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THE EFFECTS OF SALT SOLIONS ON THE HEALTH OF HUMAN SUBJECTS

Ioan Sandu[1], Maria Canache (Buşilă)[2], Viorica Vasilache[3], Ioan-Gabriel Sandu[4]

Key words: NaCl solions, solion sources, halochamber, halotherapy, solion lifespan..

Abstract: In our paper we present a series of aspects regarding the use of NaCl solions in various traditional therapies and, more recently in improving human performance. Their beneficial effects on the membranes of internal organs and on the pulmonary hilum level is well known. The role of alkali and alkaline earth chloride microelements in the adjustment of biochemical processes and the harmonization of vital organ functions of the human and animal body is also well known. In that respect, the paper provides a summary of the knowledge in the field and evaluates the aerosol concentration, using corroborated data obtained from the laser particle counter (type SIBATA GT 321) and by the differential conductometry method, under three operating halochamber modes: 240 h after initial operation start (static duty), after 48 h of ventilation with warm air (dynamic operating duty) and another 24 h after ventilation end (static operation duty).

Introduction

NaCl based solions are polydispersed systems whose particles include a wide dimensional spectrum, with microphysical and nano-structural special properties, with many practical implications (for prophylaxis and therapy of respiratory diseases, for cardio-respiratory and psycho-neuromotor parameters improvement, in purifying and improving air quality).

In general, solions are dissolved nanostructures with diameters over 50 nm, bigger than the Aitken particles. It is known that they can derive both from natural sources (marine aerosols and those found in mines) and artificial sources (halochambers, saline devices or inhalers). Used for therapeutic purposes, they can improve the life of patients, reduce the rate of hospitalizations, thereby reducing

[1] Prof. PhD., Alexandru Ioan Cuza University, Iaşi,
[2] PhD., Romanian Inventors Forum, Iaşi.
[3] PhD Student, Bolotău School, Zemeş.
[4] „Gheorghe Asachi" University , Iasi.

the number of medical exemptions, but may also harmonize the function of internal organs, or improve the performance of subjects who work in hard conditions.

The *solion lifespan* varies, according to different degrees of negative charge on the surface and to the structural complexity of these crystalline nanoclusters, from several minutes to several days. Along with the two *endogenous* factors (electrostatic and stereospecific), their stability depends, to a large extent, on a number of *exogenous* factors, the external or environmental ones: humidity, air temperature, pressure, light, presence of other distributions with a positive charge and organic factors. There are a range of other factors, included by some authors in the *endogenous* group, such as shape, size, nature of grain, the production method or source type, the production speed, capacity of flow-source, coagulation and sedimentation rate etc. (Sandu et al, 2003, Stephen, 1998, Sandu et al, 2010).

Consequently, a new generation of surface artificial halochambers, which can continuously generate saline aerosols, so as to preserve an optimal level of changeable concentration and compositions, flexible from one case to another, according to applicat, were used for the treatment of respiratory diseases and even for the improvement of the cardio-respiratory and psychoneuromotor system of human subjects who perform intense physical activities (Sandu et al., 2009b-e; 2010c, d).

1. Experimental data

Dimensional distribution and concentration of solions. Various aerosols as stable nanodispersions in a gaseous atmosphere have a quite regular size and concentration, depending on the type of source, on particles activity and on their lifespan and environmental conditions (Ştefan,1998, Sandu et al, 2003, 2010c and d). Five groups or dimensional levels can be distinguished, corresponding to different measurement methods and techniques:

- *simple small ions,* with diameters under 0.5 nm, which can be determined only in solution or melted by electrochemical methods (Gulea et al, 1994);
- *Aitken particles,* with diameters between 0.5 and 50 nm - the particles detected by the Aitken counter (Junge 1963) or by mass spectroscopy (Mitchell and Nagel, 2004);
- *average particles,* with a diameter between 50 and 100 nm, detected using laser methods (phase) *Doppler System* (Mitchell and Nagel, 2004), *Angular Light Scattering Intensity* (Mulholland et al., 1985) and *Quasi-Elastic Light Scattering* (Mitchell and Nagel, 2004);
- *large particles,* with diameters between 100 and 1000 nm, detected by *Laser Diffractometer methods* (LD) (Mitchell and Nagel, 2004), *Transmission Electron Microscopy* (MET) (Lettieri and Hembre, 1989) and the *Electrical Sensing Zone* (ESZ) (Mitchell and Nagel, 2004);

- *giant particles,* with a diameter greater than 1000 nm (up to several tens of microns), detected by the *Electrical Mobility Analyser* (Kinney et al., 1991) and by *Optical Microscopy/Image Analyser* (Hartman et al., 1991, Hartman and Doiron, 1992; Lettieri et al., 1991, Thom et al., 1985);

Tab. 1 - Dimensional groups and types of NaCl aerosols

Particle type	**Ions**	**Aitken**	**Medium**	**Large**	**Giant**
Form	Simple small ions	Large and small ion aggregates	Condensed particle	Coagulated particle	Sedimentary particle
Particle diameter (nm)	< 0,5	0,5...50	50...100	100...1000	> 1000

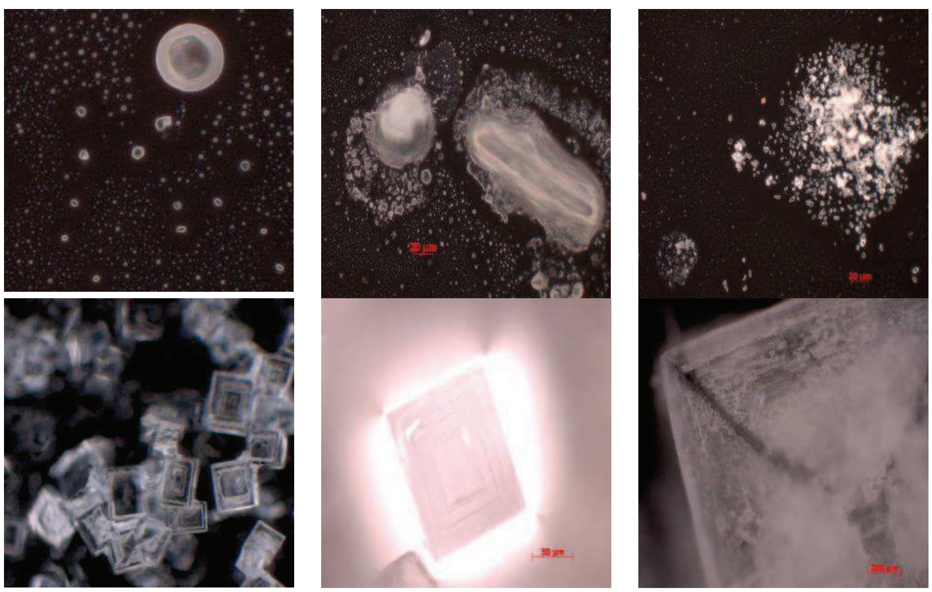

Fig.1 - Evolution of the solion from a dispersed ionic phase to a micro-crystalline one (100X -500X OM)

Irrespective of the type of power generators involved, solions include only three of the groups of particles presented in Table 1, namely: Aitken particles, the medium and the large ones. They are the result of structural reform processes in the presence of water vapors from the gaseous atmospheres, whose stability, as nanodispersed crystalline systems, depends on the electrostatic factor, as well as on the steric one (Sandu et al., 2003, 2004 a and b , 2009, 2010 a and b). Several studies on aqueous dispersed and air systems proved that solions are muable, flexible (dynamic) nanostructures, as spherical aquous conglomerate clusters with a monolayered water surface and a negative charge, which correspond to a formula such as: $[(NaCl)_n \ \ xH_2O]^-_{(aq)}$, with n = 8 - 64 and x = 0.5n – 1.5n (Sandu 2010 a şi b). It was proven that nanodispersed particles adopt, by nucleation and condensation, a polygonal structure, streamlined, reformulated by supra-structuring, which vary between ionic and crystallite, with a cubic geometry, depending on the dynamics of the dispersing system (Fig. 1).

Procedures to obtain artificial solions. The desire to bring the salt mine to the Earth's surface, where it can more easily provide ideal conditions of comfort, have led, since the beginning of 1990, to the development of a series of procedures to obtain NaCl solions, alone or in combination with other inorganic or organic compounds, with various chemical compositions, depending on their application. They can be classified into four groups, depending on the physical-mechanical, fluid and heat values of their production process:

- *division* or *mechanical erosion of the salt systems*, followed by *physical dispersion* in the halochamber atmosphere with the help of a gas stream, as esorate precipitates, fine microcrystallites, extruded microtablets, or of those systems obtained by recrystallization from supersaturated solutions through hydrothermal processes or by solvent evaporation from thin layers of concentrated solutions, achieved through dripping (Clark, 1995 a, b, c, 1996, 1998, Hickey, 1994; Pascu, 2002 a, b, 2003 a, b, c, 2006, 2007 , 2008, 2009);
- *bursting gas bubbles* of supersaturated salt solutions in the air or other inert gases (Joutsensaari et al., 2001);
- *saturated saline solution atomization* into vacuuming cyclones, followed by physical dispersion with a stream of air (Katusik et al., 2000, Merchant, 1994);
- *involvement of superficial particles,* resulting in consecutive solvolizations and anhydrizations on the surface structures, followed by the circulation of air through holes and grooves in cakes or square blocks of salt, arranged in the form of fences (veils) on the halochamber walls (Albiach, 1995 Belkin, 2005 , Konovalov, 1993, Sandu et al., 2009 a, b, c, d, e, f).

Soil features. Solion and aerosol characteristics are determined by their source, but also by environmental factors.

Among the functional characteristics that indicate the source of solions we mention: aerosol size and density, the speed of particle formation, source flow, gaseous environment enrichment factor, lifespan of aerosol particles.

Both the size and density of aerosols and their speed of particle formation and the flowrate of the source depend on the production procedures, or technologies, on the compositional characteristics of saline solutions, namely the nature and pressure of the gas agent dispersed. The lifespan and concentration of aerosol particles in the environment are determined by the reliability of the sources and the dynamics of the aerosol particles.

The most important characteristic for therapeutic and air conditioning applications is the flow-rate of the source, which was assessed by Aitken, and the average particle concentration produced per unit time (seconds). The Aitken particle lifespan varies between 12 and 72 hours, depending on the environmental factors (Junge, 1972, 1974, Sandu et al, 2003, 2010C) and the medium and large particle lifespan may last as long as several weeks.

Depending on their lifespan and on the flow-rate of the source, certain levels or thresholds of chemical load can be achieved, characterized by an optimal enrichment factor (the two give a measure of stability and uniformity (homogeneity) to the microheterogeneous dispersed system).

The NaCl solion composition may be affected by its interaction with atmospheric moisture (humidity) and with other particles or gases in the atmosphere that lead to coagulation and deflocculation, condensation or sedimentation processes. Moreover, light intensity can also influence the composition and physical microstructure of particles produced for coassistance systems with other salts, such as potassium chloride, calcium or magnesium and sodium or potassium iodide.

Apart from the three variables that characterize solions: number, volume and total surface of particles, there are also other parameters involved, such as:

a) their concentration and its variation in time, under the influence of coagulation, deflocculation, condensation/sedimentation processes etc.

b) the dimensional distribution of solions;

c) the degree of surface electrostatic charge (assessed from the distance between solions in dispersed liquid systems);

d) the degree of hydration;

e) the dynamic behavior of solions, their diffusion, mobility and drift speed;

f) the environmental humidity limit at which the formation of condensation nuclei begins.

Solion concentration is calculated according to the number of particles per unit volume. Usually, the 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, compared to the Aitken ones. The particle concentration can be measured using a particle meter, or counter, with a laser beam.

The climatic environment produced by a source includes three specific areas:

- the active layer - the area near the source, characterized by a high concentration (here, all the three dimensional solion groups meet);

- the diffuse layer (extended), characterized by a dynamic state of dimensional area distribution and lifespan, with continuously variable parameters;

- the residual layer (passive) – the area farthest from the source, or the inaccessible areas, characterized by a steady state of dimensional distribution and lifespan.

Air-conditioning systems for therapeutic and ambient purposes have an important variable parameter: the solion dimensional distribution.

The study on dimensional distributions made by Whitby in 1978 (Fig. 2), involving several methods (optical meter, relaxation room and electric mobility), led to the conclusion that dimensional distribution is composed of three log-normal Gausses (areas with characteristic behaviors for a distinct global distribution, generally corresponding to different chemical compositions, due whether to different sources of generation, or to the influence of disruptive exogenous factors).

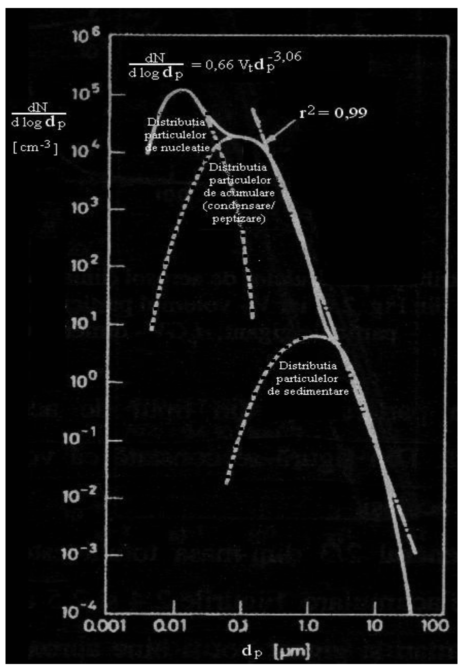

Fig. 2. Solion dimensional particle distributions obtained by Whitby (1978): ΔN - change the number of particles, dp - particle diameter, V_t - total concentration, r - coefficient of correlation between the power law and the experimental data.

The Solions dynamic behavior characteristics were the subject of a study conducted by Hidy and Brock (1972), which 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);
- bröwnian motion of particles is significant;
- the surface of particles is large compared to their volume;

Those features have specific micro-physical and nano-structural meanings, because they are based on both diffusion and sedimentation processes and also on physico-chemical processes of coagulation, deflocculation and condensation.

Another important feature of solions is the limited humidity of the environment in the formation of condensation nuclei. Large solion particles consume large amounts of water vapors from the environment, causing a decrease in the supersaturation values and of the relative humidity (Fig. 3). The micro-particle condensation and deflocculation processes depend on the nature of the salt, its total mass, the degree of solubility and on environmental conditions (Ştefan, 1992, Sandu et al., 2003).

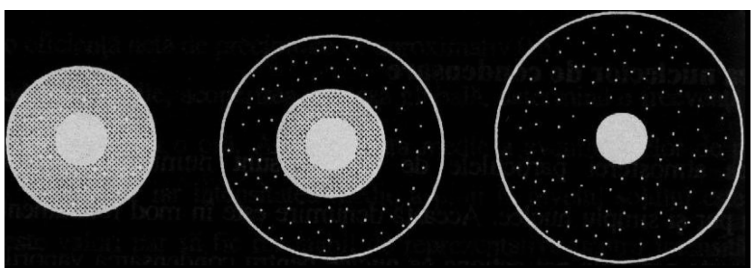

Fig. 3 - Turning the active micro-particle from solion primary particles (left) into secondary particles, resulting from condensation (center) and deflocculation (right) at higher relative humidities (95%)

Applications of solions. The better control of concentrations and dimensional distributions of solions in halotherapeutic environments is very important for their beneficial effect in the treatment of various respiratory diseases and for creating an environment of "clean air" (Sandu et al., 2004a and b).

Depending on solion concentration, saline areas may have both *therapeutic effects* (in the case of high concentrations of solions of 1-6 mg NaCl/m³, stationary for 1-4 hours) and a *prophylactic* ones (concentration below 1 mg NaCl /m³, but with a longer presence, 8-16 hours per day.

Solions affect the body by inhalation and skin absorption. By inhaling aerosols, the respiratory tracts are "cleansed" of unhealthy elements (streptococcal stafilo) present in adults, but especially in children, that may trigger and maintain a series of respiratory ailments (mostly recurrent, with tendencies to chronic) and whose presence may lead to a gradual decrease of immunity. Salt, by its nature is a bactericidal substance, which prevents the evolution of microbial cultures, in many cases behaving as a disinfectant. The dilution effect of the deposits on impurities (including microorganisms) that may cause respiratory diseases and disorders, ranging from simple hoarsenesses, bronchitis to asthma occurs due to the depositing and absorption of salt ions both at the upper and the lower respiratory tract level (especially the small aerosols). Fluidization of the mucus leads to ease of breath, removal of obstructing secretions, removal of the irritating factors, it leads to organic and sustainable self-cleaning of the respiratory tract, to the annihilation of pathogens and of the irritant and inflammatory effects.

Due to the electro-chemical properties of salt, salt ions, once deposited on the respiratory tract, in addition to a basic action on bacteria and microorganisms, cause "softening", liquefaction and easy flow of the mucus from the airways, thus enabling the disposal of foreign materials from the cilia and micro-cavities, restoring the mobility of the respiratory tract cilia, which results in progressive and long lasting relief of breath, natural and easy expectoration, elimination of allergenic or bacterigenic materials through the reflex cough function, nasal discharge, sputum etc., as symptomatic healing features of respiratory diseases.

Solions from the therapeutic atmosphere also affect the body through skin-level absorption thereof; they are absorbed in corresponding proportions to oxygen, humidity and may also act by deposition/precipitation due to moisture and to the temperature difference between the skin and the atmosphere.

Seaside and salt mine therapies (speleotherapy) based on aerosols are recommended in cases of asthma, bronchitis, emphysema, chronic rhinitis, chronic sinusitis, repeated respiratory infections, hypothyroidism and should be limited or advised against in diseases such as hyperthyroidism, pulmonary tuberculosis, epilepsy, severe hypertension, recent heart attack, angina pectoris with frequent seizures, lung cancer, pulmonary mycosis, post myocardial infarction, pregnancy. In speleotherapy it is recommended to go to the gym, to walk, to exercise etc. Those suffering from respiratory diseases are likely to heal within two weeks._The beneficial effects of speleotherapy are due to the fact that the cave has a constant air temperature (10°C), humidity is relatively high (80-100%), the airflow speed is low (0.072 m/s), which results in a comfortable environment. The increased concentration of CO_2 (0,06 - 0.08%) stimulates and revitalizes the respiratory center, the low concentration of ozone decreases smooth muscle spasms, the low air pH (4.2 - 4.5) has a bacteriostatic effect. The presence of high radioactivity

(^{222}Ra is 1,5 to 1,9x10^{-13} Curie/litre, 2-3 times higher than in the atmosphere) increases bacteria and causes lung-allergy elimination from the airways. The pressure of O_2 is 2.07 % higher than at the surface. Sustained mining, which provides a high concentration of NaCl, provides an air rich in natural aerosols; NaCl crystals are in the form of aerosol microparticles and work up to the alveolar level. The concentration and granulometric distribution of aerosols in salt mines or halochambers can be measured by the conductometric technique, modified for differential analysis by the use of a device having an aspirating bubble type system and of optical devices with a laser beam, often used to estimate the number of charged particles (aeroions and aerocations) and the granulometric distribution of aerosol, for low concentration levels.

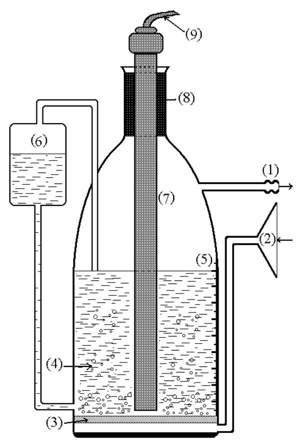

Fig. 4 - Glass bubbler aerosol generator, with enclosed transducers: 1 – extension to the vacuum pump; 2 – aerosol intake funnel; 3 – bubbling dissipator; 4 – solution under analysis; 5 – indicator for solution volume; 6 – system to adjust/complete the volume of the bubbler with tri-distilled and de-oxygenized 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

A method using differential conductometry (Pascu, 2009). A set of glass devices are employed (fig. 4): a bubbling aerosol generator with flow controllers, each equipped with a system to adjust/complete the volume of the bubbler with tripple-distilled and de-oxygenized water and a set of electrode transducers (conducting and compensating temperature) encapsulated within a standard cell, made of rigid plastic, integrated to a differential analysis installation (fig. 5) and coupled to a digital conductometer, with a computer interface.

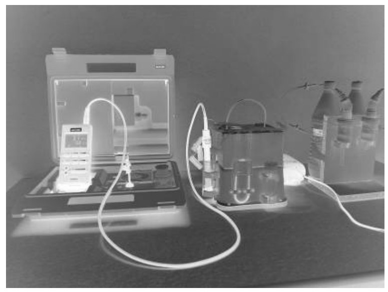

Fig. 5 - General view of the laboratory analysis equipment for differential conductometry

The differential analysis equipment is based on the chart in Fig. 6.

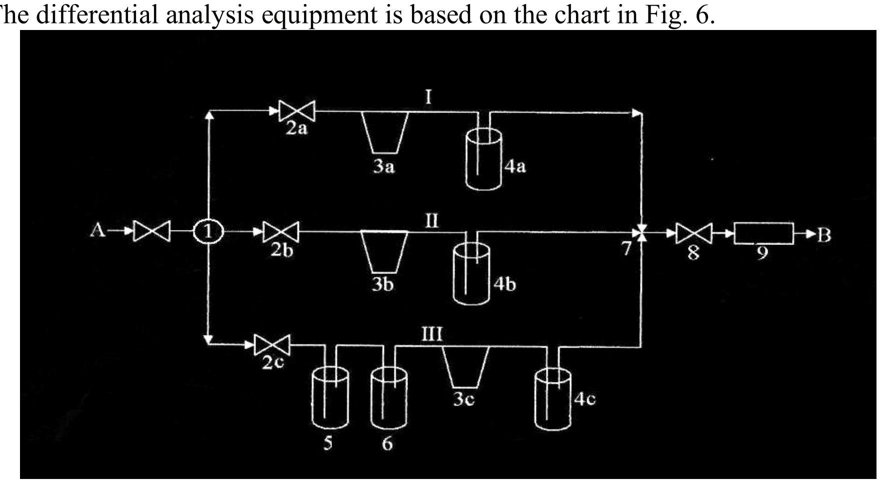

Fig. 6 - Operating chart of the analysis equipment:
I, II and III – branches or routes; A – gas intake point; B – gas discharge; 1 – distributor; 2 (a, b and c) – flow taps; 3 (a, b and c) – rotation meters or manometers; 4 (a, b and c) – glass devices for bubbling aerosol generator; 5 and 6 – additional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

For the analysis chart, a C833 conductometer was used, made by CONSORT, Belgium, with the following functional characteristics:

- pH range: -2 ... +16;
- potential range: ± 2000 mV;
- conductivity: 0 ... 2000 mS/cm;

- resistivity: 0 ... 200 MΩ cm;
- salinity: 0 ... 100 g/L;
- temperature: 0 ... 100°C.

Branches I and II of the equipment allow parallel measurements, while branch III can 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 was 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 was further bubbled by sucking it in a volume of 10 cm^3 of tripple-distilled and deoxygenized water (by 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 tripple-distilled and deoxygenized 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. Given the conditions registered by the conductometer C-833, with the following operational parameters: χ tridistilled water = 1.2 µS/cm, the bubbling time of each sample t = 15 min and the flow of bubbling air Q = 0.6L/min (in each glass device) and their analogic comparison to the standard graph in Figure 6, the quantity of NaCl retained by the volume of bubbling air was determined (marked with mNaCl) according to the relation: m_{NaCl} = conc. /100 mg. Knowing the stream Q, the volume of air has been determined: V = Q x t, where the concentration of NaCl solions in the air will be: $C_{solion} = 1000\ m_{NaCl}/V$.

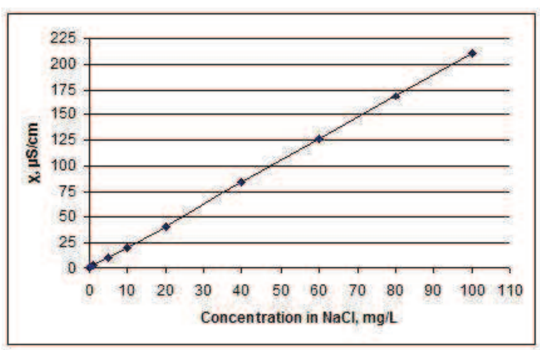

Fig. 7 - Standard curve (graph x = f(c) for water solutions of NaCl, within the range of actual concentrations)

The standard curve in Figure 7 has its tg α = 0.4762, indicating that to an increased conductivity of 1.0 µS/cm will correspond to an increase of the concentration, discreetly ranging between 0.47±0.02 mg/L of solution. The value of conductance having been determined for a pre-set experimental bubbling period (depending on the concentration reached or achieved and the diameter of the solions) is extrapolated to the standard curve when the concentration in NaCl is obtained for a given volume of solution, which will further be assessed via a conversion table or calculations, to determine the saline charge of the solions under analysis, in mg/m^3.

The laser particle counter method measures the granulometric distribution and the total volume of solion particles inside the chamber, which will further facilitate an estimation of their concentration in mg/m^3 air. An optic laser device (a SIBATA GT 321 particle meter - Fig. 8) was used for this purpose. It helps assess the distribution of the number of particles, depending on their granulometry and the number of particles whose diameter is larger than di/m^3, according to the diameter of particles *di*. Based on the results, the concentration of solions, expressed in mg/m^3 air, was calculated. Technically, the particle meter SIBATA GT 321 allows the following measuring modes:

- number of solions between 0 and 108 particles/m^3;
- size range: 0.3; 0.5; 1.0; 2.0 and 5.0 μm (particle diameter);
- operating temperature range for the halochamber: 0 – 50°C;
- aerosol gas flow processed: 2.83 L/min.

Fig. 8 - SIBATA GT 321 – the particle counter

With its help the number of particles, according to their dimensions and total volume, was firstly determined and then the concentration of solions, measured in mg/m^3, was calculated in at least three sampling points inside the halochamber.

The total volume of the solions was evaluated, considering them spherical in shape (the most likely shape of aerosol particles), while the specific weight used for calculations was 2.165 x 106 g/m^3 (which corresponds to that of solid salt).

Although the laser particle counter measurements has a series of disadvantages due to possible calculation errors and also to the presence of other types of particles in the halochamber, different in nature from solions, it is the only *in situ* analysis method available to verify the differential conductometric method (Sandu 2004a, b), the two being often corroborate.

For each determination set, the characteristics of the air pumped into the capsule and those of the cryptoclimate inside the halochamber were assessed in at least three zones, different in height, length and width. The temperature and relative humidity (UR) were measured with an electronic digital hygrometer, the pressure with a barometer and the lighting with an electronic lux meter. The lifespan of solions was estimated based on the evolution in time of the solion concentration inside the halochamber, after reaching the maximum possible level and the minimal operational limit which would no longer justify any practical use.

2. Results and discussions

Since the dynamics of the aerosol flow inside the halochamber is influenced by the environmental conditions, during measurements all the values of the parameters of pumped air were kept constant and the microclimate inside the halochamber was constantly monitored. Table 2 lists the values of those parameters.

Tab. 2 - Values of the environmental parameters inside the halochamber

Parameter Operating Conditions		Temp. (°C)	Rel. Humidit. (%)	Atmospheric Pressure (mmHg)	Lighting (lx)
Dynamic	Microclimate inside halochamber coated with salt blocks during motionless period	22 – 35	55 – 75	756 - 770	80 - 120
	Cryptoclimate inside the niche during ventilation	40 – 90	55 – 75	756 - 770	80 - 120

The experiments were performed in artificial conditions of temperature and humidity, as required by the application under study.

For the halochamber with a dynamic operating duty, determinations were also made 240 hours after the salt blocks diaphragms were mounted on the walls. The working parameters were recorded in the following three stages:

Stage I, in static duty, 240 hours after initial operation start, without hot air ventilation, when the following parameters were obtained: air temperature = 19.0°C, relative humidity = 75% (UR), atmospheric pressure = 765 mmHg, lighting = 80 lx.

Stage II, 48 hours after the measurements in stage I, when the ventilator was turned on and the air temperature was adjusted to 50°C, according to the heat exchanger; the air inside the halochamber was recycled for 10 hours; afterwards, the ventilator was turned off and the parameters (air temperature = 36.5°C, relative humidity = 65% (UR), atmospheric pressure = 765 mmHg, lighting = 80 lx) were measured.

Stage III, 24 hours after the measurements in stage II, under static conditions (without air ventilation), when the halochamber parameters were: air temperature = 24.5°C, relative humidity = 68% (UR), atmospheric pressure = 766 mmHg, lighting = 80 lx.

In this case the concentration of solions inside the halochamber was also evaluated based on the average values obtained by the laser particle counter (Table 3) and the differential conductometric method (Table 4), in three stages involving the above mentioned methodology and using the same three sampling zones.

This type of halochamber ensures a lower purity than the static halochamber. The differences in the concentration of the solions inside the halochamber, determined by the two mentioned methods, will help estimate whether it was contaminated by other types of particles. Therefore, for the halochmaber used in dynamic conditions (stage II), that difference was of 0.264 mg solions/m^3, which corresponded to 19% of contamination and was caused by other particles driven by the blower.

Under the dynamic conditions of stage II, through a forced air blow inside the halochamber, the solion generation capacity increased 4.3 times more than in stage I. After passing from dynamic to stationary duty, the halochamber registered a decrease of solion concentration rate of more than 50% in 24 hours. The value of the initial concentration measurement in stage I was reached after 144 hours. The high decrease in concentration during the first 24 hours may have been caused by the competitive and extremely dynamic processes: nucleation/ condensation and peptization /coagulation.

Depending on solion concentration, *salt air* may have a favorable effect on the respiratory system.Other factors involved in a successful treatment are the lack of allergens, the low concentration of microbes, the pH of the air, the stability of the microclimate, the presence of sodium chloride in the form of small particles, with effects on on the pulmonary alveoli.

Tab. 3 - Determination of solion concentration inside the halotchamber by the laser particle counter, under dynamic conditions in three stages

Diameter d_i of the solions (μm)	Stage I		Stage II		Stage III	
	Number of solions, Δn_i (10^6 x m^{-3})	Total volume of solions*, (10^{-14} x m^3)	Number of solions, Δn_i (10^6 x m^{-3})	Total volume of solions*, (10^{-14} x m^3)	Number of solions, Δn_i (10^6 x m^{-3})	Total volume of solions*, (10^{-14} x m^3)
0,3	1965	2776,55	3680	5199.84	2498	3529.67
0,5	217	1419.60	368	2407.46	280	1831.76
1,0	5	261.67	37	1936.32	12	628.00
2,0	4	1674.64	12	5024.00	7	2930.66
5,0	1	6541.66	7	45791.60	3	19625.00
TOTAL	2039	12674.12	4104	60359.22	2743	28245.10
Concentration** of NaCl solions, (mg/m^3)		0.292	-	1,388	-	0,649

*) considering solions as spherical;
**) evaluated based on the total volume of particles with ρ_{NaCl} = 2.3 x 10^6 g / m^3.

Tab. 4 - Experimental data from the conductometric measurements in three stages inside the dynamic halochamber

Stage	I				II				III			
Bubbler	4a	4b	4c	Solution Temperature (°C)	4a	4b	4c	Solution Temperatur (°C)	4a	4b	4c	Solution Temperatur (°C)
Bubbling time, (min)	χ, (μS/cm)				χ, (μS/cm)				χ, (μS/cm)			
0	2.0	1.7	1.2	17,5	3,1	2.7	2.0	26,5	2.5	2.0	1.5	22,0
15	2.7	2.4	1.3	15.9	5.2	4.8	2.2	21,1	3.7	3.2	1.6	17,5
15	3.4	3.1	1.4	15.1	7.3	6.9	2.4	20.0	4.9	4.4	1.7	16.6
15	4.1	3.8	1.5	14.5	9.4	9.0	2.6	18.9	6.1	5.6	1.8	15.9
15	4.8	4.5	1.6	14.1	11.5	12.1	2.8	17.8	7.3	6.8	1.9	15.3
Δχ /15 min	0.7	0.7	0.1	$\Delta\chi_{mediu}$ =	2.1	2.1	0.2	$\Delta\chi_{mediu}$	1.2	1.2	0.1	$\Delta\chi_{mediu}$
Concentration of solutions, (mg NaCl/L)				0.238	1.012				0.536			
Concentration of solions, (mg NaCl/m^3)				0.264	1.124				0.596			

Halotherapy meant in the past a visit to a salt mine, but currently there are "salt rooms" in hospitals, in which patients may inhale solions. The beneficial effect of salty air may also be increased by performing physical exercises.

Salt-based therapies, as natural therapies, have many advantrages, among which their quick results and the fact that high salt concentrations are not considered harmfull. Nevertheless, the physical condition and the health of the subject should also be taken into consideration.

In order to determine the physical condition of children, they use anamnesis, somatoscopic examination, various measurements and functional tests.

In regard to anamnesis, the data was recorded in compliance with a set form containing data on family environment, collateral inheritable affections, individual previous physiological and pathological conditions

The questions regarding data on family environment, collateral inheritable affections, and individual previous physiological and pathological conditions were answered both by parents and by their children, in order to detect possible strictly-hereditary diseases. According to the records, there were no collateral hereditary diseases, such as hemophilia, diabetes, HTA, parasitosis, heart diseases, cancer, rheumatic affections, TBC.

The data on individual previous physiological and pathological conditions was in regard to birth conditions (normal or with obstetric actions), the APGAR score, whether is was premature or on schedule and the APGAR score was 10; the weight and length at birth (a healthy newborn normally weigh 2800-4000 g, the average weight for girls being 3300 g and that of boys 3400 g; the normal length is 48-54 cm, the average for girls being 50 and for boys 51) and 85 % of the subjects registered as normal (the weight and length was influenced by the condition of the parents). All subjects reported a normal and harmonious development during childhood.

The data on individual pathological conditions included the main previously experienced ailments of the subjects up to the time of the survey. A large number of subjects (80% of the target group and 85% of the witness group) had suffered from eruptive diseases: measles, chickenpox. Certain subjects were diagnosed with streptococcal angina, convulsive coughing, hepatitis, gastritis, respiratory ailments, cardiovascular ailments, immunologic, metabolic endocrine diseases. Their meals were mainly balanced, diverse, the appetite was good in all subjects. All subjects were non-smokers, did not drink alcohol and needed approximately 2 liters of water per day. Nutrition was supplemented with vitamins and minerals for 20% of the subjects and 35 % of them had parents who smoked (experienced passive smoking). They were recommended to keep in tune with the pyramid of healthy nutrition and to attempt a natural additional vitamins and minerals supply. Their liquids supply should also be in correlation with their expelled liquids.

The survey also took into consideration the living conditions of subjects. All of them lived in clean homes, in families of 3-6 members. There were no reports of family conflicts and there were no single-parent families.

In regard to previously performed sports, subjects reported to have attended physical education classes in school, with no additional qualification as sportsmen.

Consultation results led to the identification of any medical, physical, or social problems that might have excluded subjects from the study groups. In order to be certain that the subjects under study were healthy, investigation further included a general clinical test with results recorded in their personal medical chart.

After assessing the results obtained together with characteristics specific to age and individual, they established a physical activity schedule to be performed in the therapeutic environment with saline aerosols, in compliance with the expected improvement in the function of the body, as physical exercises in an saline aerosol environment are known to be beneficial: the respiratory system increase in power, the circulatory system amplifies its functional capacity, hormone levels in blood increase (the metabolism is accelerated, children growth processes are stimulated, muscular mass increases, the risk of osteopososis is lowered), aging is slowed down, stress levels are decreased and a state general comfort is experienced, the immune system recovers (physical exercises improve will, creativity, the power of concentration, memory and emotional stabilty etc).

Conclusions

This study presents the experimental findings during the *in situ* determination of the solions concentration inside halochmabers, or surface artificial saline chambesr (one with dynamic duty and the other with static duty) which were intended to improve the functional parameters of the cardio-respiratory system, as well as the psycho-neuromotor parameters of human subjects involved in intense physical activities and to treat or improve certain ailments.

The characteristics of solions were determined by two instrumental methods: a particle counter with an optic laser and by differential conductometry.

Based on the previously presented findings, the following conclusions were reached:

- solion and aerosol characteristics are generally determined by the source, but also by the environmental factors. Thus, among the functional characteristics that describe a source of solions there are: solion size and density, the speed formation of particles, the source flow-rate, the enrichment factor of the gaseous atmosphere, the lifespan of solions;

- irrespective of the type of the generating source, solion particles contain only three groups, namely: Aitken particles (large ions and small ionic aggregates, 0.5 ... 50 nm), average (50 ... 100 nm condensed particles) and large (coagulated particles, 100 ... 1000 nm);

- the difference between the concentrations of solions determined by the two methods helps estimate halochamber contamination by other types of particles, while for the second halochamber, which operated under a dynamic duty (stage II), this difference eas only 0.264 mg solions/m^3, which corresponds to a contamination of about 19% and which was due to additional particles being driven by the blower;

- under dynamic conditions and 240 hours after mounting, the level of solion concentration inside the halochamber was 0.264 mg solions/m³ the estimated generating power being approximately 2.3 times lower;
- under dynamic conditions, in the second stage, the generating power increases 4.3 times more than in the first stage;
- the second halochamber, after passing from the dynamic duty to the stationary duty, had a decrease rate of solion concentration of more than 50% in 24 hours;
- the high decrease in concentration within the first 24 hours could have been caused by the competitive and extremely dynamic processes: nucleation/ condensation and peptization /coagulation.
- depending on the concentration of salt solions, saline spaces may have a therapeutic effect (in case of high concentrations of NaCl solion of 1-6 mg/m³ with a lifespan of 1-4 hours) or a prophylactic effect (concentrations below 1 mg NaCl/m³, but with a longer presence, 8-16 hours per day).
- solions act on the body by inhalation and by skin absorption as a remedy for many diseases, salt therapy being applied since the time of Hippocrates as a complementary and/or alternative method of protection of the airways, an old method of healing body and soul, thus successfully replacing a long-term drug treatment;
- in order to establish an adequate program of physical activities, tailored according to age and individual characteristics of subjects, with positive effects on the functioning of the body, it is necessary to know both the characteristics of the saline environment and the medical, physical, or social problems of the subjects.

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