase in environmental pollution. Of all types of pollution, air pollution is the most dangerous for humans, since it is impossible to avoid the penetration of harmful substances from the air into the human body during breathing.

Atmospheric air is especially intensively polluted in large cities, where sources of pollution are not only industrial and municipal enterprises, but also transport. Improving the air condition of human settlements is one of the objectives of Sustainable Development Goals 11 "Sustainable cities and human settlements". In Uzbekistan, the level of motorization is increasing every year. The operation of an ever-increasing fleet of vehicles is closely related to the environmental problems of sustainable development. Although issues of transport sustainability are being discussed in Uzbekistan, but mainly from an economic point of view.

According to studies, the pollution of the urban atmosphere largely depends on climatic conditions and wind conditions, partly due to the layout of the city. Uzhydromet monitors atmospheric air pollution in accordance with the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 737 dated 05.09.2019. "On improving the environmental monitoring system in the Republic of Uzbekistan".

In the city of Termez, the climate is hot desert with mild, but for such latitude relatively cold winters (with warm days and cool nights, sometimes quite serious cold spells or snowfalls are possible) and exceptionally hot summers. The overwhelming amount of precipitation falls in the period from November to April, in summer rains are extremely rare. Natural and climatic conditions are expressed by frequent inversions and stagnant phenomena in the atmosphere, which contributes to the accumulation of pollutants in the surface layer of the atmosphere. The high dustiness of the air is partly explained by the dry climate, sandy loam soils and frequent winds.

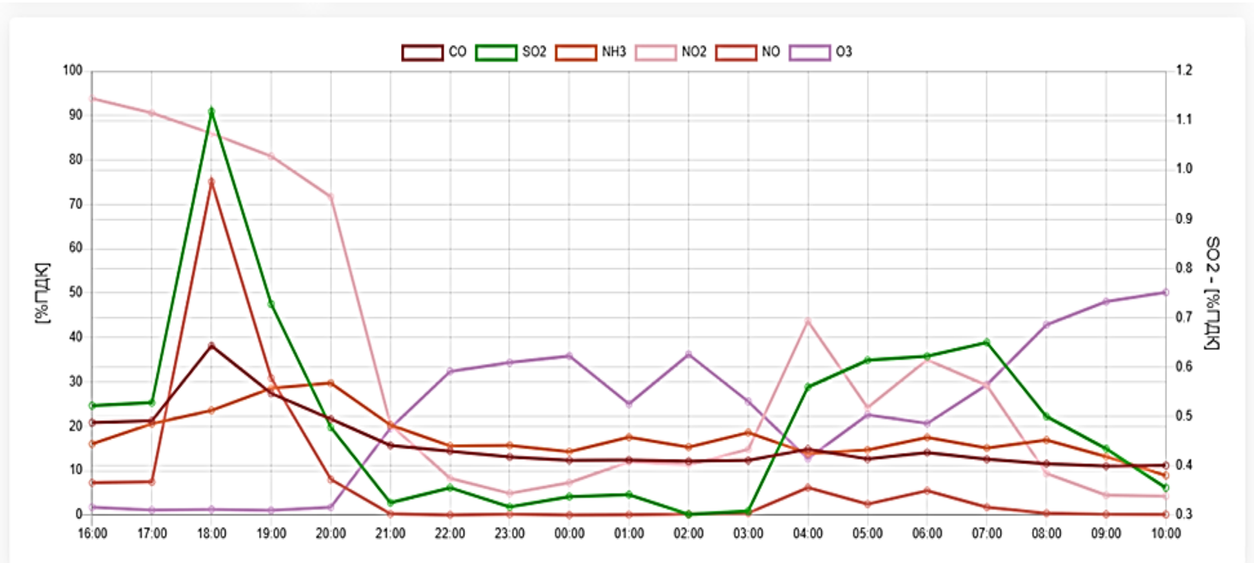
Monitoring of atmospheric air pollution in Surkhandarya region is carried out by the services of Uzhydromet located in 5 villages at 5 posts of Pnz No. 1 - Sariasia Village "Sufien" (Landmark: Artesian Tower, Mahalla "Hamkorlik"); Pnz No.2 - Sariasia Village "Dashnabad" (Landmark: Outpatient, Mahalla "Buirapush"); Pnz No. 1 - Denau Settlement "Uzbekistan" (Landmark: Gas Station, Mahalla "Okhtom"); Pnz No.1 Termez Termez District, Mahalla Navruz (Landmark International Airport Of Termez); UZHYMET-Termiz-beta

Observations of the state of atmospheric air are carried out daily with a frequency of 3 times a day (7:00; 13:00; 19:00 local time).

Sampling at the observation points of the Uzhydromet is carried out by the aspiration method, pumping air through Richter absorbers and sorption tubes.

To assess air quality, concentrations of dust, sulfur dioxide, nitrogen oxide and dioxide, carbon monoxide, phenol, hydrogen fluoride, ammonia, formaldehyde, heavy metals, solid particles PM 2.5, PM 10 are measured. For a comprehensive assessment of the state of atmospheric air, the Air Quality Index (AQI) is used, which is calculated for 5 substances having the highest concentrations.

As an example, this paper presents the results of atmospheric air monitoring post UZHYMET-Termiz-beta on May 23, 2023.



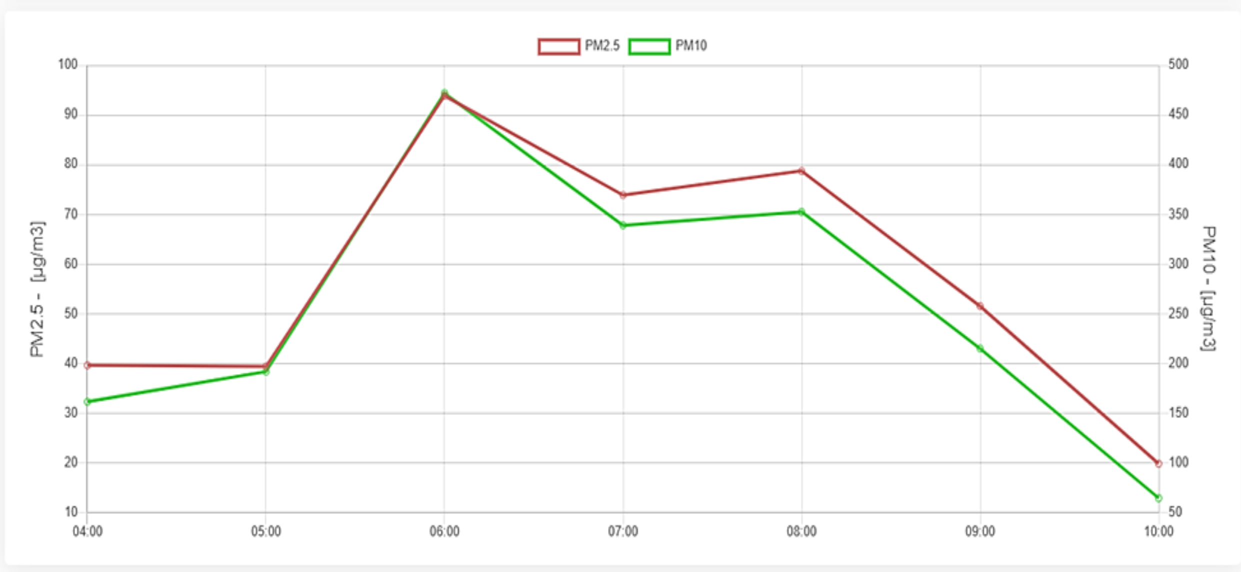


Figure 1. Concentrations of atmospheric pollutants post UZHYMET-Termiz-beta on May 23, 2023

In addition to the above substances, you should think about another aspect of the impact of vehicles on the environment. Even with a complete transition to gas fuel, engines consume oxygen to burn fuel. Accordingly, the oxygen concentration will decrease in the roadside zone. Such a phenomenon, called "oxygen runoff", has already been considered by some authors for industrial enterprises [9,10] and urban road transport [11, 12, 13]. Kitsenko A.B. to account for the oxygen runoff during the operation of vehicles, an equation based on the solution of the boundary value problem using the Green function was derived. However, the Kitsenko A.B. equation is derived without taking into account the variability of the time interval of increased traffic intensity and the uneven distribution of cars across the city. Therefore, for the practical use of this equation, it is necessary to make amendments to it, taking into account these irregularities. For this purpose, observations of traffic intensity and the degree of traffic congestion during the day were carried out on the territory of Termez for 8 months. According to the results of the observations, the coefficient of unevenness of the duration of the "rush hour" was determined, which was 0.65 and the coefficient of unevenness of the loading of roads by cars, which was 0.80.

With the help of these coefficients, the Kitsenko A.B. equation was modified and reduced to the form:

$$\Delta q = \frac{2}{\rho}\frac{N_{дв}}{S} M \sqrt{\frac{T}{\pi K_{zz}}} \qquad (1)$$

where Δ q is the change in oxygen concentration in the air due to the impact of motor vehicles; T is the time of increased traffic intensity, with;

p is the density of air, p = 1.29 kg / m^3. K_{zz} is the coefficient of turbulent diffusion. $K_{zz} = 0.01\,\frac{м^2}{с}$; M is the average amount of O_2 consumed by 1 car per 1 second, kg / (s·auth). N_{dv} – the number of cars in motion, auth; S – the area of the city (for Termez S = 27.8 km^2).

Leaving the assumption of the uniformity of the surface distribution of cars, it is necessary to take into account the uneven distribution by time of day, since the number of cars in motion in the city makes sharp "jumps" during peak hours. Therefore, in order to use equation (1), it is necessary to calculate or experimentally determine some of the quantities included in it.

1. Determination of the number of N_{dv} vehicles used during "rush hours". The total number of cars registered in Termez N = 18000 units. According to experts, a maximum of 65-70% of the total is in motion.

$$N_{дв} = 0.7 \cdot N = 0.7 \cdot 18000 = 12600 \text{ ед.} \qquad (2)$$

2. Determination of the second O_2 consumption for gasoline combustion.

We accept an average gasoline consumption of 10 kg per 100 km and an average car speed of V = 60 km/h. Then the second consumption of gasoline

$$m_{бенз} = \frac{10}{\left(\frac{100}{60}\right)\cdot 3600} = 1.7 \cdot 10^{-3}\ \frac{кг}{(с\cdot авт)} \qquad (3)$$

Burning 1 kg of gasoline consumes 3 kg of O_2.

Then $M = 1.7\cdot10^{-3}\cdot3 = 5.1\cdot10^{-3}$ кг O_2/(с·авт)

3. Determination of the duration of increased traffic intensity ("rush hour") T was produced experimentally. For further calculations, the duration of the first "rush hour" (the most common value), $T_{ср}$ = 1.3 h (4680 c), is taken as the duration of the first "rush hour". The coefficient of unevenness of the duration of the rush hour K_1 = 0.65 (Table 1).

Table 1.

Average duration of the "rush hour"

№ peak	Duration T, hour						Average T_{cp}	Coefficient of unevenness
	а	б	в	д	е	ж		
I	3	2	2	2	2	2	2.16	0.72
II	0	4	2	1	1	0	1.3	0.32
III	2	0	2	2	0	2	1.3	0.65

Equation (1) is derived without taking into account the variability of the time interval of increased traffic intensity and the uneven distribution of cars throughout the city. Therefore, in order to use this equation, it is necessary to make amendments to it, taking into account these irregularities.

The uneven loading of roads by cars is estimated by their average numbers

$$N_{\text{cp}} = \frac{N_{cp1} + N_{cp2} + N_{cp3} + N_{cp4} + N_{cp5} + N_{cp6}}{6} = = \frac{98+92+95+85+35+32+39}{6} = \frac{476}{6} = 79.3 \text{ авт/5 мин} =$$

$$=15.86 \text{ авт/ мин} \quad (4)$$

Coefficient of unevenness

$$\text{K}^2 = \frac{N_{cp}}{N_{max}} = \frac{79}{98} = 0.80 \quad (5)$$

After introducing the coefficients K_1 and K_2, equation (2.5) will take the form:

$$\Delta \text{q} = \frac{2}{\rho} \frac{N_{дв} \cdot K_2}{S} M \sqrt{\frac{TK_1}{\pi K_{zz}}} \quad (6)$$

Let's call the resulting equation the "modified Kitsenko A.B. equation". Using it, we can determine the theoretically possible decrease in the Δq_{teor} oxygen content under the influence of motor vehicles and compare it with the experimentally determined $\Delta q_{эквп}$, which will allow us to evaluate the possibility of using equation (6) for practical calculations.

Substituting numerical values into equation (6), we obtain

$$\Delta q = \frac{2 \cdot 12927 \cdot 0{,}80}{1.29 \cdot 27.8 \cdot 10^6} \cdot 5 \cdot 10^{-3} \sqrt{\frac{7776 \cdot 0{,}65}{3.14 \cdot 0{,}01}} = 0.0115 = 0.115\ \%$$

Theoretically, a possible decrease in the oxygen content in the city's atmosphere during the "rush hour" may amount to 0.115%.

Our further task was to experimentally determine the O_2 content near highways and in residential areas of the city.

To obtain data on the oxygen content in the breathing zone in the territories adjacent to the highways of the city of Termez with a high degree of representativeness, it is desirable to conduct continuous monitoring, but this is impossible in terms of time, labor and material resources. The interaction and movement of gases in the surface zone is a complex multifactorial process, which it is advisable to investigate by selective control methods [1-3].

We applied a 2-step cluster sampling. It is also advisable to use cluster sampling to study such processes [14].

1) The first stage is the representation of the city territory in the form of a cluster.

2) According to the results of measurements in the summer period, the average value of the % O_2 content in the roadside zone of each district was determined at three points of each street (Table 2):

1) The average value of the oxygen content in the roadside zones of the city was determined $X_{cp} = 20.28\%$

The variance is determined

$$\delta = \sum(X_i - X_{cp})^2 = 0.0049$$

Table 2.

Average O_2 content along the highways of streets X

Street names	Istomino	Lenin	I. Karimova	Madaniyat	S.Saodat	Airtom, A	Navoi	Ibn Sina
conditional designation	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
% O_2 content	20.3	20.45	20.2	20.3	20.24	20.35	20.3	20.12

3) The mean square deviation is determined by the formula

$$\sigma = \sqrt{\frac{\delta}{m-1}}, \quad (7)$$

where m is the number of observations equal to the number of administrative units (streets)

$$\sigma = \sqrt{\frac{0.0049}{7}} = \sqrt{0,00007} = 0.26$$

We determine the number of streets required for research (sample size), provided that with a probability of 0.954 the sampling error does not exceed 0.2% (± 0.1%) with a standard deviation σ = 0.26

$$n = \frac{t^2\sigma^2 N}{N\Delta_x^2 + t^2\sigma^2} \quad (8)$$

where t is the confidence coefficient determined by the Laplace table (Table 3)

Table 3.

The Laplace table

Probability P	0.683	0.954	0.997
Coefficient t	1	2	3

We accept t = 2
σ is the standard deviation, σ = 0.26
N is the volume of the general population.
N = 8th street
Δx – sampling error. Δx=0.2 % (±0.1%)

$$n = \frac{2^2 \cdot 0.26^2 \cdot 8}{8 \cdot 0.2^2 + 2^2 \cdot 0.26^2} = 3.66$$

to conduct research, it is enough to choose 3 streets.

5) We will select 3-x streets for further research. To do this, measurements of the concentration of O_2 on each of the highways belonging to this street were carried out in each district, which made it possible to determine the σ of each street. Table 4 shows the values of σ for each street.

Table 4.

σ values for the streets of the city of Termez

Ibn Sina	Lenin	Istomino	A. Navoi	I.Karimova	Airtom, A	Madaniyat	S.Saodat
0.15162	0.13974	0.13991	0.14876	0.14344	0.13890	0.13670	0.14050

For further research, the following streets were chosen (according to the highest values of σ, as the worst)

- Ibn Sino (σ = 0.15162)
- Navoi (σ = 0.14876)
- I.Karimov (σ = 0.14344)

6) Determination of the probability that the sampling error Δx will not exceed ±0.1%

$$P = P_{гор} \cdot P_{рай} = 0.954^2 = 0.91012$$

Conclusion: a sample consisting of 3-x streets in them with a probability of 0.91 will provide an error in determining the O_2 content in the atmosphere of the city ± 0.1%

In addition to measurements at selected points on the main streets (2-x lane), measurements were carried out in parallel on nearby 1-x lane streets and in residential areas located within a radius of 100 m from the selected point.

Figure 2 shows, as an example, a graph of the change in the percentage of O_2 from 6.00 to 20.00 according to the average values for September 2022. The dotted line shows a graph of the change in traffic intensity over the same period of time. The figure shows that the end of the "rush hour" is accompanied by an increase in O_2 content. For example, after the end of the I "rush hour" (10.00 o'clock), an increase in the O_2 content to 20.1% begins.

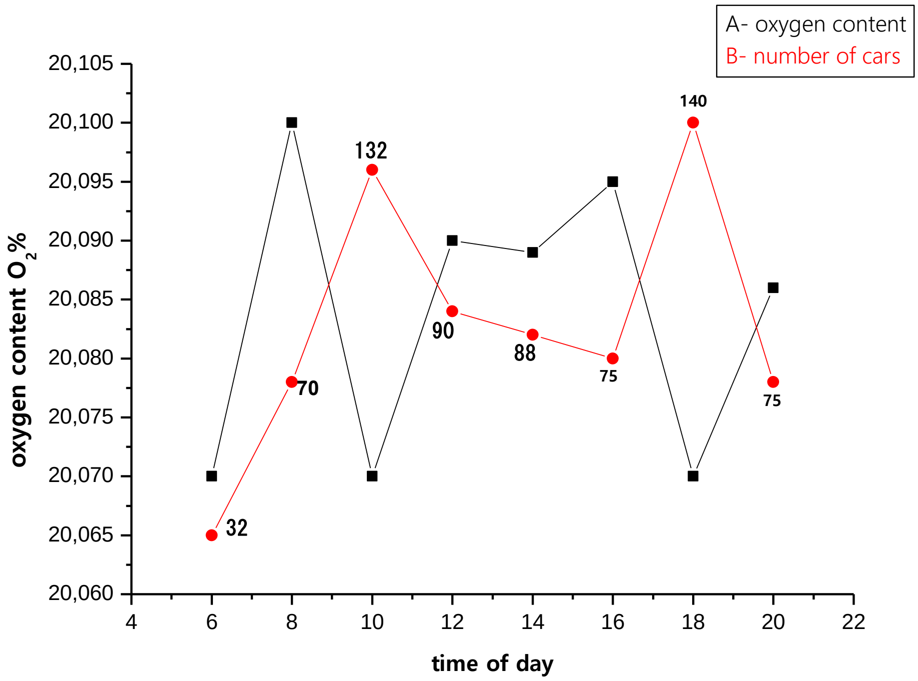


Figure 2. Combined graphs of changes in the number of cars and O_2 content in the air during the day for roads with 4-x lane traffic (september 2022)

Our further task is to test the possibility of using the modified Kitsenko A.B. equation for practical calculations of reducing the concentration of O_2 and determining the conditions under which this decrease can reach dangerous values, which is especially important during the rapid growth of motorization.

To test the possibility of using the modified equation (6) Kitsenko A.B. for practical calculations, let's compare the theoretical and experimental values of Δq

$$\Delta q = \frac{|\Delta q_{теор} - \Delta q_{эксп}|}{\Delta q_{теор}} = \frac{|0.115 - 0.224|}{0.115} = 0.947 \approx 9.4\%,$$

it follows from this that the modified equation (6) can be used for practical calculations of reducing the oxygen content in urban air with an accuracy of about 9%.

Conclusion. So, if the value of the O_2 concentration before the "rush hour" is approaching critical (19.6...19.54%), the population should be warned to take precautions. It is obvious that the calculated value of Δq is obtained at certain values of S, T, N_{dv}, which correspond to the current state of road transport in Termez. If any of these indicators change, it is necessary to make adjustments to the equation [4-8].

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