THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI.
FASCICLE IX. METALLURGY AND MATERIALS SCIENCE
N^0. 2 – 2011, ISSN 1453 – 083X

UP TO DATE METHODS AND TECHNICS INVOLVED IN MONITORING THE AEROSOLS FROM NATURAL AND ARTIFICIAL HALOCHAMBERS

Maria CANACHE[1], Ion SANDU[2], Tudor LUPAŞCU[3], Constantin PASCU[4]

[1] Bolotău School, Zemeş, County of Bacău Romania;
[2] "Al.I.Cuza" University of Iaşi Romania;
[3] Chemistry Institute of the Moldavia Science Academy, Chisinau, R.Moldova
[4] S.C. Tehnobionic SRL, Buzău, Romania

ABSTRACT

This paper presents the main modern methods and techniques used in monitoring the aerosols in natural and artificial halochambers, with implications for research of the therapeutic environments optimization conditions. There are focused the "in situ" methods to determine in real time the morphological and functional characteristics of NaCl based aerosols, highlighting the solions with multiple effect.

KEYWORD: chemical analysis, environment factors, halochamber, particles counter, solions

1. Introduction

Environmental pollution has grown and diversified over time with serious consequences on human, animals and plants health, becoming today one of the important concerns of specialists in various fields of science and technology, focused on the following areas: reducing to minimmum the pollution effects, development of green technologies and efficient technologies for treating industrial and domestic waste water, the treatment of surface and ground water for drinking purposes, the detoxofocation of the soil and air, and in the prevention and treatment of diseases and occupational illnesses [1, 2].

To limit the harmful effects of pollution on health, in all EU countries there are programs compiled for anticipating and preventing illness, to increase body resistance, especially for children and the elderly. A relatively clean atmosphere at a given time, may be pollutted by contaminated air masses transported from great distances, thus influencing the climatic elements regime: intensity of solar radiation, visibility, cloudiness, precipitation and through them, all the physical chemical and biological processes occurring in the environment. To prevent and reduce harmful effects on the living environment (water, air, soil, vegetation) and implicitly on man, measurements on environmental parameters are performed. The control of the environmental pollution includes detection and measurement of pollutants problems, the organization of monitoring and surveillance system on the ground and adopting rules on the maximum permissible exposure of people to action of those pollutants (these measures are extended to all the flora and fauna and environmental resources) [1, 3, 4].

There might be a positive influence on the functioning of the body in case of a program of sporting activities tailored to age and individual peculiarities, in a therapeutic environment, with saline aerosols from halochambers (natural or artificial). Among the benefits of movement in an indoor environment with saline aerosols, are included: increase of the respiratory power of ventilation, enhancing of the functional capacity of the circulatory system by increasing blood levels and hormonal activity, speeding up metabolism, boost of the growth processes, mulsculare mass development, increase resistance to stress and the increase of overall comfort (movement improves will, creativity, concentration power, memory, emotional stability etc.) [3].

Achieving optimal aerosol salt concentrations required for such activities occur in a special room with 150 m^3 capacity, ionized windows, UV filters, equipped with a dry air electricity generation, which consists of fan, heat exchanger and a diaphragm, made of 50 blocks of rock salt and/or other salts, such as KCl, $MgCl_2$, $CaCl_2$ and KI, each cake obtained by pressing or melting salt containing a single kind of salt, while on the active surface has a dense network of small channels. The device continuously recirculats air in the room, which is conditioned to 60...65% RH and 20...22ºC, using a ventilator, which allows circulation of 0.25...0.35 m³/s, after which the air stream passes through a heat exchanger oil-based, allowing to raise the temperature at 90...120ºC to the diaphragm level, which passes through the holes in salt blocks and by the thermal effects of erosion takes negative salt-loaded nanoparticles [5-10].

Healthy or apparently healthy people may be exposed to the saline atmosphere about 30 min/day for prevention and mineralisation of the body, for 12 to 18 days a cure, which may be repeated cyclically at approx. 1 month or more as needed. In the cold light treatment - a complementary treatment is between 30 and 60 min/day for at least 12 days [5, 6].

This paper presents the main methods and technics used in monitoring environmental pollution and atmospheric characterization of halochambers used in the prevention and treatment of respiratory diseases, as well as improving cardio-respiratory and psycho-neuro-motor parameters of the human subject. Also, taking into account the effects of pollutants concentration in closed working or living spaces, it is studied the impact of internal microclimate factors on human body.

2. Methods and Techniques for monitoring the environmental pollution

Detection and measurement of environmental pollution it is performed in the following ways: organoleptic, based on the biological indicators and by using physico-chemical methods [11, 12].

The organoleptic determination is limited by the physical properties of the pollutants and by the sensitivity of the human body to pollutants (for a pollutant to be detected by the senses, the arousal is required to have as low as possible concentrations to give a sufficient margin of safety for personnel exposed to it).

Organoleptic examination involves the following senses:

- *sight*, which helps to detect smoke, smog, air and water turbidity and coloration, finding oil slicks and other pollutants on the ground, and to observe side effects of pollution, particularly those that lead to damage of the vegetation;
- *smell* is the most effective sense for detecting air pollutants, and because of the sensitivity of the respiratory system can take into account in the study of air pollution and its first symptoms of irritation;
- *taste* may be involved in assessing water quality. As regards food, he gives us an indication of their flavor and freshness, the contents of the DDT or other pesticide with specific odor and flavor;
- *hearing* is a fine indicator for noise, it can replace any other means of detection in daily practice (no effectiveness in the field of ultrasound and infrasound, which can be as dangerous as the audible sound).

Biological indicators are also very useful and effective in characterizing the degree of environmental pollution, by using biological reactions of individuals, populations and biocenoses under different conditions of environmental pollution.

Specialized instrumental methods for determining real-time air pollution are the most used and can be classified as follows:

- global methods, which give the result of a group of pollutants, such as atmospheric turbidity, without specifying the nature of impurifying particles or beta global radioactivity, without specifying individual radionuclides;
- analytical methods in detail, separating the components of air pollution;
- physical methods involving instruments determining specific parameters physico-mechanical, optical and acoustic radiative (temperature, light, radiation, vibration etc.).
- chemical methods involving chemical and radio-chemical processing (implicitly radio-activation analysis) and physical processing machines or devices such as electronic, photonic, thermal, X-rays or γ etc., by electrochemical, biochemical, photochemical, radiochemical and other processes;
- biological methods, involving bacterial impurities and other microbiological contaminants, with specific markers for identifying pollutant agents.

Of great practical importance is the division of instrumental methods for determining air pollution: methods “in situ” and laboratory methods (which in turn can be physical and chemical).

Methods "in situ", by place of observation may be: terrestrial or spatial.

The **terrestrial analysis** can determine:

- thermal pollution with the help of ordinary meteorologic thermometers, thermographic devies or thermometers with relay signal to central station;
- acoustic noise with special equipment for recording mechanical radiation intensity with different frequencies;
- ionizing radiation dose rate in air, which can be operatively measured using radiometers. If the device is equipped with scintillation probes and an electronic scheme analyzing the gamma radiation energy, valuable results can be achieved even for the individual components of pollution;
- atmospheric turbidity, by optoelectronic devices, whose data are necessary as an indication of

visibility and as an indication of power of the pollutant sources.

Spatial analysis are possible by means of satellites, which measure terrestrial atmospheric pollution levels in some areas (function on longitude, latitude and altitude) and on different moments or periods of time. These include:

- the radiation level, that can be determined using radiometers placed on satellites, but only in the area crossed by them;
- atmospheric turbidity is determined by optical methods. This concerns not only the hint of smoke and other microparticles, but also nebulosity (cloud coverage) which is very important in terms of weather (specialized satellites are launched into orbit for such remarks, which oversee development of nebulosity allover the globe).

Analysis of atmospheric composition in detail may be made by conventional spectrographic methods or by new methods involving lasers.

Among laboratory methods, must be mentioned the specific analytical chemistry ones and the physical methods by instrumental disciplinary or transdisciplinary techniques, in co-assisted system or in conjunction, whether or not involving sampling and/or processing of samples for analysis, that can influence the determinations results. The presence of some chemical compounds in the atmosphere is not an indication of pollution, since many of the major polluting agents are normally presnt in very small quantities also in what we consider clean air. Therefore, it is not sufficient to study only qualitative the presence of these substances in the air, but it is necessary to determine their quantity too, in order to define the passage "threshold" or "level" of pollution. The technical details of collecting samples for analysis depend on the condition of the pollutant agent (gas, aerosols, dust etc.).

In oder to collect samples for analysis, they are used:

- filtering and impact agents, for particle-from substances which are particles with diameters exceeding 5 micrometers;
- absorbents, (PbO_2 cylinders for sulfur, paper impregnated with calcium carbonate, for fluorides, lead acetate impregnated plates for sulphide, rubber for ozone etc.).
- catchments of gases in balloons, by absobing on liquids or solids, in triethanolamine or $KHCO_3$;

Taking of air samples must be representative, to contain in a fair manner the same qualities and characteristics of the volume of air from which is collected. Sampling should be done in areas not blazed (corners) or the right of the evacuation areas/entry (vehicular), with strong currents, which masks the true state of pollution. Sampling device should be placed in the breathing zone of the human, where it absorbs air can be inspired from places not located too high or too low.

Sampling must meet the actual composition of pollutants, both physically (particle size) and chemical (chemical composition). Sampling is done separately using fiters for diferrent particle size and function on chemical nature, when there are used porous materials with ad- or absorbent capacity, which separates the components of pollutants after their chemical reactivity. The speed of airflow that enters the sampling probe or reaching the collector has to be equal to the overall speed of the airflow in the sampling (isokinetic sampling). This ensures the maintaining the composition of the dispersed by size. From this point of view, particle collectors can be integral, ie the kind that captures all the particles in the air unlike those which separate the particles after their granulometry [13].

3. Methods and techniques for determining the characteristics of the atmosphere in halochambers

Natural or artificial halochambers are saline aerosol enclosures, which allow acquiring solion concentration levels and varying the chemical nature of active cations or anions in their structure, conditions required for different prophylactic purposes and in the treatment of respiratory diseases, as well as in improving cardio-respiratory parameters and psycho-neuromotor of the human subjects involved in strenous phisical activities [14-19].

Our team have developed several halochamber systems, static and dynamic, for different diseases, but also to improve sports and intellectual performance of pupils and students, who have been subject to inventions files patented by AGEPI Chisinau and pending for patent at OSIM Bucharest [20-22].

For measuring and monitoring atmospheric composition of a halochamber there are used methods to determine the microclimatic parameters of an enclosure, such as: work rooms or halls, gyms, swimming pools etc. and also a number of specific methods, such as: the solions concentration conductometric determination, of the quantity of particles with laser beam particle counting, airions dosage and other [5].

Below we present specific methods for determining the solions characteristics in halochambers, much used by our research team, one of which having an absolute degree of novelty, being recently patented [23, 24].

Characteristics of aerosols particles and generally of the aerosol are determined by the source and also by the microclimate and environmental factors.

Therefore, functional characteristics that describe the source of saline aerosol are discussed (size and density of aerosol, particle formation rate, flow of the source, respectively the enrichment factor of the environmental gaseous particle, the lifetime of particles), in order to select the optimal model generator and of the nano-structural and micro-physical properties of aerosols (aerosol concentration and its variation over time, particle size distribution, dynamic behavior of aerosol, the diffusion, mobility and drift velocity of particles, and also the limits of environmental humidity which allow the formation of condensation nuclei), for a better understanding of their involvement in microclimates [5, 15, 16, 19].

In order to determine the concentration, granulometry, volume and lifespan of the negative saline aerions (solions) inside the halochamaber have been corroborated two instrumental methods: laser optical particle counter and differential conductometry.

Laser particle counter method

Solions concentration represent the number of particles per unit volume. Usually, numerical concentration of all aerosol particles is equivalent to the number of Aitken particles per unit volume, as the number of medium and large particles is insignificant in comparison with Aitken particles [5, 15, 16]. Measuring the concentration of particles can be made using laser optical device, known as SIBATA GT 321 particle counter (Fig. 1).

Fig. 1. *SIBATA GT 321 – the particle counter.*

The particle meter SIBATA GT 321 allows the following determinations grids: number of solions between 0 and 10^8 particles/m^3; size range (particle diameter): 0.3; 0.5; 1.0; 2.0 and 5.0 µm; operating temperature range for the halochamber: 0 – 50ºC; aerosol gas flow processed: 2.83 L/min.

The particle counting method, the only available "in situ" method of analysis, which allows verification of conductometric method, has a number of disadvantages, on one hand due to calculus errors, and secondly because of the presence in the halochamber of other particle types [15, 16].

Method using the differential conductometry

The disadvantages mentioned can be eliminated by using, to determine NaCl discreet concentrations in gaseous environments, the differential conductivity technique, using a set of glass devices (Fig. 2) for aerosol bubbling through suction, with flows controlled by rotameters, each having an adjustment/filling of the bubbling volume with de-oxygenized and tridistilled water and a set of electrodes transducers (conductive and temperature compensating) encapsulated within a standard cell amde of rigid plastic, integrated to a differential analysis installation (Fig. 3), and coupled to a digital conductometer, also endowed with a computer interface [23]. In the analysis equipment chart, a C833 Conductometer has been used, made by CONSORT Belgium company, and it has the following functional characteristics: pH range: -2 ... +16; potential range: ±2000 V; conductivity: 0 ... 2000 mS/cm; resistivity: 0 ... 200 MΩcm; salinity: 0 ... 100 g/L; temperature: 0 ... 100ºC [5, 15, 16].

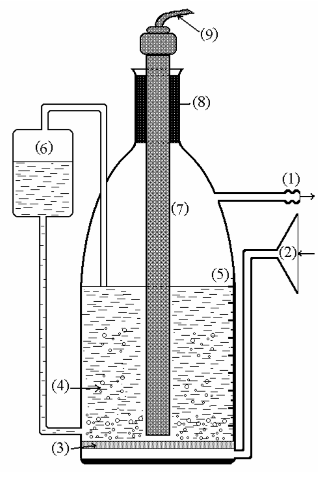

Fig. 2. *Glass bubbler aerosol generator, with enclosed transducers:*
1 – extension to the vacuum pump; 2 – aerosol intake funnel; 3 – bubbling dissipator;
4 – solution under analysis; 5 – indicator for solution volume; 6 – system to adjust /complete the volume of the bubbler with tri-distilled and de-oxygenized water;
7 – electrodes transducers encapsulated in a rigid plastic sheath, type standard cell;
8 – rubber stopper for encapsulated electrodes and sealing device;
9 – connection conductor to the digital conductometer.

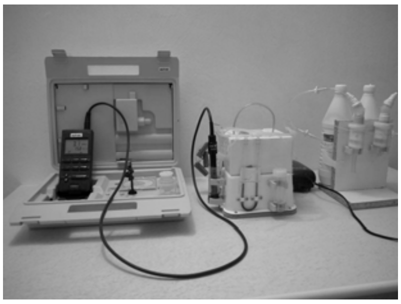

Fig. 3. *General view of the laboratory analysis Equipment by differential conductometry.*

Differential analysis equipment is based on the chart in Fig. 4.

Branches I and II of the equipment allow parallel measurements while branch III permits to determine basic conductometric variations of the air lacking NaCl and being retained by the washing recipients (5) and (6). The flow in all three branches has been equally adjusted by taps (2a, 2b and 2c) and flow controllers (3a, 3b and 3c) VEB MLW Prufgerate – Werk Medingen Sitz Freital, type LD, while the air containing solions has been further bubbled by sucking it in a volume of 10 cm^3 of three-distilled and de-oxygenized water (through washing it with a purified argon stream). During the bubbling process, any aerosol emission from the capsule into the tank (halochamber) is closed. After the bubbling process, the NaCl saline charge of the aerosol is retained by the tri-distilled and de-oxygenized water inside the glass device. After a bubbling time pre-set between 10 and 60 minutes, the conductivity variation of the solution inside the three glass devices (4a, 4b and 4c) is measured [5].

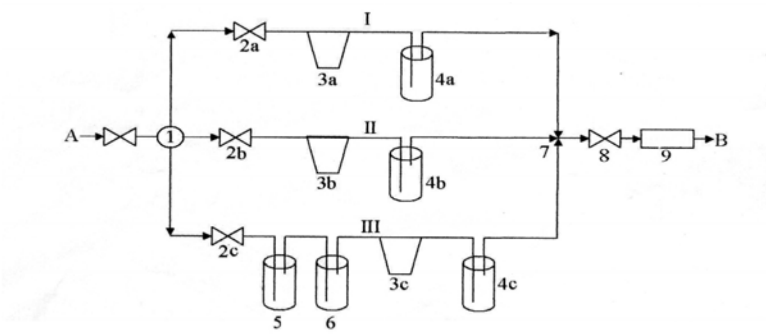

Fig. 4. *Operating chart of the analysis equipment:*
I, II and III – branches or routes; A – gas intake point; B – gas discharge; 1 – distributor; 2 (a, b and c) – flow taps; 3(a, b and c) – rotation meters or manometers; 4 (a, b and c) – glass devices for bubbling aerosol generator; 5 and 6 – additional recipients for restraining NaCl solions; 7 – differential collector; 8 – final tap; 9 –vacuum pump.

4. The impact of internal microclimate on human body

Internal microclimate factors (temperature, atmospheric humidity and pressure, natural/artificial light, air currents, turbidity etc.) can affect both reliability and conservability of goods from the respective enclosure, as well as humans who work or are cured inside. Temperature, the most important climate factor, by its fluctuations, can influence environment humidity, especially in the cold season. High temperatures lead to lower relative humidity, while temperature with short fluctuations can cause in time to the phenomenon of exudate and dew on the cold walls, leading to efflorescence activation and mold, the atmosphere becoming thus unfit for some activities, particularly inside halochamber [3, 13, 19].

The atmospheric humidity in the enclosed spaces of halochambers and sport systems must be always maintained at values of 50-65%, while temperature should be between 18 and 22°C (fluctuations must be ± 3ºC, to seek an adjustment of the microclimate factors).

Between the effects of environment temperature increase there are also some aspects of human health (especially people with heart or lung diseases) resulting in increased mortality due to heat and boosting carriers of infectious diseases (high temperatures allow the development and spread of certain diseases and viruses), and increased seasonal production of pollen or other allergen nanodispersions.

The quench of the body by air bath, sun, aerosols etc. may increase the body's resistance, not only to bad weather, but also to gas agresivity, dust and infectious diseases. Among the diseases that negatively affect the human body as a result of the decrease of its resistance to natural environmental factors, there are the ENT (rhinitis, sinusitis, laryngitis, tonsillitis etc.), pulmonology/respiratory (asthma, bronchopneumonia, silicosis etc.) and cardiac. Decreasing of the body's resistance, following a insufficient quench tells his word especially in young ages, in children and the elderly, clean air movement or in negative aerosls being beneficial for the proper functioning of the heart and lungs. Increased morbidity of people suffering from an inflammatory lung disease such as asthma or bronchitis, is associated with increased pollution [10].

Pursuit of sporting activities in saline aerosol environments helps to quench the body.

Starting from the undeniable benefits of speleotherapy, it has sought creating microclimates to "simulate" the conditions in the mine. Artificial saline (halochambers) became a convenient and considerably cheaper alternative to natural ones. Both the natural and the artificial saline aerosols used in therapy lead to improved quality of life. Halotherapy/salinotherapy is a very simple process of treatment, by no means not involving the administration of medicines or food supplements, diet or bed rest. Yet, how simple is the process, the more complex the mechanism of salt in the body. Halotherapy involves on the one hand, respiratory inhalation of saline aerosols, and on the other hand, their absorption through the skin. Negative ion charge neutralizes the positive charges caused by tobacco smoke, or electrosmog, thus restoring balance in the body. Salt is an essential element in the functioning of the body, and has multiple local effects. Salt therapy, as a natural therapy, has many advantages, including fast action and high salt concentration, which has no contraindications [4, 10, 25-29].

In order to use a solion environment there are needed information on solion lifetime, solion size distribution and concentration, processes for obtaining artificial solions, solion characteristics and their therapeutic applications. Stringent control of concentration and dimensional distributions of solions in the halotherapy environment is very important for the medical effect of various respiratory diseases treatment and for creating an environment of "clean air" [4, 15, 16]. Depending on the solions concentration, saline areas can have both therapeutic effect (in case of high concentrations of NaCl solions of 1-6 mg/m³ in the stationary during 1-4 hours) and a prophylactic one (concentration of NaCl is 1 mg/m³, but with a longer presence, 8-16 hours per day).

To determine the role of therapeutic or prophylactic of saline areas is necessary the knowledge and application of methods and techniques for determining structural-functional solion characteristics from saline environments.

In the exploitation of natural halochambers - salt mines, there are used measuring devices for determining and verifying micocroclimate parameters, but also those used in solions characterizing. Measurement of underground caverns resulted from salt mining is done using sonic cavernmeter. This device helps to determine the level/depth, shape and size of enclosures and galleries, by measuring the time required for directional beams of sound pulse from a transmitter into the probe to the mining room wall and back to the sender. It is necessary to know the shape and size of the chamber for driving the aeration process, activation of solions and reaching the optimal concentration etc.[12, 24].

In order to determine the chemical composition of air in salt mines, samples are taken resembling to the artificial halochambers, to include fresh air circuit from entrance to exit.

Time-keeping device for prelevation is 30 minutes in each sampling point, average results of minimum five measurements and analysis being recorded. Following measurements and qualitative analysis of air samples saline air characteristics are determined, namely the NaCl concentration.

Solions and general aerosols characteristics are determined by the source, but also by environmental factors. Among the functional characteristics that describe a solion source are mentioned: size and aerosol density, particle formation rate, the flow source, gaseous environment enrichment factor, the lifetime of aerosols particles.

Both the size and density of aerosol and particle speed formation and flow source, are depending on obtaining processes or technologies, on the compositional characteristics of saline solutions, namely on the nature and pressure of the gas dispersed. Lifetime and concentration of aerosol particles in the environment are determined by reliability of sources and the dynamics of aerosol particles. The most important characteristic for therapeutic applications and air conditioning is the flow source, which is expressed by Aitken and medium particle concentration produced per unit time (seconds).

For Aitken particles, their lifetime vary between 12 and 72 hours, depending on environmental factors, and for medium and large particles lifetime can vary up to several weeks. Depending on the lifetime and on the source flow, there can be achieved certain levels or thresholds of chemical load, characterized by an optimal enrichment factor (the two gives a measure of stability and uniformity to the microeterogenous dispersed system) [9, 10, 14-16, 18].

NaCl solions composition can change due to interaction with atmospheric humidity and other particles or gases in the atmosphere, coagulation processes taking place, peptizing, condensation or sedimentation.

Also illuminating radiation can influence the composition and physical microstructure of particles for co-assisting systems with other salts, such as potassium, calcium or magnesium chloride and sodium or potassium iodide [9, 10, 14, 18].

For the characterization solions, together with the three variables: number, volume and total surface of particles, there are involved other parameters, such as: solions concentration and its variation in time under the influence of coagulation, peptization, condensation or settling processes etc.; solions dimensional distribution, the degree of electrostatic charge of the surface (measured through the distance between solions in liquid dispersed systems); degree of hydration, the dynamic behavior of solions, diffusion, mobility and speed drift of them; environmental humidity limit at which begins the condensation nuclei formation [9, 10, 14, 18].

Usually, numerical concentration of all aerosol particles is equivalent to the Aitken particles number per unit volume, as the number of medium and large particles is insignificant in comparison with Aitken, that can be easily measured with meter or particle laser beam counter.

In case of air-conditioning systems, for therapeutic and environmental purposes, an important parameter of variation is the size distribution of solions. The study by Whitby [30] on dimensional distributions obtained by several methods (optical meter, electric mobility and relaxation room) led to the fact that the dimensional distribution is composed of three log-normal Gauss curves (areas with characteristic behavior for a given global distribution and generally corresponding to different chemical compositions, whether due to different sources of generation, or to the influence of disruptive exogenous factors).

Solions dynamic behavior characteristics were the subject of a study conducted by Hidy and Brock [29] who concluded the following: particle sedimentation rate varies over time, the ratio of inertial forces and viscous forces is small (inertial effects of the movement of particles can be neglected) there is a significant Brownian motion of particles, particle surface is large compared to their volume.

These features have microphysical and nano-structural specific meanings, because they are based on both diffusion and sedimentation processes and coagulation, condensation and deflocculation physico-chemical processes.

Another feature of the solion is environment humidity limity in the formation of condensation nuclei. Condensation and deflocculation processes of the microparticles of salt depend on the nature of salt, on its total mass, the degree of solubility and the environmental conditions (nuclei formed on aerosol particles consume large amounts of water vapor in the environment, causing a decrease in the supersaturation and relative humidity values).

Saline environment, therapeutic by its constant climate in terms of thermo-hygro-baric is free from air currents and polluting products, with a minimum concentration of microorganisms and antibacterial properties.

The speleotherapeutic cure has a mucolytic effect, antiinflammatory, hypo-sensitizing, activation of the hemostatic effects mechanisms that assure resistance to microorganisms, to different allergens, and an immunomodulating effect. It is known that it is much easier to help avoid disease than to treat it. But nowadays it's hard to breathe clean air in cities, given the pollution that surrounds us.

In order to be able to do this, a trip to the mountains or the sea is necessary (which is not always available because of cost or lack of free time) or purchase a device that brings freshness and purity of mountain air, neutralizing the positive ions emitted by electronical devices (computers, televisions, radios etc.) [3, 17].

5. Conclusions

Monitoring environmental pollution is an activity that falls within the requirements of both the business companies and labels in the category of point polluters, and the institutions empowered to determine and prevention of pollution risk and those concerned with hygiene and public health, and also the safety and security at work.

From this point of view we distinguish two ways of involvement of the monitoring methods and techniques, namely: determining the degree of environmental pollution and the sources affecting air, water and soil and atmosphere that characterize the work premises, for habitat and halotherapy, establishing on one hand the concentrations of generating noxes cumulated "in situ" and on the other hand the levels of aerosols involved in prevention and treatments.

To determine the role of preventive or prophylactic aerosol spaces is necessary to apply specific methods and techniques, for determining structural-functional characteristics of halochambers and solions.

The therapy of respiratory diseases, the improving cardio-respiratory parameters and psycho-neuromotor system of human subjects requires a strict control of concentration and particle size distribution of aerosols halochamber.

Determining of concentration, granulometry, volume and lifetime of solions in halochamber can be achieved by corroborating two instrumental methods: the particle counter based on a laser optical system and differential conductivity.

References

[1]. Barnea, E. - *Effects of air pollution on the respiratory in children*, Medical Publishing House, Bucharest, 1978.

[2]. Ciplea, L.I., Ciplea, Al. - *Environmental Pollution,* Technical Publishing, Bucharest, 1978.

[3]. Sandu I., Chirazi M. - *Sports Systems Ecology,* Ed Performantica, Iasi, 2010.

[4]. Sandu I., Atyim P., Sandu I. C. A. - *Complements of descriptive chemistry*, Ed Dacia, .

[5]. Sandu I., Chirazi M., Canache M., Sandu G.I., Alexeianu M.T., Sandu V.A., Vasilache V. - *Research on NaCl saline aerosols II. New artificial halochamber characteristics*, Environmental Engineering and Management Journal, vol. 9, nr 8, (2010), pp. 1105-1113.

[6]. Sandu, I., Canache, M., Vasilache, V. - *The Role of Salt Solins on Human Subjects*, Present Environment & Sustainable Development, 5, (2011), p.57-64.

[7]. Sandu I., Poruciuc A., Alexianu, M., Curcă R-G., Weller O. - *Salt and Human Health: Science, Archaeology, Ancient Texts and Traditional Practices of Eastern Romania*, Mankind Quarterly, 50, 3-4, (2010), pp. 225-256.

[8]. Sandu I., Alexianu M., Curcă R-G., Weller O., Pascu C. - *Halotherapy: From Ethnoscience to Scientific Explanations*, Environmental Engineering and Management Journal, vol. 8, 6, (2009), pp.1331-1338, Cluj-Napoca, 2002.

[9]. Chernova, O., Matiushina, S, Volianik, M. - *The dinamics of the persistence characteristics of a speleotherapy mine*, Zh. Mikrobiol Immunobiol, 3, (1996), pp 78-80.

[10]. Chervinskaya, A.V., Zilber, N.A. - *Halotherapy for treatment of respiratory diseases*, Journal of aerosol medicine: deposition, clearance, and effects in the lung, 8, 3, (1995), pp. 221-232.

[11]. Căluianu, S. - Measurement and control of air pollution, Matrix Rom Publishing House, Bucharest, 1999.

[12]. **Deák, E., Deák, G., Aurelian, F., Găman, M.** - Techniques to control and prevent environmental pollution to the mines in Romania, Universitas Publishing House, Petrosani, 2007.

[13]. Sommer, K., Wünsch, K.H., Zettler, M. - Compediu chemistry, ALL Publishing House, Bucharest, 2000.

[14]. Sandu I., Pascu C., Sandu I.G., Ciobanu G., Vasile V. - Ciobanu O., *The obtaining and characterization of NaCl nanocrystalline dispersions for saline – type therapeutical media. I. Theoretical aspects*, Revista de Chimie, 54, 10, (2003), pp. 807-812.

[15]. Sandu I., Pascu C., Sandu I.G., Ciobanu G., Sandu A.V., Ciobanu O. - *The obtaining and characterization of NaCl nanocrystalline dispersions for saline – type therapeutical climate. III. The evaluation of the SALIN device reliability*, Revista de Chimie, 55, 11, (2004), pp.971-978.

[16]. Sandu I., Pascu C., Sandu I.G., Ciobanu G., Sandu A.V., Ciobanu O. - *The obtaining and characterization of NaCl nanocrystalline dispersions for saline – type therapeutical environments. II. The in situ analysis of saline room aerosols,* Revista de Chimie, 55, 10, (2004), pp.791-797.

[17]. Sandu I., Pascu C., Vasile V. - *Obtaining of dry mixt aerosols for therapeutical environments*, Haloteherapy, Adjuvant Therapy in the Treatment of Respiratory Disorders, http://saltmed.blogspot.com/, 13, (2006), 4, pp.15–19.

[18]. Sandu I., Chirazi M., Canache M., Sandu G.I., Alexeianu M.T., Sandu V.A., Vasilache V. - *Research on NaCl saline aerosols I. Natural and artificial sources and their implications*, Environmental Engineering and Management Journal, vol. 9, nr 6, (2010), pp. 881-888.

[19]. Ştefan, S. - *Atmospheric aerosol physics,* ALL Publishing House, Bucharest, 1998.

[20]. Sandu I., Canache M., Lupascu T., Sandu I. G., Sandu A.V. - *Surface Artificial Halochamber,* Patent MD4040(B1)/2010. 05.31.

[21]. Sandu I., Stirbu C., Chirazi M., Stirbu C., Sandu A. V. - *Surface Artificial Microsalt Mine,* Patent MD4039(B1)/2010.05.31.

[22]. Sandu I., Stirbu C., Lupascu T., Chirazi M., Stirbu C., Sandu A. V. - *Artificial Surface Halochamber",* Patent MD4089(B1)/2011.01.31.

[22]. Pascu, C., Sandu, I., Ciobanu, G., Sandu I.G., Vasile, V., Ciobanu, O., Sandu, A. V., **Pascu, A**. - *Method and Device for Determining Saline Aerosols "in situ"*, Patent RO122232/27.03.2009,

[23]. Mulholland, G.W., Hartman, A.W., Hembree, G.C., Marx, E. and Lettieri, T. R. - *Development of a One-Micrometer Diameter Particle Size Standard Reference Material*, Journal of research of the National Bureau of Standards, 90, (1985), pp. 3-26.

[24]. Pascu C. - *Procedure and Devices for the Controlled Obtaining of Dry Saline Aerosols with Therapeutic Effect and Air Purification*, Patents WO03024568(A2)/2003.

[25]. Pascu C. - *Procedure and devices for the controlled obtaining of dry saline aerosols with therapeutic effect and air purification*, Patents RO120787(B1)/2006.

[26]. Pascu C. - *Procedure and devices for the controlled obtaining of dry saline aerosols with therapeutic effect and air purification*, Patents RO121371(B1)/2007.

[27]. Pascu C. - *Procedure and Devices for the Controlled Obtaining of Dry Saline Aerosols with Therapeutic Effect*, Patent WO2008060173 (A2)/2008.

[28]. Pascu C. - *Process and Device for Intensive Generation of Dry Aerosols with Therapeutical Effect*, Patent RO122128 (B1)/2009.

[29]. Hidy, G.M, Brock, J. R. - *Topics in Current Aerosol Research*, International Reviews in Aerosol Physics and Chemistry, vol. I, Pergamon Press, London, 1972.

[30]. Whitby, K. T. - *The physical characteristics of sulphur aerosols*, Atmospheric Environment, 12, (1978), pp. 135-159.