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SOME PROBLEMS OF THE ENVIRONMENTAL POLLUTION WITH RESPECT TO ANTHROPOGENIC IMPACT (DUE TO LOCAL WARS)

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Introduction

The sources for atmosphere pollution are basically of two types: natural and artificial (anthropogenic). The first comprises volcanoes, dusty storms, forest combustion, erosive soil dust, plants dust, micro-organisms and other factors. Anthropogenic sources of environmental pollution are more diverse, powerful and enduring as compared to natural. One more source for anthropogenic pollution is deleterious substances entered into the environment during military conflicts. It is natural that nobody thinks of ecology in such cases, a relatively weak system of environmental protection falls fully out of order, new sources of environmental pollution emerge. Results of scientific research demonstrated that in the years 1942-1943 pollination of Caucasian Glacier significantly increased (the process was caused by military operations under way in the Northern Caucasus). During Iraq-Kuwait conflict (1991) up to million tons of oil was being daily burned on oil-mining sites. Huge amount of soot, carbonic acids, sulfur dioxide and other substances was being dispersed into atmosphere [1-6]. As seen above, confrontations between countries play a very significant role in the process of environmental pollution. Not only population suffers from the polluted environment, additives transmitted through air and sea flows cause global pollution of the whole environment. Therefore this issue needs to be examined in more detail. We decided to study the problem on the example of the basic conflict zone – Caucasus, as Georgia is located in the center of Caucasian zone, it is natural, that its environment is affected by USA-Iraq conflicts, as well as Russian-Chechnyan, conflicts. Both local and global distribution of deleterious substances dispersed in the atmosphere from the conflict zone as a result of using various weapons are also to be studied.

1. Explosive Substances and Overpressure

The usage of explosive substances is particularly important during wars. While transforming chemical substances the ignitable elements (hydrogen and carbon) reaction of chemical transition of explosion develops so rapidly that the generated airs fail to expand and at first occupy approximately the same volume as the volume of ignitable substance itself. And this volume is thousand times less than the volume occupied by ignitable airs

during atmosphere pressure. The generated air of vast mass is located in limited size; therefore the pressure reaches tens of thousands of atmosphere. Spontaneous isolation of large volume hot airs in suppressed space generates high pressure and creates impingement waves. Their joint actions on the array of ignitable substances cause its destruction. The consequent waves generated during explosion traverse more rapidly then the previous as a result of which they reach the paramount ones, strengthen them and create the so called percussive waves moving on supersonic speed [7-9]. It should also be noted here that there is unperturbed air located right to the percussive wave preserving its pressure, solidity and temperature. On the verge of percussive wave these parameters are swiftly changing. Percussive wave can be generated in any environment. This requires sharp swift increase of pressure in given circumstance resulting from an explosion or high electrical discharging etc. The paper will only deal with percussive wave resulting from an explosion. The energy emitted as a result of explosion of explosive substance into air transforms into a percussive air wave almost completely and its action depends on the amount and limit of pressure in it and the duration of its influence. In case of exploding any type of object varies between 20-300 thousand kg/cm^2 depending on the initial pressure of explosive substance on the front of percussive wave and the object. And it is due to such high pressure that the percussive wave in the contraction zone causes smashing of rocks.

In order to calculate capacity of the percussive waves and elucidate a question- what is a distance that is dangerous for live organisms, we have used the following formulas [7-9]:

$$\Delta p = \frac{0.84}{\overline{R}} + \frac{2.7}{\overline{R^2}} + \frac{7}{\overline{R^3}} \quad , \qquad (1)$$

where Δp is the value of over pressure in the percussive wave at the distance L , R is the value of equivalent radius for the distance L from the center of explosion and is defined by the following formula $\overline{R} = \frac{L}{\sqrt[3]{C}}$, C_{eqv} is the amount of equivalent mass is equal $C_{eqv} = \frac{Q}{\varepsilon_{tr}}$, ε_{tr} is specific heat of exploded Trotyl, Q is the amount of full energy emitted in the process of explosion is defined by the formula $Q = qM$, M is mass, q is specific heat of exploded mass.

On the basis of above mentioned formulas we have performed a lot of calculations for the different kind of missiles, bombs and charges. Below we presented some of those.

Artillery was used extensively and fairly conventionally during the Second Chechen Campaign. Artillery multiple rocket systems, such as the venerable BM22 Uragan with its 16 220mm rockets and the 9K-58 Smerch with its 12 300mm rockets, also rained destruction on Chechnya. Russian surface-to-surface missiles, such as the Scud B and SS21 Scarab were also fired against targets in Chechnya. There is about 480-500 kg. explosive substances in the warhead of above mentioned rocket systems. As calculations have showed overpressure at the distance 25 m. reaches 1.2 atm. And it is allowed to kill life organisms at this distance. Besides these systems, the Russian deployed fuel-air weapons [1-6].

We have calculated the overpressure of blast waves by the (1) formula. The calculations have shown that in several dozen microsecond (10^{-6} second), the pressure

at the center of the explosion can reach 30 kg./cm^2 (which is about 28 times more than normal atmospheric pressure at sea level) with a temperature between 2.500-3.000 degrees Centigrade. This is 1.5 to 2 times greater than the overpressure caused by conventional explosives. Personal under the cloud are literally crushed to death.- Outside the cloud area, the explosion generates the blast wave which is followed by a negative pressure phase as the cloud rapidly cools. The resultant vacuum pulls in loose objects to fill the void. As a result, a full-air explosive can have the effect of a factual nuclear weapon without residual radiation. Since a full-air mixture flows easily into any cavities, neither natural terrain features nor non-hermetically sealed field fortification (emplacements, covered slit trenches, bunkers) protect against the effects of full-air explosive. If a full-air charge is fired inside a building or bunker, the cloud is contained and this amplifies the destruction of the load-bearing components of the structure. Full-air can be an effective weapon against exposed anomy personnel, combat equipment, fortified areas and individual fighting position. The *'Buratino'* was the main thermo baric delivery system used against Groznyy. It was first combat-tested in Afganistan's Panjshir valley in the early 1980s during the Soviet-Afgan War. Built by the Omsk Transmash design bureau, Buratino is a 30-barrel 220mm multiple rocket launcher system mounted on a T-72 tank chasis. It is found in the chemical troops' separate flame thrower battalions. It is in observed-fire system with a maximum effective range of 3.5 km. (other sources say it has a maximum range of five kilometers). The minimum range is 400 m. The rocket mounts an incendiary or a thermo baric warhead. The zone of assured destruction from a Buratino salvo is 200x400 m. The official designation of the Buratino is the TOS-1.

There is about 1000 kg. Explosive substances in the warhead of the TOS-1. Our calculations have showed that percussive wave (there is about 1.7 atm. overpressure) is killed alive organisms in the area with a radius 250 m. The thermo baric warhead is filled with a combustible liquid, most likely containing powdered tetranite. When the warhead explodes, the liquid is vaporized, creating an aerosol cloud. When the cloud mixes with oxygen, it detonates, first creating a high temperature cloud of flame followed by a crushing overpressure.

2. Investigation of Harmful Substances Transfer and Diffusion in the Atmosphere by Empirical Model

The main sources of pollution during conflict situations are the following: Used missiles; used military shells; Burning of oils and oil products during war. Now we will investigate harmful substances transfer and diffusion in the atmosphere resulted from burning of oils and oil products during war. The issue was studied on the examples of US-Iraq, Iraq-Kuwait, Russia-Chechnya and US-Afghanistan conflicts. To calculate the land surface concentrations of hazardous substances dispersed into the atmosphere we obtained authentic materials dealing with the average amount of hazardous substances dispersed into the environment daily, weekly, monthly and annually during each conflict, afterwards the substances had been classified. We calculated the concentrations of hazardous substances dispersed into the atmosphere on the basis of analysis as well as statistic models. The following points were studies in both cases:

1. Transition of hazardous substances emitted in atmosphere as a result of oil products combusting during wars;
2. Transition of aerosols and gas substances from used military shells in space and time.

Maximum value of the earth surface concentration of harmful substances Cm (mg/m^3) which in case of non-favorable meteorological conditions is reached at the distance. Xm (m) from the round pipe source can be defined by the formula [7,11-13]:

$$C_m = \frac{AM\eta mnF}{H^2\sqrt[3]{V_1\Delta T}}\ , \qquad (2)$$

where A is a coefficient of temperature stratification of the atmosphere (A=200 for the Georgian conditions); M-is mass of harmful substances ejected away from the source in unit of time (gr/c); F is non-dimensional coefficient which indicate velocity of harmful substances deposition in the atmosphere. For area harmful substance and small dispersed aerosols (dust, soot) F=1. For large dispersed dust and aerosols, when coefficient of peelings is more, than 90% F=2. When coefficient of peelings is between 75% and 90% F=2.5. When coefficient of peelings is not exceed 75%, then F=3; H is height of the source (m); ΔT is a deference between the temperature of the ejected harmful substances and the temperature of the environment; η is non-dimensional coefficient, which describes influence of the orography on the distribution of harmful substances in space. For the plate locality, when change of high is less than zom on 1 km then η=1. Opposite value of η is defined from the cartographical maps (two kilometer away from the source; V_1 is mass of harmful substances ejected from the pipe source in the unite time and value of V_1 can be defined by the formula: $V_1 = \frac{\pi D^2}{4} w_0$, (3)

Where, D is a diameter of the pipe; w_0 is an average velocity of harmful substances which is ejected from the pipe (M/C); m and n are non-dimensional coefficients describing conditions of the ejection and defined by the well known formulas [xxx}.

Calculations have been performed on the basis of the considered model for the value of ground concentration of harmful substances sprayed out in the atmosphere:

1. in case when one borehole is exploded;
2. in case when several boreholes are exploded at the same time.

At first we performed calculations for No_x, possible concentrations of No_x were calculated for each borehole, when the heights the sources of harmful substances sprayed out in the atmosphere were h=0.5, 1, 5, 10 and our primary data were D=0.4 (m) for pipe diameter, the speed of emerging admixtures W = 12 (m/sc), temperature change of atmosphere and admixtures $\triangle T$ = 380^{0}C and the weight of the admixture **M** = 10 m/sc. The results obtained are displayed on Table 4, as seen from the table, the more the speed of admixture emergence W_0, the less is the maximum value of ground concentration which is natural since in case of the high admixture emergence speed the height of its vertical ascent grows and consequently the maximal value of ground concentration is achieved far off the source. The results of concentrations calculated for all possible values of W_0 and by various wind speeds are displayed on Table 4. According to the table, the maximal value of ground concentration is highest (C_{mu} = 2867 mg/m^3) when the wind speed U = 10 m/sc and

W_0 = 16 m/sc. In order to calculate concentration values for the same case we assumed that we had punctual source with 20 m diameter and 1 m height, with 5250 g harmful substance emerging. This case was considered for various wind speeds and various W_0s and the obtained results are given in Table 7.

Table 7 shows that W_0 = 4 m/sc and the maximal value of ground concentration during dangerous wind speed is C_{mu} = 2091 and is achieved at 114 m and under the same conditions, i.e. when W_0 = 4 m/sc and the wind speed U = 1 m/sc, maximal concentration is reduced C_{mu} 12.8 mg/m^3 – at 342 m. The concentration value at 342 m during the dangerous wind speed was calculated and C = 1089 mg/m^3 was obtained which essentially differs from maximal concentration values when U = 1, 3, 5, 10 (m/sc).

Similar results were obtained when W_0 = 4, 8, 12, 16 (m/sc).

Table 1. Concentrations of NO_x ejected from the 500 pipes (D=20 m)

A	h	D	Wo	ΔT	F	η	M(g/sc)	Cm	Xm	X	U(m/sc)	Cmu	Xmu	C(mg/m^3)	Cmx	Umx	C_{342ze}
200	1	20	4	380˚	1	1	5250	2091	114	20000	1	12,8	342	3,15	3,52	112	1089
200	1	20	4	380˚	1	1	5250	2091	114	20000	3	40	342	3,15	3,52	112	1089
200	1	200	4	380˚	1	1	5250	2091	114	20000	5	69,4	342	3,15	3,52	112	1089
200	1	20	4	380˚	1	1	5250	2091	114	20000	10	151	342	3,15	3,52	112	1089
200	1	20	8	380˚	1	1	5250	1046	128	20000	1	5,06	384	1,76	1,99	140,8	545
200	1	20	8	380˚	1	1	5250	1046	128	20000	3	15,7	384	1,76	1,99	140,8	545
200	1	20	8	380˚	1	1	5250	1046	128	20000	5	27,02	384	1,76	1,99	140,8	545
200	1	20	8	380˚	1	1	5250	1046	128	20000	10	58	384	1,76	1,99	140,8	545
200	1	20	12	380˚	1	1	5250	697	137	20000	1	2,94	411	1,25	1,43	161	363
200	1	20	12	380˚	1	1	5250	697	137	20000	3	9,09	411	1,25	1,43	161	363
200	1	20	12	380˚	1	1	5250	697	137	20000	5	15,6	411	1,25	1,43	161	363
200	1	20	12	380˚	1	1	5250	697	137	20000	10	33,2	411	1,25	1,43	161	363
200	1	20	16	380˚	1	1	5250	523	144	20000	1	2	431	0,98	1,13	177	272
200	1	20	16	380˚	1	1	5250	523	144	20000	3	6,17	431	0,98	1,13	177	272
200	1	20	16	380˚	1	1	5250	523	144	20000	5	10,5	431	0,98	1,13	177	272
200	1	20	16	380˚	1	1	5250	523	144	20000	10	22,4	431	0,98	1,13	177	272

Table 2. Concentrations of NO_x ejected from one pipe for different value of W_0

A	h	D(m)	Wo	ΔT	F	η_1	M(g/sc)	Cm	Xm	X	V (m/sc)	Cmu	Xmu	C(mg/m^3)
200	0,1	0,4	4	380˚	1	1	10	4290	4,5	20000	1	183	14	0,27
200	0,1	0,4	4	380˚	1	1	10	4290	4,5	20000	3	663	14	0,27
200	0,1	0,4	4	380˚	1	1	10	4290	4,5	20000	5	1250	12	0,27
200	0,1	0,4	4	380˚	1	1	10	4290	4,5	20000	10	2867	5,15	0,27
200	0,1	0,4	8	380˚	1	1	10	2145	5	20000	1	71	15	0,15
200	0,1	0,4	8	380˚	1	1	10	2145	5	20000	3	250	15	0,15
200	0,1	0,4	8	380˚	1	1	10	2145	5	20000	5	468	9	0,15
200	0,1	0,4	8	380˚	1	1	10	2145	5	20000	10	1102	7	0,15
200	0,1	0,4	12	380˚	1	1	10	1430	5,4	20000	1	41	16	0,11
200	0,1	0,4	12	380˚	1	1	10	1430	5,4	20000	3	142	16	0,11
200	0,1	0,4	12	380˚	1	1	10	1430	5,4	20000	5	264	16	0,11
200	0,1	0,4	12	380˚	1	1	10	1430	5,4	20000	10	624	9	0,11
200	0,1	0,4	16	380˚	1	1	10	1072	6	20000	1	28	17	0,09
200	0,1	0,4	16	380˚	1	1	10	1072	6	20000	3	95	17	0,09
200	0,1	0,4	16	380˚	1	1	10	1072	6	20000	5	176	17	0,09
200	0,1	0,4	16	380˚	1	1	10	1072	6	20000	10	416	11	0,09

3. Investigation of The adverse Substances Distribution in the Atmosphere on the Basis of Analytical Model.

Let us assume that a source of harmful substances is located at altitude H_0 and it's ejected q kg substances in unity of time. Also let us assume that along the axis ox is blowing wind with the constant velocity. Our aim is to calculate the adverse substances concentrations in every point (x,y,z) of investigated area at the moment t. To solve above mentioned problem we use the following equation [7-13]:

$$\frac{\partial C}{\partial t}+U\frac{\partial C}{\partial x}+V\frac{\partial C}{\partial y}+W\frac{\partial C}{\partial z}=\frac{\partial}{\partial x}(\nu_1\frac{\partial C}{\partial x})+\frac{\partial}{\partial y}(\nu_2\frac{\partial C}{\partial y})+\frac{\partial}{\partial z}(\nu_3\frac{\partial C}{\partial z})+W_0\frac{\partial C}{\partial z}-\alpha c, \quad (4)$$

where $C-$is concentration; U,V,W are the axel components of wind velocity along axis $x,y,z,$; $t-$is time; $\nu-$ is coefficient of turbulent diffusion ; $W_0-$is the velocity of substance's deposition; $\alpha-$is the coefficient that determines the velocity of substance concentration chances during the process of substance decomposition and transformation. For passive reagents $\alpha=0$. For light substances $W_0=0$.

In the first approximation, when $W_0 = V = W = \alpha = 0;$ $U = const$ and $\nu_1 = \nu_2 = \nu_3 = \nu = consat$, the equation (4) will have the following form:

$$\frac{\partial C}{\partial t} + U\frac{\partial C}{\partial x} = \nu\left(\frac{\partial^2 C}{\partial x^2} + \frac{\partial^2 C}{\partial y^2} + \frac{\partial^2 C}{\partial z^2}\right), \tag{5}$$

The equation (5) is solving with the following initial and boundary conditions:

$$\begin{gathered} C = q\delta(x)\delta(y)\delta(z-H), \text{ when } t = 0, \\ C = 0, \text{ when } |x| \to \infty \text{ and } |y| \to \infty, \\ C = 0, \text{ when } z \to \infty, \\ \nu\frac{\partial C}{\partial z} = 0, \text{ or } C = 0, \text{ when } z = 0. \end{gathered} \tag{6}$$

where $\delta(x)$ -is delta function of Dirak.

If in (6) we use limit when $t \to \infty$, then we will have the following stationary solution:

$$C = \frac{q\exp\left(-\frac{U(R-x)}{2\nu}\right)}{2\nu\pi^{\frac{3}{2}}R}\int_0^\infty \exp\left[-\left(\eta + \frac{UR}{4\nu\eta}\right)^2\right]d\eta = \frac{q\exp\left[-\frac{U(R-x)}{2\nu}\right]}{4\nu\pi R}, \tag{7}$$

In case of turbulent kinematic coefficients along axis $ox, oy,$ and oz are different the equation (5) has the following form:

$$\frac{\partial C}{\partial t} + U\frac{\partial C}{\partial x} = \nu_1\frac{\partial^2 C}{\partial x^2} + \nu_2\frac{\partial^2 C}{\partial y^2} + \nu_3\frac{\partial^2 C}{\partial z^2}, \tag{8}$$

Solution of the equation (8) with the initial and focendary conditions (6)
In is this expression pass into limit when $t \to \infty,$ then we obtain the following formula:

$$C = \frac{q}{4\pi\sqrt{\nu_1\nu_2\nu_3}}\left[\frac{\exp\left(-\frac{U}{2\nu_1}(R_1\sqrt{\nu_1} - X)\right)}{R_1} \pm \frac{\exp\left(-\frac{U}{2\nu_1}(R_2\sqrt{\nu_1} - X)\right)}{R_2}\right]$$

$$R_1 = \sqrt{\frac{x^2}{\nu_1} + \frac{y^2}{\nu_2} + \frac{(z-H)^2}{\nu_3}} \text{ and } R_2 = \sqrt{\frac{x^2}{\nu_1} + \frac{y^2}{\nu_2} + \frac{(z+H)^2}{\nu_3}} \tag{9}$$

Formula (9) shows that the dimensions of R_1 and R_2 are $[R] = sc^{1/2}$.

The equation (4) can be solved only when ν_3 is the function of z, is possible only through numerical methods. For analytic solution we shall consider that it is a constant value and alters only according to the temperature stratification of atmosphere. Pasquille F. classification was applied for the characterization of atmosphere conditions [14].

Table 3.values of turbulence cinematic factors corresponding to various temperature stratifications

Stability classes	Condition of temperature stratification	$v_1 = v_2$ (m^2/sc)	v_3 (m^2/sc)	v (mean)
1	Strong non-stability	250-260	45-50	185
2	Medium non-stability	100-110	15-20	61
3	Weak non-stability	30-35	6-7	19.5
4	Indistinguishable balance	10-15	2-3	7.5
5	Stabile condition (weak)	3-5	0.4-0.5	2.23
6	Stability	1-1.5	0.2-0.3	0.75

It is clear that turbulent mixing is so great for the first three classes that dangerous concentrations of discharged substances will never concentrate near the earth surface. Consequently the calculations shall be conducted for the last three classes. They correspond to the abnormal meteorological conditions that contribute to the increasing concentration of harmful substances in the atmosphere. Three-dimension pictures of concentration distribution have the following appearance for the stationary case Fig. 1-3. Fig. 1-3 depicts the case when the spray-out of harmful substances in the atmosphere is the result of the explosion of more than 500 boreholes. Here the following values serve as initial data: q = 5250 g, U = 1, 3, 5, 10 m/sc. The results are given for various h-heights, the v cinematic factor of turbulence is considered to be a constant value and changes only according to the change in temperature stratification of atmosphere. Since 6 classes of stability correspond to the temperature stratification, we have 6 possible values of v for C. Concentration distributions are given for each stratification conditions. As the figures show, the concentration values are significantly small during non-stability (first three classes) which is natural since turbulent mixing is so high for the considered three classes that minor harmful substances are accumulated near the earth surface. As for the last three classes (stability), it seems that concentrations are considerably high.

Results of Analytical Models with Account of Atmosphere Stratification

Strong non-stability

q=5250 g/sc, u=3 m/sc, ν =183 m^2 /sc, y=0.00001

h=1 m

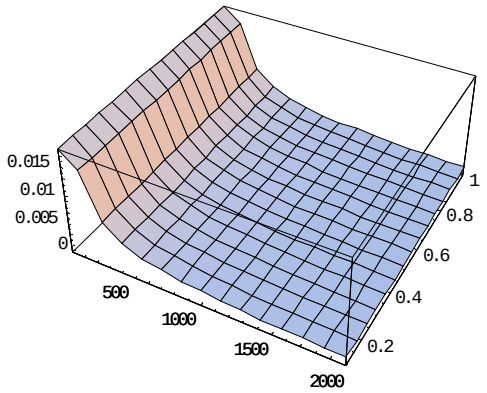

Fig. 1. Indistinguishable balance ($\nu = 7.5\,m^2$ /sc)

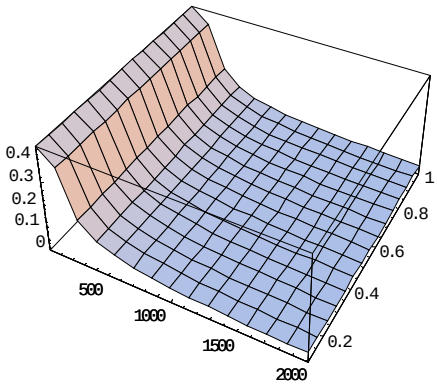

Fig.2 Stability ($\nu = 0.75\ \mathrm{m}^2/\mathrm{sc}$)

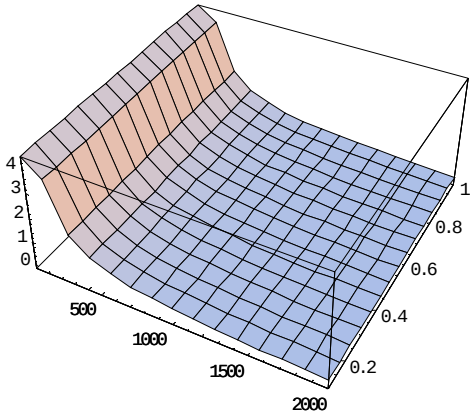

Fig.3

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