British Journal of Global Ecology and Sustainable Development
Volume-11, Dec., 2022
ISSN (E): 2754-9291

FACTORS OF DAMAGE CAUSED BY MOTOR VEHICLES TO THE ENVIRONMENT

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ANNATATION

Measures to reduce air pollution associated with automobile emissions have their own specifics. One of the means of reducing air pollution in cities by carbureted cars is the introduction of protective means that reduce the emission of gasoline fumes from the supply system of cars, gas stations, car cisterns. More than 200 kinds of ingredients are formed in motor vehicles during the combustion of fuel. Of these, non-toxic elements that are considered: nitrogen, oxygen, water vapor and carbon dioxide (CO_2 - angdric carbonate). Toxic ingredients that pose a danger to human life and the environment are carbon monoxide (CO), nitrogen oxides N_xO_y, aldehydes, hydrocarbons, sulfur dioxide, carbon black, benz(a)pyrene and others. From the list of toxic wastes, we will mainly consider three ingredients: carbon monoxide (CO), hydrocarbons that have no time to combustion C_nH_m, nitrogen oxides NO_x.

Keywords: vehicle groups, engine heating, technical condition, carburetor, fumes, fuels, toxic ingredients, non-toxic elements, lead compound, environmental conditions.

Gasoline vapor is released into the environment from the fuel tank and the float chamber of the carburetor. Losses from vaporization during vehicle refueling consist of two factors: the first is displacement of the vapor mixture from the fuel tank, the second is vaporization of gasoline from the jet coming from the filler nozzle of the fuel dispensing valve while filling the tank.

Determination of emissions from mobile vehicles. Gross emissions of toxic exhaust gases from group vehicles that operate in areas (city, intercity highways, industrial areas, and other locations) are determined by the following formulas:

$$M_{iдв} = \sum N_{jk} \cdot L_{jk} \cdot a_в \cdot m_{itjk} \cdot K_{tcjk}\ ;\ \text{kg/year} \quad (1)$$

Where:

N_{jk} - the number of vehicles of group j equipped with engines of type K;

L_{jk} - среднегодовое расстояние автомобилей группы j двигателями типа К, тыс. км;

$a_в$ - coefficient taking into account the work of the vehicle;

m_{itjk} - specific amount of i-th pollutants, cars of group j with type K engines, g/km

K_{tcjk} - multiplication of coefficients that take into account the technical condition and operation of vehicles.

Example for calculation:

Calculate the amount of pollutants per total number of cars of different groups in the city of 250 000 inhabitants. Let's enter all the calculated data according to the following table.

Table 1

Types of cars	Operational performance			CO		C_nH_T		NO_x	
	N_{jk}	L_{jk}	a_B	m_{itjk}	K_{tcjk}	m_{itjk}	K_{tcjk}	m_{itjk}	K_{tcjk}
Trucks and special vehicles with gasoline engines	364	14720	0,82	49,6	1,7	10,7	1,6	6,3	0,9
Trucks and special vehicles with diesel engines	690	12330	0,8	10,5	1,5	6,2	1,4	6,4	0,93
Trucks (gas-powered)	350	15910	0,84	22,3	1,5	7,9	1,4	6,0	0,93
Buses (gasoline engines)	124	16300	0,87	45,6	1,7	8,5	1,6	6,2	0,9
Buses (diesel engines)	72	13800	0,83	10,8	1,5	6,2	1,4	6,4	0,93
Buses (gas-powered)	1280	17540	0,88	22,3	1,5	7,9	1,4	6,0	0,93
Passenger cars (gasoline engines)	4426	18160	0,85	14,9	1,5	1,3	1,4	1,8	0,93
Passenger cars (with diesel engines)	110	14840	0,82	10,5	1,5	6,2	1,4	6,4	0,93
Passenger cars (gas cylinders)	1204	15520	0,91	11,6	1,4	0,52	1,3	0,67	0,91
Total	8620	-	-	-	-	-	-	-	-

Determine the amount of each pollutant from table (1) of moving vehicles related to all types.

1. Carbon monoxide - CO:

M_{co} = 364 · 14720 · 0,82 · 49,6 · 1,7 + 690 · 12330 · 0,8 · 10,5 · 1,5 + 350 · 15910 · 0,84 · 22,3 · 1,5 + 124 · 16300 · 0,87 · 45,6 · 1,7 + 72 · 13800 · 0,83 · 10,8 · 1,5 + 1280 · 17540 · 0,88 · 22,3 · 1,5 + 4426 · 18160 · 0,85 · 14,9 · 1,5 + 110 · 14840 · 0,82 · 10,5 · 1,5 + 1204 · 15520 · 0,91 · 11,6 · 1,4 = 370470,51 + 107197,02 + 156463,71 + 136314,58 + 13359,95 + 660873,52 + 1526946,1 + 21082,45 + 276150,36 = 3268858,2 kg/year = 3268,86 ton/year.

2. Hydrocarbons - C_nH_T:

$M_{C_nH_T}$ = 364 · 14720 · 0,82 · 10,7 · 1,6 + 690 · 12330 · 0,8 · 6,2 · 1,4 + 350 · 15910 · 0,84 · 7,9 · 1,4 + 124 · 16300 · 0,87 · 8,5 · 1,6 + 72 · 13800 · 0,83 · 6,2 · 1,4 +1280 · 17540 · 0,88 · 7,9 · 1,4 + 4426 · 18160 · 0,85 · 1,3 · 1,4 + 110 · 14840 · 0,82 · 6,2 · 1,4 +1204 · 15520 · 0,91· 0,52 · 1,3 = 75218,87 + 59077,47 + 51733,59 + 23914,84 + 7158,29 + 218513,04 + 124341,92 + 11618,77 + 276150,36 = 847727,15 kg/year = 847,73 ton/year.

3. Nitrous Oxides - NO_x:

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M_{NOx} = 364 · 14720 · 0,82 · 6,3 · 0,9 + 690 · 12330 · 0,8 · 6,4 · 0,93 + 350 · 15910 · 0,84 · 6,0 · 0,93 + 124 · 16300 · 0,87 · 6,2 · 0,9 + 72 · 13800 · 0,83 · 6,4 · 0,93 + 1280 · 17540 · 0,88 · 6,0 · 0,93 + 4426 · 18160 · 0,85 · 1,8 · 0,93 + 110 · 14840 · 0,82 · 6,4 · 0,93 + 1204 · 15520 · 0,91 · 0,67 · 0,91 = 24911,86 + 40510,26 + 26100,67 + 9812,12 + 4908,54 + 110244,37 + 114367,24 + 7967,16 + 10367,54 = 349189,76 kg/year = 349,19 ton/year.

4. The amount of harmful substances in total:

$M_{iдв} = M_{co} + M_{CпHт} + M_{NOx}$ = 3268,86 + 847,73 + 349,19 = 4465,78 ton/year.

Calculation of the emission of pollutants from cars during heating and idling

Determined by the gross emissions in a certain time of harmful substances during heating and idling a group of cars the following formula:

$$M = \sum a_в \cdot (M_{ik}{}^{I} + M_{ik}{}^{II}) \cdot N_{jk} \cdot D_p \cdot 10^{-3};\ \text{kg/year} \qquad (2)$$

Where:

$a_в$ - the coefficient of output of the vehicles at work;

N_{jk} - number of vehicles of group j equipped with engines of type K;

D_p - number of days in the year, day;

$M_{ik}{}^{I}$, $M_{ik}{}^{II}$ of exhaust harmful gases in the types i during heating and idling related to the group K.

$$M_{ik}{}^{I} = T_{пpik} \cdot t_{пр},\ \text{gr}; \qquad (3)$$

$$M_{ik}{}^{II} = T_{xxik} \cdot t_{xx},\ \text{gr}. \qquad (4)$$

Where:

$T_{пpik}$ - the specific index of harmful gases in species i when heating cars belonging to the group K, gr/min;

T_{xxik} - specific index of harmful gases in kinds of i at idling of cars, gr/min;

$t_{пр}$ - time for warming up of the engines, min;

t_{xx} - total time in a day of idling of engines of cars, min.

The number of lead connections from one vehicle per group K during the reporting period is determined by the following formula:

$$M_{ск} = 0,7 \cdot d_c \cdot (q_{пр}\, t_{пр} + q_{xx}\, t_{xx} + q_1\, L_1),\ \text{gr}. \qquad (5)$$

Where:

d_c - amount of lead in 1 liter of gasoline, gr/l;

$q_{пр}$, q_{xx}, q_1 - gasoline consumption respectively during heating, driving and idling of cars, l/min or l/km.

The amount of lead from a group of vehicles per year is determined as follows:

$$M_{ic} = \sum a_в \cdot M_{ск} \cdot N_{jk} \cdot D_p \cdot 10^{-3},\ \text{kg/year} \qquad (6)$$

Example for calculation:

Determine the gross emissions of harmful substances started by the engine running but not moving cars. Calculations are performed in the spring-summer period when the air temperature should be higher than +5°S.

All the calculated data are recorded in the following table.

Table 2

Types of cars	Operational performance			CO		$C_пH_т$		NO_x	
	D_p day	$t_{пр}$ minutes	t_{xx} minutes	$m_{пр}$ gr/min	τ_{xx} gr/min	$m_{пр}$ gr/min	τ_{xx} gr/min	$m_{пр}$ gr/min	τ_{xx} gr/min
I	253	4,0	65	15	13,5	1,6	1,6	0,18	0,18
II	253	5,2	82	3,2	2,8	0,94	0,94	0,19	0,19
III	300	5,0	74	6,82	6,08	1,18	1,18	0,17	0,17
IV	300	5,0	108	13,8	12,42	1,27	1,27	0,18	0,18
V	300	6,0	122	3,26	2,94	0,93	0,93	0,18	0,18
VI	365	5,5	96	6,75	6,08	1,18	1,18	0,17	0,17
VII	365	3,2	37	4,5	4,05	0,21	0,21	0,05	0,05
VIII	305	4,3	48	3,17	2,86	0,93	0,93	0,19	0,19
IX	305	4,0	25	3,51	3,16	0,08	0,08	0,02	0,02

We determined separately the amount of each harmful substance during engine heating and idling according to the formulas (2).

1. Carbon monoxide - CO:

M_{co} = 0,82 · (15 · 4,0 + 13,5 · 65) · 357 · 253 + 0,8 · (3,2 · 5,2 + 2,8 · 82) · 685 · 253 + 0,84 · (6,82 · 5,0 + 6,08 7 · 4) · 340 · 305 + 0,87 · (13,8 · 5,0 + 12,42 · 108) · 114 · 305 + 0,83 · (3,26 · 6,0 + 2,94 · 122) · 68 · 305 + 0,88 · (6,75 · 5,5 + 6,08 · 96) · 1275 · 365 + 0,85 · (4,5 · 3,2 + 4,05 · 37) · 4432 · 365 + 0,82 · (3,17 · 4,3 + 2,86 · 48) · 97 · 305 + 0,9 · (3,51 · 4,0 + 3,16 · 25) · 976 · 365 = 69434,27 + 34139,70 + 42162,01 + 42663,25 + 6511,1 + 254238,27 + 225848,35 + 3661,06 + 30161,56 = 708819,57 kg = 708,82 ton/year.

2. Hydrocarbons - $C_пH_т$:

$M_{C_пH_т}$ = 0,82 · (1,6 · 4,0 + 1,6 · 65) · 357 · 253 + 0,8 · (0,94 · 5,2 + 0,94 · 82) · 685 · 253 + 0,84 · (1,18 · 5,0 + 1,18\ · 74) · 340 · 305 + 0,87 · (1,27 · 5,0 + 1,27 · 108) · 114 · 305 + 0,83 · (0,93 · 6,0 + 0,93 · 122) · 68 · 305 + 0,88 · (1,18 · 5,5 + 1,18 · 96) · 1275 · 365 + 0,85 · (0,21 · 3,2 + 0,21 · 37) · 4432 · 365 + 0,82 (0,93· 4,3 + 0,93 · 48) · 97 · 305 + 0,9 · (0,08 · 4,0 + 0,08 · 25) · 976 · 365 = 176,58 + 11364,37 + 8120,21 + 4341,16 + 2049,18 + 49049,4 + 11607,98 + 1179,96 + 75,09 = 95963,94 kg = 95,96 ton/year.

3. Nitrous Oxides - NO_x:

M_{Nox} = 0,82 · (0,18 · 4,0 + 0,18 · 65) · 357 · 253 + 0,8 · (0,19 · 5,2 + 0,19 · 82) · 685 · 253 + 0,84 · (0,17 · 5,0 + 0,17 · 74) · 340 · 305 + 0,87 · (0,18 · 5,0 + 0,18 · 108) · 114 · 305 + 0,83 · (0,18 · 6,0 + 0,18 · 122) · 68 · 305 + 0,88 · (0,17 · 5,5 + 0,17 · 96) · 1275 · 365 + 0,85 · (0,05 · 3,2 + 0,05 · 37) · 4432 · 365 + 0,82· (0,19 · 4,3 + 0,19 · 48) · 97 · 305 + 0,9 · (0,02 · 4,0 + 0,02 · 25) · 976 · 365 = 919,86 + 2297,05 + 1169,86 + 615,28 + 396,62 + 7066,44 + 2763,81 + 241,07 + 118,02 = 11588,01 kg = 11,59 ton/year.

Total pollutant emissions equals:

$M_{ic} = M_{co} + M_{C_пH_т} + M_{NOx} = 708{,}82 + 95{,}96 + 11{,}59 = 816{,}37$ ton/year.

To determine the amount of lead in fuels, we take the following data:

$d_c = 0{,}17$ gr/l; $q_{пр} = 0{,}045$ l/min; $q_{xx} = 0{,}041$ l/min; $q_1 = 0{,}33$ l/km.

According to the formulas (5)

$M_{ic} = 0{,}82 \cdot 0{,}7 \cdot 0{,}17 \cdot (0{,}045 + 4{,}0 \cdot 253 + 0{,}041 \cdot 65 \cdot 253 + 0{,}33 \cdot 14680) \cdot 357 + 0{,}87 \cdot 0{,}7 \cdot 0{,}17 \cdot (0{,}046 \cdot 5{,}0 \cdot 253 + 0{,}041 \cdot 108 \cdot 253 + 0{,}33 \cdot 16400) \cdot 114 + 0{,}85 \cdot 0{,}7 \cdot 0{,}17 \cdot (0{,}045 \cdot 3{,}2 \cdot 365 + 0{,}041 \cdot 37 \cdot 365 + 0{,}33 \cdot 18200) \cdot 4432 = 193{,}83 + 77{,}77 + 2964{,}26 = 3235{,}86$ kg.

The amount of total harmful substances:

$M_{\Sigma} = M_{idd} + M_{icT} + M_{ic} = 4265{,}76 + 816{,}37 + 3{,}24 = 5085{,}37$ ton/year.

Harmful substances in percent:

$$M_{idd} = \frac{4265{,}76}{5085{,}37} \cdot 100\ \% = 83{,}88\ \%;$$

$$M_{ic} = \frac{816{,}37}{5085{,}37} \cdot 100\ \% = 16{,}05\ \%;$$

$$M_{idd} = \frac{3{,}24}{5085{,}37} \cdot 100\ \% = 0{,}07\ \%.$$

So, when driving cars in most of the time, more harmful substances are formed in this mode. The amount of harmful substances when the engines are running in stationary state will be less than driving modes, but the harmfulness will be sensitively higher. Due to the very small amount of lead in the exhaust gases has a strong harmful effect, so we recommend not to use leaded gasoline.

CONCLUSIONS

1. A combination of measures to reduce fuel consumption and protect the environment, the main directions of which should be to improve the environmental situation associated with road transport:
2. Introduction of environmentally appropriate speed limits in cities and on country roads;
3. Implementation of control over the technical condition of vehicles using modern stationary and pre-mobile diagnostic equipment.
4. It is known that the most environmentally friendly vehicles running on compressed or liquefied gas, mass production of which is associated with certain difficulties. At this

time, about 90% of the operated vehicles in our country are equipped with gas equipment.

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