Analysis of hydroaeroionization efficiency in natural systems

A V Ramzaev and V I Garshin
Don State Technical University, 1, Gagarin sq., Rostov-on-Don, 344000, Russia

E-mail: sandr03@yandex.ru

Abstract. The article deals with the problem of aeroionization in various technosphere facilities: in living quarters, study rooms, in natural environment and on the shop floor. The special attention is paid to the problem of hydroaeroionization due to its availability for implementation and potential for use for hygienic purposes. The authors carried out the experimental study in hydroaeroionization next to fountains and waterfalls. The measurements were taken with MAC-01 aeroion counter and were accompanied by the control of temperature, atmosphere pressure and relative air humidity in the area next to the controlled object. The variations in concentration of positive and negative ions in the air next to the controlled objects were less than 30%. The experimental results are consistent with the basic results of the study of balloelectric effect previously observed by other authors. The documents on development of a uniquely designed hydroaeroionizer were cited.

Aeroionization plays the key role in microclimate of the living quarters, study rooms and production premises.

Multiple studies in the field of air ionization were carried out. Thanks to sufficient availability of development of high-voltage power sources, generating the corona discharge in the air is currently not a problem. For that reason, there are many ionizers of different purposes and capacity in the market. However, as is seen from the literary sources, it is too early to speak about unambiguous and reliable information on the biological effect of ionized air as there is much information about the adverse effects of aeroions.

The reason of such controversial information is, in our opinion, the lack of comprehensive study in this area and of evidential base as a consequence.

A number of researchers in the aforementioned area established that premises with artificial microclimate created by the forced ventilation and air conditioning system are characterized by the lack of negative ions. The reason is the mass use of synthetic materials in interior décor and furniture finish. This also promotes accumulation in the air of hygienically harmful positive aeroions. The application of the artificial air ionization principle may ensure the optimal functioning of various systems of the human body.

The outstanding Russian scientist A. L. Chizhevsky and his followers proved the need to saturate the air with negative aeroions [1]. The researchers established that the environment enriched with negative ions reduces the fatigue, increases the amplitude of biological response, the reflectory excitation of nerve cells, reduces the possibility of blood clots in blood vessels, increases the number of red blood cells, lowers blood sugar, relieves stress. The optimum balance of the aeroionic environment exerts positive influence on the cardiac cycle parameters and respiratory frequency as well as on the bioelectric
potential of human brain. This is not the exhaustive list of healing benefits of the negatively charged ions.

However, there are groups of people, for whom the uncontrolled staying in the environment with high concentration of aeroions is contraindicated due to high sensitivity of their bodies to ionized air. Therefore, the optimal dosed air ionization is important in each specific case.

For more than half a century passed since the fundamental study of Chizhevsky, the global computerization of the society has taken place. In 90% of cases there are no negative ions near personal computers. In most of working and study rooms with PCs the air ion composition is not controlled.

We find ourselves in the situation, where against the background of abundance of ionizing devices and controversial information on their effects on a human, the same should be used with caution. In the last, at the moment, article [2] Cherny K. A. focused on spectral composition of aeroions (in terms of mobility) from ionizers type I and II (36 kW and 5.8 kW respectively), paying special attention to distribution of intermediate aeroions in space. He states that many of them are separated when type I ionizer is operating. These aeroions are the result of association of heteropolar pairs with molecular aeroions. Moreover, not all the ionizers may create favourable, biopositive atmosphere in the closed premises.

The line of our research is the aeroionic climate in different technosphere facilities. The aeroionic climate in living, production conditions, in study rooms is of particular interest to us. The special attention is paid to development of technical means to adjust the aeroionic climate parameters [3].

To solve the problems under consideration, the staff members of the Department of Safety of Manufacturing Processes and Production in the Don State Technical University have been monitoring and analysing the parameters of aeroionic climate in natural environment next to water bodies (lakes, fountains), in suburban areas of Rostov-on-Don, in living quarters of residential district of Rostov-on-Don [4], in enterprises, shopping malls, next to the traffic arteries [5] for several years. We have been developing the technical means based on SanPiN 2.2.2.542. The works resulted in publications and developments (patents) [6]. In order to bring the ion generation mode in line with the recommended regulations for hygienisation of living quarters, production and study premises, the bipolar ionizer has been developed and tested.

The scope of works is described in details in the article thesis [7].

Hydroaeroionization is quite available and promising in our opinion. Its nature and possible effects on the human health are provided in the conference materials [8].

However, until now there is only limited information on hydroaeroionization. This fact excited our interest in the problem.

In this paper we set the objective to evaluate the application of aeroionic climate with air humidified by the sprayed water (fountains, waterfalls). In other words, to evaluate the level and influence of balloelectric effect.

When spraying the water, the electrons, as in ionization, escape due to emission of “unpaired electrons”, which are in a water molecule. For instance, it is known that when spraying water in the presence of iodine vapour, the concentration of light negative ions increases by 10-15%. It is also known that the direct escape of electrons was detected when water was exposed to beams with the wavelength of 130-200 um, which corresponds to the energy of several electron volts. This may be compared to what is observed during formation of ionized atoms of oxygen in atmosphere ionization [8].

In case of balloelectric effect, the prevalence of negative charges (influence of the Earth's field negative charge) causes the negative unipolarity during water spraying. This is important from the biological standpoint as it creates the conditions for generation of O, O2, and oxidation-reduction processes that are similar to those observed under the influence of atmosphere ionization.

Thanks to different values, physical and chemical nature and structure, different hydroaeroions may be differently perceived by the body when inhaled.

Light ions - hydroxonium and hydroxyl ions - pass the longest distance to reach the pulmonary alveoli, penetrating further into the bloodstream, taking part in acid-base processes; medium, heavy and ultra-heavy ions may not go that deep due to their large size.
In order to evaluate the aeroionization level as a consequence of balooelectic effect when spraying the water, in July 2019 we conducted the measurements at the distance of 10 metres from the fountain edge from the downwind side in Y. Gagarin Square (table 1) and in Druzhinnikov Square (table 2).

Figure 1. Fountain view in Y. Gagarin Square (Rostov-on-Don).

Table 1. Weather conditions: $t=31^\circ C$, $p=740$ mmHg, air humidity = 61%.

| No. | $n^+ \times 10^3$ l/cm$^3$ | $n^- \times 10^3$ l/cm$^3$ | $Y = n^+ / n^-$ | $P = (n^+ - n^-) / (n^+ + n^-)$ |
|-----|-----------------|-----------------|----------------|-------------------------------|
| 1   | 0.32            | 0.36            | 0.80           | -0.058                        |
| 2   | 0.27            | 0.50            | 0.54           | -0.299                        |
| 3   | 0.37            | 0.38            | 0.97           | -0.013                        |
| 4   | 0.11            | 0.17            | 0.65           | -0.214                        |
| 5   | 0.21            | 0.53            | 0.40           | -0.432                        |
| 6   | 0.41            | 0.48            | 0.85           | -0.078                        |
| 7   | 0.36            | 0.50            | 0.72           | -0.162                        |

$Y_{ave} = 0.822, P_{ave} = -0.209$

Figure 2. Fountain view in Druzhinnikov Square (Rostov-on-Don).
Table 2. Weather conditions: \( t=31^\circ C \), \( p =737 \) mmHg, air humidity = 66%.

| No. | \( n^+ \times 10^3 \) l/cm\(^3\) | \( n^- \times 10^3 \) l/cm\(^3\) | \( Y = n^+ / n^- \) | \( P = (n^+ - n^-) / (n^+ + n^-) \) |
|-----|-----------------|-----------------|----------------|------------------|
| 1   | 0.19            | 0.84            | 0.23           | -0.631           |
| 2   | 0.32            | 0.61            | 0.52           | -0.311           |
| 3   | 0.17            | 0.54            | 0.32           | -0.521           |
| 4   | 0.18            | 0.77            | 0.23           | -0.621           |
| 5   | 0.28            | 0.66            | 0.42           | -0.404           |
| 6   | 0.32            | 1.13            | 0.27           | -0.558           |

\( Y_{ave} =0.332 \) \( P_{ave} = -0.507 \)

Figure 3. Water cascade of Vodopadny spring located on the right bank of Temernik River (Rostov-on-Don).

Table 3. Results of study of air ionization next to water cascade.

|                  | \( n^+ \times 10^3 \) l/cm\(^3\) | \( n^- \times 10^3 \) l/cm\(^3\) | \( Y = n^+ / n^- \) | \( P = (n^+ - n^-) / (n^+ + n^-) \) |
|------------------|-----------------|-----------------|----------------|------------------|
| **Upper stage**  |                 |                 |                |                  |
| air temperature =34 \(^\circ\)C, air humidity = 51\% | 0.50            | 0.42            | 1.19           | 0.086            |
|                  | 0.74            | 0.52            | 1.42           | 0.174            |
|                  | 0.41            | 0.44            | 0.93           | -0.035           |
|                  | 0.43            | 0.50            | 0.86           | -0.084           |
|                  | \( Y_{ave} =0.110 \) |                  | \( P_{ave} =0.035 \) |
| **Medium stage** |                 |                 |                |                  |
| air temperature =32 \(^\circ\)C, air humidity = 56\% | 0.53            | 0.50            | 1.06           | 0.029            |
|                  | 0.72            | 0.34            | 2.12           | 0.358            |
|                  | 0.87            | 0.43            | 2.02           | 0.338            |
|                  | 0.89            | 0.57            | 1.56           | 0.219            |
|                  | 0.64            | 0.33            | 1.93           | 0.319            |
|                  | \( Y_{ave} =1.738 \) |                  | \( P_{ave} =0.252 \) |
| **Lower stage**  |                 |                 |                |                  |
| air temperature =28 \(^\circ\)C, air humidity = 67\% | 1.54            | 2.93            | 0.53           | -0.311           |
|                  | 1.56            | 2.69            | 0.58           | -0.265           |
|                  | 1.97            | 2.75            | 0.72           | -0.165           |
|                  | 2.02            | 2.68            | 0.75           | -0.140           |
|                  | 1.89            | 3.05            | 0.62           | -0.234           |
|                  | \( Y_{ave} =0.640 \) |                  | \( P_{ave} =0.223 \) |
When falling from the high altitude, the jet disintegrates into small drops accompanied by the balloelectric effect. In one of cascade waterfalls in Rostov-on-Don (Vodopadny spring located on the right bank of Temernik River) formed by the water running from the natural sources and falling from the height of 6 metres in three stages of 2 metres each, the values shown in table 3 were obtained.

Based on the results of measurements it was established that aerosol concentrated over the cascade lower stage is ionized, i.e. negatively charged, which was also observed near the fountains under consideration.

We developed and patented the hydroaeroionizer model [6] that ensures comfortable conditions and compliance with hygienic requirements to environment in small premises. The device comprises the housing in form of a pan made of dielectric material filled with water, electric drive rotating the disks and centrifugal pump feeding water through the tubes to the disks and deflectors-sprayers for the disk drops.

In case of mist spraying of water, the charged part of the double electric layer comes off from its surface. The smaller the drops, the greater the degree of the drop charge separation. Small hydrosole drops bear the negative charge, the larger ones are positively charged.

The optimal operational efficiency of the hydroaeroionizer is ensured by the normal position of the deflectors-sprayers towards the paths of the primary drops torn away from the disks in the direction tangential to the edge of the latter. This enables the maximum increase in hydrosole unipolarity at high performance of the device and, consequently, the approximation of the resulting air environment to hygienic requirements.

Thus, the observed balloelectric effect (air ionization at water dispersion to the size of drops comparable with the thickness of double electric layer at liquid-gas boundary) results in generation of light negative ions, which, as is well-known, have positive effect on human health. There are many available technical means of hydroaeroionization that may be used in small recreations for hygienic purposes.

References
[1] Chizhevsky A L 1933 Problems of ionization Proceedings of the Central Research Laboratory of Ionization, Voronezh, ed. Commune 1 487
[2] Cherny K A 2011 The main parameters of the aero ionic composition of the air environment of rooms and their consideration in the development of methods for the use of corona aero ionizers Life Safety 3 10-5
[3] Gaponov V L, Klenov E N, Geraskova S E and Baklanova A V 2010 Comparative observations of aeroionic climate collection. scientific tr Technosphere safety, reliability, quality, resource saving Rostov on Don XII 442-44
[4] Garshin V I, Klenov E N and Baklanova A V 2011 Observations of aero ionic climate in the recreation zone of Rostov-on-Don Sat. of the scientific works. The state and prospects of the development of agricultural engineering. Materials international. scientific and practical conf. March 2-3. Rostov on Don 375-7
[5] Gaponov V L, Klenov E N, Yunkina A V, Shepty N S and Gladkova D G 2015 Observation diary of aeroionic climate in Rostov-on-Don Technosphere safety 153-60
[6] Yunkina A V, Volodina E V, Garshin V I, Klenov E N and Gladkova D G Pat. of the Russian Federation No 181390 appl. 07.02.2018, publ. 11.07.2018
[7] Yunkina A V, Garshin V I and Gaponov V L 2016 “Improving the safety and comfort of working conditions through the use of aero ionization.”, Patent Manuscript № 164-B, 2016 VINITI RAS dated 12/07/2016
[8] Obrosov A N 1962 Aero ionization and hydro aero ionization in medicine Materials of the All-Union. conferences on aero- and hydro aero ionization (Tashkent, May 25-29, 1960). Tashkent, Medgiz UzSSR 306
[9] Tammet H 1999 The limits of air ion mobility resolution Proc. 11th Int. Conf. Atmos. Electr., Montgomery 626-9
[10] Wu C C and Lee W M 1999 Oxidation of volatile organic compounds by negative air ions. *Journal of Hazard Material* 67(2) 310-34

[11] Dudarev A A, Turubarov V I, Chervinskaya A V 2004 The new approaches to dosimetry of aerosol ions. *Occupational Medicine and Industrial Ecology* 6 22-5

[12] Partonen T 1999 Bright light and high-density negative air ionization reduces symptoms of seasonal effective disorder. *West Journal Medicine* 171(5-6) 315-6

[13] Garshin V I and Ramzaev A V 2020 Experience in solving some problems of air ionization. *IOP Conf. Ser.: Mater. Sci. Eng.* 913 052034