УДК 615.844+621.387

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CURRENT ISSUES MONITOR OF THE LEVEL OF AIR IONIZATION IN ENCLOSED SPACE

The relevance of work, the basic spheres of artificial air ionization in human life, the main aspects of air ionization in medical practice were determined. Comparative description of the known devices of determination of light air ions concentration was conducted, their advantages and disadvantages were defined, the ways of elimination of these drawbacks were marked. Taking into account the studies the own version of the device for measuring the concentration of light ions in the artificial air ionization was developed. The basic technical indicators of the developed device for measuring of light air ions concentration were given, comparative description of the developed device was conducted with the known meters of air ions, which showed that the developed device provides much lower measurement error (5%) than analogues, at the same time it has wider measuring range, provides the possibility to measure at the certain point of space, increases the sensitivity of the system to 100 ions/sm3, at the cost price of development not more than 3000 USD., while analogues cost more than $1000. Actuality of the use of the developed air ions meter has been proven for monitoring the level of light air ions concentration in the zone of impact on a patient.

Keywords: *air ionotherapy; air ionizer; light air ions; concentration of air ions; counter ions.*

Introduction. An important biological role of ionized air is proven in the works of a number of authors. Studies of physiological, health care and hygiene aspects of the impact of ions have been conducted, the results of which were published in the works of A.L. Chyzhevskyi [1], L.L. Vasyliev [2], V.P. Skipetrov [3], M.N. Lyvshyts [4], M.E. Bocharov [5] and other scientists. Some of them participated in the development of guidelines and standards of valuation of air ionic state indoors and outdoors. Due to these works optimal levels of ionization for living quarters and industrial premises were rationalized. Therapeutic and prophylactic mechanisms of ions per person based on a number of diseases were studied.

Problem statement. Unfortunately, the literature does not assess the relationship between dose of ions and received biological effect due to the lack of available and precise methods and tools for measuring the amount of ions generated. L.L. Vasyliev [2] indicated that air ionization obeys the Arnd-Schulz rule. So, low doses stimulate the activities of living organisms, medium – stimulate and subdue the physiological processes, strong – inhibit, stronger – depress. But thorough research on the impact of dosed air ionization was not carried out because, despite the obvious advantages of ions generators, they have not obtained a wide use in clinical practice. This can be explained by the fact that there is still no devices for metered production of the required number of ions; developed devices of artificial air ionization do not contain a channel to control the level of air ionizer performance and do not have a complete supply of portable devices for measuring the concentration of ions, which are necessary for optimization of methodology for air ionization sessions, photo- air ionization and franklinization on dose, exposure time and the distance between the source and the patient air ionization and to monitor the performance of these devices. Known methods of measuring the concentration of ions are also imperfect and have significant measurement errors. In this regard, treatment methods using air ionic influence in specific diseases are not developed, and the development of devices to control the level of air ionization in the procedures of artificial air ionization is an urgent task.

Analysis of recent research and publications. Among the scientists involved in the development of devices for aeroionization are the most famous in world: Kh.F. Tammet, Ya.I. Salm, M.A. Reynat, A.P. Bushmyn, Yu.Yy. Pil, O.N. Raznovan, V.A. Karpukhin, R.Drexler, P.Fiala, K.Bartusek, M.Misaki, W.A. Hoppel, K.L. Alpin [6, 7]. Unfortunately this list is not submitted by scientists from Ukraine. In Ukraine there are publications devoted hygienic value of air ionization or determining the optimal location of air ionizers. Little attention pays to the issue of the development of devices for monitoring parameters of artificial air ionization in Ukraine. Ukraine does not produce devices of such designation; three ion counters produced in Russia are known abroad and several devices of Western Europe, Japan and the United States.

They realize the aspiration method of measurement [1, 4, 6, 7]. Efforts to improve the method and means to realize it hasn't resulted substantially. All existing devices demonstrate a high measurement error (40 %), they can determine the concentration of ions in a particular point in space, due to the enclosed measuring chamber and forced pumping of ionized air through it, which distorts the real picture of the distribution of concentration of ions in space and lowers their actual value. Moreover aspiration ion counters are expensive (at least $ 1,000) and not all the hospitals are able to buy them. Attempts to use open collector method [6–10] to eliminate these

deficiencies also did not bring the desired results. Famous industrial counters that implement this method are mostly used as indicators of the ions and do not provide any quantitative information [4, 7]. Therefore, the development of effective and precise device for measuring the number of ions in the ambient air and the area of influence in aeroionotherapy is an urgent task.

Objective setting. The aim of the article is to review the existing methods of artificial air ionization and methods and devices for measuring the concentration of light ions in enclosed space of medical institutions formed by the procedures of artificial aeroionization, determine their advantages and disadvantages, and a description of the method and device of authors' design.

Basic part. The air is an important component of the environment and basic vital factor in the existence of the life on Earth. Air is a natural gas mixture in atmosphere that differs in composition in open and closed space. Today the level of air pollution in large cities is critical and has the negative impact on human health and causes the disease increase a decrease in life expectancy. Besides cleanliness and defined chemical composition, air is characterized by electrical conductivity caused the presence in the air of electrically charged particles of the physical and chemical nature, called ions.And the level of their concentration is an important feature of the air.

Depending on the size and mobility of the ions there are three groups: light, medium and heavy [1] their characteristics are given in Table 1 [7].

Table 1

Classification and Basic Parameters of Air ions

Ion Type	Movability ($см^2$/В с)	Diameter (micron)	Characteristics
Light Ions	3.0–0.1	0.001–0.003	Gas oxygen ions of the size of a molecule, small size, high mobility, small time life
Medium Ions	0.1–0.005	0.003–0.03	Medium size, less mobile than light ions
Heavy (Langevin ions)	0.005–0.002	>0.03	Stiff, there are on the particles of dust or moisture

Positive impact on living organisms has the same light air ions, as confirmed by research of scientists in the world [1–7]. By the formation nature negative and positive air ions are distinguish. Their content and ratio in the atmosphere varies depending on the season, geography, weather conditions and highly depends on air pollution. High level of air pollution leads to formation of heavy ions and aerosols, reducing the concentration of light ions to the critical value. Indoor air ions are absorbed by plastic therefore in modern homes and offices their concentration is extremely low. This leads to poor health, the emergence of headaches, nausea, dizziness, decreased performance and other negative phenomena. If phenomenon is systemic, the diseases arise in human body. This is especially true for people who are in enclosed space where there is no flow of clean air, in rooms with air conditioning turned on, in rooms where there is decoration with plastic and other artificial materials, enterprises where production conditions associated with strong air and deionization, premises where a large number of office equipment is installed.

The most famous way to maintain the hygienic standards of the concentration of ions in the rooms is artificial air ionization. Devices that produce air ions are called ion generators or air ionizers. They can be divided into bulky air ionizing settings used in air supply systems to the common areas and industrial facilities and portable household air ionizers that have been used for improvement of air in houses and cars.

Literature and patents analysis allowed to make generalized classification of air ionizers [7]. Also, the source [7] thoroughly explained the principles to obtain light ions in each type of air ionizer, their strengths and weaknesses and identifies which ones are best for use at home and for therapeutic or prophylactic action.

Market and literature analysis according to the instrument of artificial air ionization showed that the biggest drawback of all known designs is absence of indication of the number of ions generated and the lack of opportunities of regulation and establishing the required dose of ions. This limits the use of air ionizers in medicine and explains the fact that air ionizers are used at home for improvement of air or in special research laboratories equipped with complex and expensive installations to study the entire spectrum of air ions.

Comparative analysis of manufactured industrial meters of ion concentrations showed that the main method of measurement implemented in devices is aspiration technique that is considered to be the most versatile. The main advantage of this method is the ability to perform measurements for the entire spectrum of ions, but because of the complexity of technical implementation, this advantage is not implemented in any device and used only in laboratory ion spectrometers. Instead, the list of shortcomings of aspiration method is essential [6–9] including a great time measurement; the presence of strong electric field distorts the measurement results; while blowing air through the measuring capacitor distorted picture of the electric field, which also leads to considerable measurement error; there are significant measurement error in the absence of ions, which are caused by: errors electrometer, given current that occurs when changing voltage or capacity of the measuring

capacitor and is caused by random changes in the dielectric constant of air flowing through the condenser, current noise, which is caused by the properties of insulators and is independent of the operating modes of the measuring capacitor; the application of the aspiration condenser there is marginal effect, depending on the registration scheme ion current can increase or decrease the concentration of ions measured in relation to the real value of the concentration of ions in space.

Consideration of methodological error increases total measurement error counter aspiration to almost 100 %, which can not be considered a satisfied result. Also it is notable that a closed chamber is used as the primary transmitter. Its design makes it impossible to reconcile with seating area measuring impact on the patient, making it impossible to use such equipment for the control of medical ion generators. Thus, despite the advantages of aspiration method of measuring the concentration of ions, it is iappropriate for biomedical research.

The most famous designs of the aspiration meters are counters of Ebert, Bohoiavlenskyi, Tammeta Kh.V., Makarov A.B., Ya.Yu. Reinet, Salma Ya.I., A.Schetylin A., Hostev V.A., foreign developers are Drexler P., P.Fiala, K.Bartusek, Moore C.B., Hoppel W.A., Alpin K.L [7].

The author has worked on improvement of the open collector method [7, 8] and developed a device measuring the concentration of light ions [7–10] in particular point of airspace environment regardless of their condition, density and velocity field and other conditions without power supply.

Figure 2 demonstrates appearance of the developed device measuring the concentration of light ions (ion counter), table 2 shows the technical characteristics.

Figure 2 Appearance of the device measuring the concentration of light ions

Table 2

Technical characteristics of the device measuring the concentration of light ions

Technical Characteristics		
Measurement range	Electrical charge, ***нКл*** Air ion concentration, $\mathbf{10^{12}}$ ***дм*$^{-3}$**	0–250; 0–2500 0–12,5; 0–125
Measurement time		not more than ***4 s***
Preparation time		At once after turning on
Work mode		continious
Variation instrument readings		not more than ***2 %.***
Measurement error, %		±5
Measurement of positive and negative ions		+
Sensitivity, ion/cm^3		100
Switching measuring ranges		manual
Power supply		Battery, 6 V
Device dimensions, mm		162×122×50
Device weight		0,6 kilo

The device work is based on measuring the ionic current that flows through the measuring electrode made in the form of a certain size volume (cube, spheres, and planes) which, together with the input capacitor is designed to accumulate charges ions concentration in a particular point of airspace. Open measuring electrode has a number of advantages over the aspiration chamber and provides an opportunity to consider the effect of electric fields and convection currents, absence of blowing air through the measuring chamber eliminates ion depletion of investigated air.

Thus developed device for measuring the concentration of light ions provides a measurement error of 5 %, which is 5.8 times less than in the existing industrial concentration meters of light ions. The use of composite

primary structures transmitter with a memory capacity enhanced the threshold measurements to 100 ions/cm^3 and expand the measurement range of 0 to 125·109 el.ch./cm^3. The developed tool allows to measure the electrical charge and concentration of auto-sensing charge sign ions [6–10].

In addition, the proposed air ionic microcoulombmeter also provides the following benefits [7, 9]:

- fixing the measurement indefinitely, until the next reset or after a certain time with automatic reset;
- proposed the parameter selecting of the primary transmitter and scale magnet electric measuring mechanism block display can simplify the counting impressions directly to the number of charges or ions;
- use of magnet electric measuring mechanism reduces dependence on electro network interference device to which it is insensitive;
- measurement with automatic definition of the ion charge sign;
- low cost.

Technical characteristics of the developed device demonstrates its competitiveness at a much lower price (cost about 2,000 USD.), which is an obvious advantage. Development is protected by patent of Ukraine [9].

Conclusion. The use of this equipment during procedures of air ionotherapy will determine the best time of the procedure of franklinization, generating optimal distance from the electrode to the patient to maximize therapeutic effect, it will create a table-dose and exposure time for specific diseases. Developed ion counter is applicable in air ionization offices, franklinization offices, offices of ozone therapy and speleotherapy to control the natural background level of ionization and ionization in the zone of the premises and open space, and can also have non-standard use. In addition the device can be used to check the premises on their compliance with health standards for air ionic composition. Such methods will make much more effective use of the procedures of air ionization and expand its practical value. Next steps of investigations are issues of determining the effect of treatments ionization of air in enclosed space on cardio-vascular system, by monitoring a level of ionization, time procedures and diagnostic parameters of the functional state of the patient, such as heart rate, recording an electrocardiogram, blood pressure, determining cardiac rhythm and so on. This allows to create tables of preventive impact of artificial air ionization and explore obtaining a therapeutic effect.

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Стаття надійшла до редакції 22.04.2016