Experience in solving some problems of air ionization

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Abstract. This article presents the results of observing the aero-ionic background, provides a brief list of ionizers recommended for creating hygienically acceptable conditions in small rooms. Aeroionic background was compared without ionization and with it. For the statistical processing of a 450 measurements array within a period of 4 seconds, a unified program block was used, which provides the typical characteristics of arrays in a visual form. The results of the tests on water treatment by ultrasound are presented. The treatment was accompanied by a balloelectric effect, in which, after a short period of time, light negative air ions became much larger than the positive ones known to have a negative effect on humans.

Introduction

The research is dedicated to the search and testing of affordable means of correcting the aeroionic climate in small rooms in accordance with hygienic standards. At the same time, the following conditions were available: ventilation, aeroionization and hydroaeroionization. To monitor the parameters of the aero-ionic climate in the course of our research, we used the Sapphire-3K aero-ion counter, which provides a synchronous measurement of the concentration of aero-ions of both polarities in air.

The concentration of air ions was carried out in a room with a volume \( V = 4 \times 6 \times 2.85 \text{ m}^3 \) with the counter Sapphire 3K aero ions with averaging period of 4 seconds. In each separate report, the concentration of positive and negative ions was recorded simultaneously. The volume of a separate array of measurements was 450. The results of processing one numerical array are presented in the form of a unified information block, shown in Figure 1.

The following positions are displayed accordingly:
1 – probability density function;
2 – ion concentration distribution function;
3 – histogram of ion concentration distribution;
4 – ion concentration time series.

Installation setup for the concentration measurement \( n^+ \) and \( n^- \) ions of different signs arising from the water spraying under the ultrasonic vibrations action, is shown in Figure 2. At a certain thickness of the water layer 5 on the surface of the water located above the center of the ultrasonic emitter 4, there is a fountain 8 of large and small water particles moving upward.

These particles drive air in the vessel 1. The air stream through the opening 2 carries out mainly small particles of water. Larger particles of water are not captured by the air stream and fall down. A new continuous flow of air into the vessel 1 occurs through the opening 3. The aerosol stream 9...
leaving the vessel 1 enters the device 7, which measures the concentration of positively and negatively charged particles of water in the aerosol. As such a meter was used the device “Sapphire - 3K”.

**Figure 1.** Clean background of negative air ions

**Figure 2.** The installation scheme for the aerosol formation under the ultrasound action.
1-vessel with two holes (2 and 3); 4 - an ultrasonic emitter; 5 - water; 6 - generator of ultrasonic vibrations; 7 - meter concentration of charged particles of liquid

**Results**
The final results of two experiments on correcting the aero-ionic climate on different days are summarized in tables of the Table 1 type. They contain the median, mode, mathematical...
expectation, standard deviation and coefficient of variation of aero-ions for the two series of experiments from each information block (Figure 1).

The bottom row of the tables shows the unipolarity coefficients, which were calculated by the formula:

\[
y = \frac{n^+ - n^-}{n^+ + n^-},
\]

where \(n^+\) - denotes the positive ion concentration,
\(n^-\) - denotes the negative ion concentration.

**Table 1.** Ion concentration \(10^3\) ion / cm\(^3\).

| Distribution options | Background (-) | Background (+) | Correction (–) | Correction (+) |
|----------------------|----------------|----------------|---------------|---------------|
| Mediana              | 0.105          | 0.125          | 69.8          | 0.0672        |
| Moda                 | 0.114          | 0.139          | 60.2          | 0.591         |
| MO                   | 0.104          | 0.125          | 22.9          | 0.0868        |
| SKO                  | 0.0478         | 0.0705         | 27.6          | 0.116         |
| Relative deviation   | 0.455          | 0.564          | 0.395         | 0.467         |
| Unipolarity coefficient | +0.087         | -0.989         |               |               |

After the third experiment, the data on the unipolarity of the aero-ionic background were summarized in Table 2.

**Table 2.** Unipolarity coefficient.

| Experience 1 | Experience 2 | Experience 3 |
|--------------|--------------|--------------|
| background   | correction.  | background   | correction   |
| +0.087       | -0.989       | +0.053       | -0.990       |
| background   | correction.  | background   | correction   |
| +0.019       | -0.971       | +0.019       | -0.971       |

In all three experiments, the pure background of aero ions was positively unipolar. Background correction was carried out by the “Effluvion 0.02” ionizer located at a distance of 0.45 m from the counter input window. In this case, negative ionization was within \((22,7 \pm 28,2) \cdot 10^3\) ion/cm\(^3\) with a unipolarity coefficient of 0.97, which is included in the normative range. It is known that the concentration of negative ions decreases with increasing the distance from the generator.

In our experiments, a decrease in the negative ions concentration by 1.3 times was observed with a change in the distance from the generator from 0.1 m to 0.15 m. This fact suggests that for placing the indicated volume of one ionizer of the type “Effluvion 0.02” is enough. In this case, it is necessary to increase the number of the low-power ionizers, based on the parameters of a given room.

When aerosol is formed under the action of ultrasound, as follows from Figure 3, the formation of hydro-aero-ions of different signs actually takes place.
At the initial stage of operation of the installation, shown in Fig. 2, there are sharp changes in the concentration of positively and negatively charged hydro aero ions. However, an increase in the concentration of negatively charged hydro aero ions with time and a decrease in the concentration of positively charged hydro aero ions are clearly visible. The observed maximum concentrations $n^+$ and $n^-$ do not exceed the recommended optimal levels of aero ionization in the human breathing zone $n^+$ from $600 \text{ cm}^{-3}$ till $50000 \text{ cm}^{-3}$ and $n^-$ from $600 \text{ cm}^{-3}$ till $50000 \text{ cm}^{-3}$.

**Discussion**

Aero ionization plays an important role in the microclimate of residential, educational and industrial premises.

The outstanding Russian scientist A. L. Chizhevsky and his followers convincingly showed the need to saturate the air with negative air ions [1]. They found that negative air ions, falling into the lungs when breathing, give their charge to the red blood cells, which, in turn, transfer this charge to the cells and tissues of the whole body.

Over the past half a century after the fundamental research of Chizhevsky, a global computerization of society has taken place. In 90% of cases, negative ions near the PC are absent. In the overwhelming majority of working and educational premises with a personal computer, the ionic composition of air is not controlled [2].

A. L. Chizhevsky used a biological unit (BU) to determine the dose of aero ionization — the amount of aero ion inhaled by a person under natural conditions per day. With a concentration of aero ions of $1 \ldots 10$ thousand $/ \text{ cm}^3$ a person receives $1\text{BU}$ per day. Such a dose is considered preventive, general health. The therapeutic dose according to Chizhevsky is $20 \text{BU}$. At the resorts per day, a person receives 5 times the treatment dose. The average course of treatment of the incidence of 10 to 30 sessions (days).

There is another approach to dosimetry of air ions [3] based on the control of the potential and the charge received by a person by inhaling ionized air.
It has been proven that spa air is most useful, and post-thunderous air can be oversaturated with ozone, which is harmful to the respiratory tract.

A lot of research has been done in the field of air ionization. Due to the sufficient availability of creating high-voltage current sources, obtaining a corona discharge in air is not currently very difficult. In this regard, many ionizers for various purposes and power appeared on the market. However, as shown in literary sources, it is premature to talk about the unambiguous and reliable information on the biological effect of ionized air, because there is a lot of information about the negative effect of air ions.

The reason for this information inconsistency, in our opinion, is the lack of completeness of the research in this area and, as a consequence, the lack of evidence. A situation when an abundance of ionization agents and conflicting information about their effects on humans arises, they should be used with caution.

In his article [4] Cherny K.A. focused on the spectral composition of aero ions (in mobility) from type I and II ionizers (36 kV and 5.8 kV, respectively), especially considering the distribution of intermediate aero ions in space. He reports that a lot of them are released during the operation of type I ionizers. These air ions appear as a result of the association of bipolar pairs with molecular air ions. And not all ionizers are capable of creating a favorable, bio positive air environment in enclosed spaces.

In our studies, first of all, we took into account the work of the scientific school representatives of the Tartu University [5], which presents the aero ions formation studies results, their spectral composition, dispersion and neutralization of excess in airspace and technical means to solve these problems.

The primary task of our research is to control the aero ionic composition of the air. Aero ionic climate observation was carried out in the training rooms of the Don State Technical University.

The existing equipment (Sapphire-3K) provides a measurement of the concentration of light air ions. Initially, our task was to observe the aero ionic background in small classrooms with and without students.

A number of background measurements were made with an aero ion counter. It should be noted that the Sapphire-3K aero ion counter is not affordable for mass use. For this purpose, we can recommend the classic analog method for measuring the air ions concentration. We have proposed a block diagram of such a device in the article [6].

In the course of the study, as the aero ionic climate correctors in small rooms of ionizers “ANION”, “Riga-2”, “Effluvion 0.02”, “Fanline” and others, we were interested in the spatial distribution of aero ions, the interaction of aero ion fluxes with ventilation, and the ability to control aero ionic climate.

Medical institutions have established many facts of the negative air ions' healing effect. However, in 90% of cases, negative air ions near the PVEM are absent.

In the overwhelming majority of working and educational premises with a PVEM, the ionic composition of the air is not controlled, and the aero ionic background is not adjusted.

For effective correction of the aero ionic climate in order to create the conditions regulated by the SanPiN 2.2.4.1294-03, it is necessary to know the aero ionic situation: amplitude of disturbances (deviations from the standards), frequency of their repetition, duration.

The initial data for the design can be the results of measurements of the concentration of air ions in the room and the nature of its pulsation.

The reason for such disturbances can be: natural oscillations of the concentration of aero ions in the plasma and stochastic disturbances.

In the case of the ionizer acting as an aero ionic climate corrector, disturbances caused by the processes of accumulation and recombination of ions in a controlled room are also possible.

The use of hydro aero ionization seems to be a promising direction for creating comfortable conditions in the breathing zone of workers. A similar phenomenon is observed in vivo with mechanical crushing of water particles (balloelectric effect). In this case, a positive charge remains
connected with large drops, and a negative charge with small drops, which leads to saturation of the air with a large number of negative ions.

Artificial reproduction of a similar effect for controlling the indoor microclimate, as well as for treating various human ailments, can be carried out using a hydro aero ionizer. In this device, the formation of ions occurs due to the mechanical fragmentation of water particles.

For example, in a GI-59 hydro aero ionizer, water from a rotating cone is thrown to a spray bottle, where it is crushed into tiny drops. In this case, ions of different signs are formed, carried out by the air flow from the device through the outlet [7].

This device uses a high-speed electric motor, creates a loud noise and significantly increases the humidity in the surrounding area. The processes of the ions’ formation of different signs, their concentration in the resulting aerosol in such hydro aero ionizers are little controlled.

As our studies have shown, the separation of electric charges of different signs occurs when the ultrasonic vibrations are excited in water of such intensity that water is crushed into small particles on its surface. The resulting aerosol contains water particles, positively and negatively charged.

After 10 minutes of the device operation, there is a smoother change in the concentration of hydro aero ions of different signs and a steady excess of the concentration of negative hydro aero ions. Separate concentration values \( n^+ \) and \( n^- \) do not exceed the optimal levels of aero ionization in the human breathing zone given above.

But the unipolarity coefficient \( K_y = n^+ / n^- \) less than the optimal level of 0.8, and even less than the maximum permissible level of 0.5.

Thus, the production of hydro aero ions by spraying water using ultrasound can be used for hydro aero ionization only with the appropriate adjustment of the above scheme for producing hydro aero ions in order to approximate the unipolarity coefficient to the recommended values.

Summary
1. The use of low-power ionizers ("Effluvion-01", "Fanline") as the aero ionic climate correctors in small rooms ensures its compliance with hygiene standards with a predominance of light negative aero ions.
2. The observed character of a decrease in the aero ions concentration with increasing distance from the generator requires an increase in the number of ionizers and the appropriate algorithms’ development [10] and the recommendations for calculation.
3. When designing an aero ionic climate in a specific room, it is desirable to take into account the amount of information obtained in the process of numerous observations of its characteristics in various objects of the techno sphere [11,12,13].
4. With long-term continuous monitoring of the hydro aero ionization process, the control objectivity is prevented by wetting the electrode system of the device. Therefore, short-term measurements provide greater reliability, and the process of hydro aero ionization by spraying water and using the balloelectric effect should be carried out under the control of the air humidity ratio and aero ionic productivity.
5. It is possible to recommend a useful model of a hydro aero ionizer [14] for familiarization using water spraying, the description of which contains the expressions for obtaining the conditions for the maximum effect of the ion charges separation.

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