Acta of Turin Polytechnic University in Tashkent, 2022, 31, 51-54
Published Online March 2022 in Acta TTPU (http://www.acta.polito.uz/)

CALCULATION OF THE AMOUNT OF EMISSIONS OF HARMFUL SUBSTANCES BY CARS AT URBAN INTERSECTIONS

Bazarov B.I.*, Ernazarov A.A..**

*Tashkent State Transport University, **Andijan machine - building Institute

*Email: baxtbb@mail.ru

**Email: aziz-ernazarov@mail.ru

Abstract– A study of the traffic flow of one of the busiest central streets of the city of Jizzakh – I. Karimov Avenue. A complete description of the intersections of this transport highway is given. To perform the calculations, observations and counting of the number of vehicles crossing intersections were carried out. The calculation of the amount of exhaust gas emissions into the atmosphere was made.

Key words– Road transport, motorway, vehicle emissions, intersection, structure of the flow of vehicles.

I INTRODUCTION

Automobile transport has become the most serious source of atmospheric air pollution in our time. This is especially noticeable in large cities.

The main consequence of the increase in the number of vehicles is the increase in anthropogenic impact on the environment and, above all, on the atmosphere of built-up areas. Car emissions, first of all, are dangerous because they enter directly into the surface layer of the atmosphere, where the wind speed is negligible and therefore gases are poorly dispersed [1,2,4,6].

The purpose of this work is to identify the maximum possible concentrations of pollutants emitted by vehicles on I.Karimov Avenue in the city of Jizzakh. During the operation of transport, a huge amount of dust and toxic substances contained in the exhaust gases of power plants enter the atmosphere, high noise levels are created, air, soil, water bodies are polluted as a result of the discharge and spillage of fuels and lubricants, many other substances harmful to the natural environment and humans are formed. The level of gas contamination of highways and adjacent territories depends on the intensity of car traffic, the width and relief of the street, wind speed, the share of freight transport and buses in the total flow, and other factors. It is difficult to disperse car emissions on cramped streets. As a result, almost all residents of the city experience the harmful effects of polluted air.

In the period July – August 2021, a study of the traffic flow along the entire length of I. Karimov Avenue (Jizzakh) was conducted. This urban transport highway was chosen as the busiest, connecting the main transport overpasses of the city of Jizzakh, both intra-city routes of motor transport and intercity routes pass through it.

The total length of I.Krimov Avenue is 7197 m. The width of the roadway is 23 m.. The number of traffic lanes in each direction is 3. There are six regulated intersections: from Mustakillik Street, Baynaminal Street, Khamrakulova Street, Shifokorlar Street, Kalia Street, Tashkent Street.

The need to divide I.Karimov Avenue into separate section is caused both by the presence intersections of various types and by the different nature of traffic flow throughout the avenue.

The following division of I. Karimov Avenue into section was carried out (the approximate length of each section was determined using a navigator), the frequency of traffic light was determined for regulated intersections, taking into account the effect of prohibiting ("red" and 2 "yellow") and permitting ("green") traffic light signals. During the research work, the "Methodology for determining vehicle emissions for conducting summary calculations of urban air pollution" was used to estimate the values of emissions of pollutants into the atmosphere by motor vehicles on urban highways[3].

II CALCULATION OF EMISSIONS OF MOVING VEHICLES

The emission of the i-th pollutant (g/s) by a moving motor vehicle flow on a motorway (or its section) with a fixed length L (km) is determined by the formula:

$$M_{Li} = \frac{L}{3600} * \sum_{1}^{k} M_{k.i}^{m} * G_K * r_{Vk,i} \quad (1)$$

where:

$M_{k.i}^{m}$ (g/km) is the mileage emission of the i-th harmful substance by k-th group cars for urban operating conditions;

k - number of groups of cars;

G_K (1/hour) - the actual highest traffic intensity, i.e. the number of cars of each of the k groups passing through a fixed section of the selected section of the motorway per unit of time in both directions along all lanes;

$r_{Vk,i}$ - correction factor taking into account the average speed of traffic flow on the selected highway (or its section);

1/3600 - conversion factor "hour" to "sec";

L (km) - the length of the motorway (or its section) from which the length of the queue of cars in front of the forbidding traffic light signal is excluded and the length of the corresponding intersection zone (for intersections where additional surveys were conducted)[4].

Calculation of vehicle emissions in the area of a regulated intersection.

When calculating the levels of air pollution in the intersection zones, it is necessary to proceed from the highest values of the content of harmful substances in the exhaust gases characteristic of the modes of movement of cars in the area of the intersection of highways (braking, idling, acceleration). The release of the i-th pollutant (g/min) in the intersection zone at a traffic light prohibiting signal is determined by the formula:

$$M_{Ci} = \frac{P}{40} \sum_{n-1}^{N_{cycle}} \sum_{k-1}^{N_{groups}} (M_{Ci,k} * G_{k.n}) \quad (2)$$

where:

P (min) is the duration of the prohibiting signal of the traffic light (including yellow);

N_{cycle} - the number of cycles of the forbidding traffic light signal for a 20-minute period of time;

N_{groups} - number of groups of cars;

M_{Ci} (g/min) is the specific emission of the i-th pollutant by cars of the k-th group that are in the "queue" at the forbidding traffic light signal;

$G_{k.n}$ is the number of cars of group k that are in the "queue" in the intersection area at the end of the nth cycle of the traffic light prohibiting signal.

Thus, for a motorway (or its section) in the presence of a regulated intersection, the total emission M will be equal to:

$$M = \sum_{1}^{n} (M_{C1} + M_{C2}) + M_{L1} + M_{L2} + \sum_{1}^{m} (M_{C3} + M_{C4}) + M_{L3} + M_{L4} \quad (3)$$

where:

M_{C1}, M_{C2}, M_{C3}, M_{C4} is the emission into the atmosphere by cars located in the intersection zone with a forbidding traffic light signal;

M_{L1}, M_{L2}, M_{L3}, M_{L4} - emission into the atmosphere by cars moving along this highway during the time period under consideration;

n, m - the number of stops of the traffic flow before the intersection, respectively, on one and the other streets forming it for a 20-minute period of time;

indexes 1 and 2 correspond to each of the 2 directions of traffic on a highway with a higher traffic intensity, and 3 and 4 correspond respectively for a highway with a lower traffic intensity[3].

As initial data for calculating vehicle emissions into the atmosphere, the results of field surveys of the structure and intensity of traffic flows with a subdivision for the main categories of vehicles were used[6].

Emission calculations were performed for the following harmful substances entering the atmosphere with the exhaust gases of cars:

- carbon monoxide (CO);
- nitrogen oxides NO_x (in terms of nitrogen dioxide);
- sulfur dioxide (SO_2);

To determine the characteristics of traffic flows on the selected sections of I. Karimov Avenue, the accounting of passing vehicles in both directions with a subdivision by groups was carried out, Table 1.

This table shows the number of vehicles passing through the corresponding section of I. Karimov Avenue for 1 hour of observation time on this section. The observation time is selected - the summer period, the observation hours are 11-00 to 14-00, the days of the week are Saturday and Sunday, since during this period there is a maximum load of motor traffic on the selected overpass of the city.

A preliminary analysis of Table 1 allows us to identify the most loaded sections of the highway.

In our case, this is the intersection with Mustakillik Street and the intersection with Tashkent Street. There is the greatest movement of vehicles here – up to 1,500 cars per 1 hour (during peak hours). A significant load of the intersection with Tashkent Street is due to the fact that this intersection is a link between intra-city transport networks and intercity.

The analysis of Table 1 by groups of vehicles allows you to specify the type of vehicles represented on the streets of the city in greater numbers - passenger vehicles - about 88%

TABLE 1: ACCOUNTING OF MOTOR VEHICLES

Vehicle group	I. Karimov Avenue				
	Intersection with Mustakillik Street	Intersection with Baqnaminal Street	Crossroads with Shifokors' Street	Intersection with Kaliya Street	Intersection with Tashkent Street
P - passenger car	1282	658	782	721	1498
T<3 t - trucks	52	87	53	76	86
T>3t trucks	6	1	1	1	16
B - the buses	48	33	29	32	83
DT – disel trucks	13	0	0	0	26
Total	**1401**	**779**	**865**	**830**	**1709**

of the total number of passing vehicles on the studied street, 4% - buses of the "Isuzu" type.

In the study of regulated intersections, the length of the queue of standing vehicles for a forbidding traffic light signal is taken into account, the data obtained is supposed to be used to calculate the dispersion of emissions in the direction of residential areas.

The calculation of emissions of pollutants by vehicles at each allocated site was carried out with the distribution by groups of vehicles for both moving and standing vehicles at regulated intersections according to the above methodology, Tables 2-4, Fig. 1-3.

Name of the intersection	Mass emission, g/s	g/s per 1 m
Mustakillik Street	5,281	0,021
Street B a nominal	1,400	0,006
Shifokors' Street	0,414	0,007
Kaliya Street	1,493	0,008
Tashkent Street	4,596	0,021
Total	**13,184**	**0,063**

TABLE 2: CALCULATION OF *CO* EMISSIONS (TOTALS)

A preliminary analysis of *CO* emissions allows you to specify the areas (for this substance) with the highest values – the intersection with Mustakillik Street and Tashkent Street.

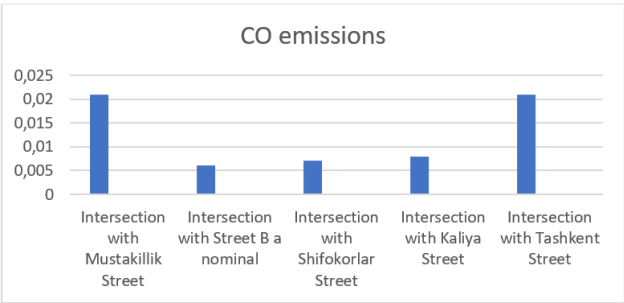

Fig. 1: Emission of *CO* g/s per 1 m. of linear sections

Name of the intersection	Mass emission, g/s	g/s per 1 m
Mustakillik Street	0,204	0,000917
Street B a nominal	0,089	0,000413
Shifokors' Street	0,055	0,000379
Kaliya Street	0,078	0,000419
Tashkent Street	0,230	0,001921
Total	**0,656**	**0,004049**

TABLE 3: CALCULATION OF NO_x EMISSIONS (TOTALS)

A preliminary analysis of NO_x emissions allows you to specify the areas (for this substance) with the highest values – the intersection of Mustakillik streets and Tashkent streets.

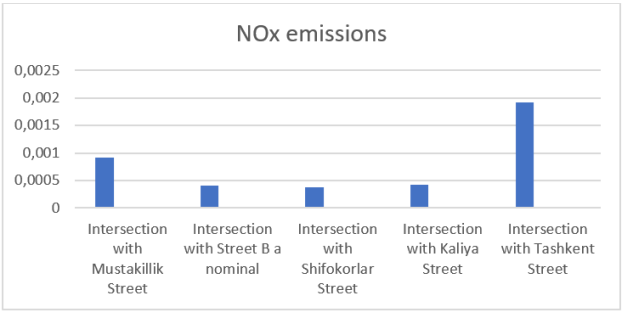

Fig. 2: NO_x emission g/s per 1 m. of linear sections

Further analysis of the tables will make it possible to determine such positions as the most polluted section of I. Karimov Avenue, "the type of vehicles that have the greatest negative impact on the OS", "the concentration of harmful substances mg/m3 from vehicles", the dependence of the emission of harmful substances on the mode of movement of vehicles and the type of vehicles, etc.[5].

The city of Jizzakh is characterized by compact urban development, the main highways run through all residential areas and vehicle emissions have a direct negative impact on the health of the city's population. Therefore, the issue of the impact of vehicle emissions on the health of the popu-

lation for our city is relevant, requires its study and making important decisions.

Name of the intersection	Mass emission, g/s	g/s per 1 m
Mustakillik Street	0,00677967	5,74087E-05
Street B a nominal	0,004817484	2,23032E-05
Shifokors' Street	0,00143092	2,55522E-05
Kaliya Street	0,004913175	2,64149E-05
Tashkent Street	0,006289401	5,87794E-05
Total	**0,01923065**	**0,000190458**

TABLE 4: CALCULATION OF CO_2 EMISSIONS (FINAL VALUES)

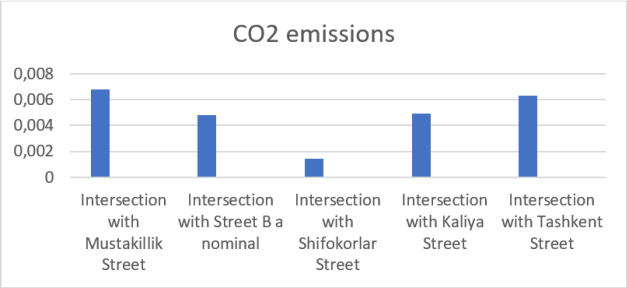

Fig. 3: CO_2 emission g/s per 1 m. of linear sections

As a result of the conducted field surveys of urban highways, streets and intersections with increased traffic intensity were identified. A study of the traffic flow of one of the busiest central streets of the city – I. Karimov Avenue.

III CONCLUSION

The analysis of the collected and calculated data made it possible to identify the busiest sections of the considered urban highway, classify the traffic flow, identify groups of vehicles that make the greatest contribution to the pollution of the city's atmosphere (taking into account the traffic flow mode). The practical work carried out will make it possible to use the data obtained in the future to compile summary reports on emissions, specific calculations on atmospheric air pollution and subsequent assessment of the impact of polluted air on the population living along urban highways, as well as to give some recommendations on the organization and regulation of vehicle traffic within residential areas of the city: the creation of additional road interchanges, redirection of freight transit vehicles to bypass residential areas, etc.

IV REFERENCES

[1] Grushnikov V. A., Aspects of alternative ecology of motor transport // Transport: science, technology, management. Scientific Information collection, 2021, No. 9, pp. 39-43., *doi: 10.36535/0236-1914-2021-09-7.*

[2] Litman T., Smart Transportation Emission Reduction Strategies. Identifying Truly Optimal Ways to Conserve Energy and Reduce Emissions., Victoria Transport Policy Institute, 2015.

[3] Kazhaev A., Almetova Z., Shepelev V., Shubenkova K., Modelling urban route transport network parameters with traffic, demand and infrastructural limitations being considered., IOP Conference Series: Earth and Environmental Science 177, 2018, *doi: 10.1088/1755-1315/177/1/0120.22*

[4] Kerimov M., Safiullin R., Marusin A., Evaluation of functional efficiency of automated traffic enforcement systems Transportation Research Procedia, 20 (2017), pp. 288-294, *doi: 10.1016/j.trpro.2017.01.025.*

[5] Marusin A., Danilov I. A Method for assessing the influence of automated traffic enforcement system parameters on traffic safety Transportation Research Procedia, 36 (2018), pp. 500-506, *doi: 10.1016/j.trpro.2018.12.136.*

[6] Bazarov B. I., Kalauov S. A., Vasidov A. X. Alternative motor fuel/ Monograph. Tashkent: SHAMS ASA, 2014.