EXPERIMENTAL INVESTIGATION ON SPACE CONFIGURATION AND INFLUENCE OF ELECTROMAGNETIC FIELD OF SHORT WAVE APPARATUSES IN MEDICAL THERAPY

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Abstract

The usage of short waves in the medical therapy started to become quite popular in the recent decades. The space-time configuration research of the electromagnetic field in the patient area within the UHF range is really important for the treatment used in physiotherapy methods. Based on the results of this study are defined the system's mode which induce the electromagnetic field in the patient area, the number of the therapeutic procedures and duration of each of them. The radiators (antennas) in the physiotherapy are often in proximity to the patient's body, i.e it is necessary to consider the impact of the body to the patient, the parameters of the antenna and to the research of the area in the near field. In this paper are presented and described in graphic form the conducted studies for electromagnetic field strength in the very near field in real clinical conditions.

At high frequencies, polarizing molecules are in the patient's body completely failed changing their spatial orientation and appear vibrations of the dipoles around neutral position. This process is related to the generation of heat. A characteristic feature of UHF waves impact on the body that the heat is produced within the body itself. In physiotherapy are used transmitters, which excited the electrical field for the induction of these frequencies. A pair of two "electrodes" usually acts as antenna system on these devices. The antenna system is ensuring the influence of the electromagnetic field of a small part of the human body.

1. INTRODUCTION

In the theory of antennas and the distribution of electromagnetic waves are defined three areas: the first area (far field) in which the angular distribution of the field is independent of the distance from the antenna and the emitted wave is spherical. The second zone is the very near radiating field (Fresnel zone) in which the angular distribution of the field depends on the distance from the antenna. In this area radiated wave, which is actually a plane wave, is gradually becoming a spherical wave. The third area is the near reactive field, which is located at a distance between 0 and λ/2π from the antenna where the reactive field dominates. It is the area of interest in medical systems for the physiotherapy [4]. For an antenna with a maximum size, which is small compared to the wavelength, the energy in the very near field is mostly reactive. This stored energy is transmitted periodically from the antenna to the near field. The reactive near field extends from the antenna to a distance "R" from the antenna. The formula for calculation of this distance is:

$$R = \frac{\lambda}{2\pi} \tag{1}$$

where λ is the wavelength.

2. EXPERIMENTAL INVESTIGATION ON THE SPACE CONFIGURATION OF THE ELECTROMAGNETIC FIELD

For exploring the space-time configuration in the patient area in the measurements, a transmission frequency of the device is used, which is close to the used frequency, namely – 29.5 MHz with a wavelength 10.1 m approximately. In our case, the very near field extends at a distance R = 1.62 m from the antenna, considered in the formula (1).

The definition of the two components $\vec{E}$ and $\vec{H}$ of the electromagnetic field at the revelant points of the patient area is necessary for making the desired measurements. When determining the shape of the area of the space / the plane, which the simulation is performed, the main consideration is the reporting of the mutual position of the electrodes (antennas) of the system and its emplacement to the treatment area of the patient's body. A common case in physical therapy is the used of an apparatus with a pair of emitters. It can be seen the measured antenna system with the exact location of the disc nozzle in Figura 1. [1]

In order to facilitate and accelerate the sampling and the calculation (simplification of the algorithms based on the use of symmetry) is appropriate the space area to be approximated by a regular geometric figure. This would be allowed using the available symmetry for optimization the developed algorithms for sampling and calculation. The used geometric figure should also cover the maximum radiating surface. If we use the formal requirement of symmetry, the suitable plane figures are rectangle, square and circle. This matches with the usual forms of radiation surfaces. In the case of a circle can be selected algorithm which completes the circle of points situated in concentric circles starting from the center. In the case of a circle can be selected algorithm which completes the circle with points, situated in concentric circles, starting from the center. [2]

Figure 1. The used antenna system with disc nozzles of each of the emitters during the study of space-time configuration of the electromagnetic field

To facilitate the measurement and interpretation of the results was used a graphical representation of the antenna system (placement of the vibrators relative to one another) in the vertical plane (Figure 2). Formally the figure can be considered as a trapezoid, which is in accordance with the usual position of the electrodes (antennas) of Figure 1. The mid-segment of the trapezoid (Figure 2) is the axis between the centers of the antennas. It is important to know the location of the vibrators, as they can be located closer or further away, the distance should be between 2 and 10 centimeters. And depending from their size and location, can determine the distribution of the field and the change of the temperature on the patient.

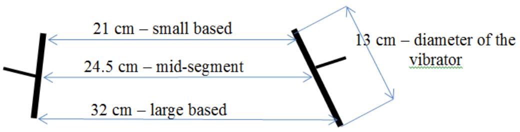

Figure 2. A graphical representation of the antenna system (position of vibrators relative to one another in the vertical plane).

3. RESULTS AND ILLUSTRATION OF THE INVESTIGATION OF THE ELECTROMAGNETIC FIELD

The measurements of the electrical intensity were made at different points in small base, large base and mid-segment on the trapezoid, and in the points of the radius of one emitter.

The measured values are in relative units, as for the electric strength and the magnetic induction. These values are related of course with the absolute values with an accuracy of one coefficient. The magnetic induction in the respective sections was calculated was calculated by the following expression:

$$\frac{E}{H} = \eta = 120\pi \approx 377\Omega \qquad (2)$$

where η is the characteristic impedance. [3]

In Table 1 are given in relative units the obtained values for the electric intensity and magnetic induction in the various items of the bases and the mid-segment of the trapezoid (Figure 2) and the radius of one of the emitters in parallel placement of the measured antenna of electrical in parallel placement of the antenna in the patient area. In Table 2 are given in relative units the obtained values for the electric intensity and magnetic induction in the various items of the bases and the mid-segment of the trapezoid (Figure 2) and the radius of one of the emitters when the measured antenna measurement is perpendicular of electrical line of force.

Table 1. *Relative values of the measured levels of electric intensity E and magnetic intensity H in parallel placement of the antenna in the patient area*

Small base		Mid-segment		Large base		Radius	
E	H	E	H	E	H	E	H
77,1	0,204	64,1	0,17	77,3	0,205	75,5	0,2
77,8	0,206	67,4	0.179	78,3	0,208	74,5	0,198
77,7	0,205	65,7	0.174	77,8	0,206	72,5	0,192

Table 2. *Relative values of the measured levels of electric intensity E and magnetic intensity H in perpendicular placement of the antenna in the patient area*

Small base		Mid-segment		Large base		Radius	
E	H	E	H	E	H	E	H
78,1	0,2072	61,9	0,1642	77,6	0,2058	77,8	0,2064
78,5	0,2082	64,5	0,1711	78,2	0,2074	76,2	0,2021
78,2	0,2074	62,4	0,1655	78	0,2069	75,2	0,1994

Of Figure 3 is illustrated a screen of the spectrum analyzer for measuring the relative level of the electrical intensity. The tick is for a broadcasting frequency, together with significant harmonic of the radiation to the right of the main tick. These harmonics appear, as the apparatus is operated in the mode of the amplitude manipulation. The amplitude manipulation is a method often used in the physiotherapy, in order to avoid the adaptation of the patient to the parameters of the influence electromagnetic field and thus to provide, if necessary, a longer course of treatment for more severe disease. The screen of the spectrum analyzer can be seen in figure 4, where is the oscillogram of the broadcasting amplitude manipulated signal.

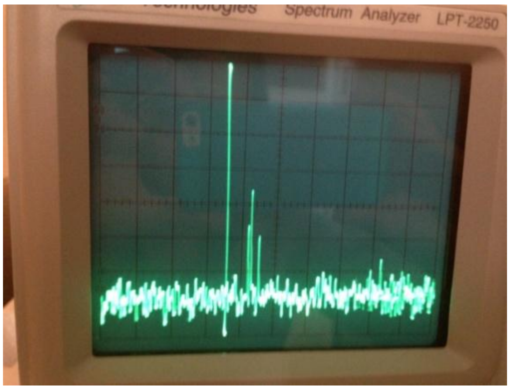

Figure 3. A screen of spectrum analyser at measurement of the relative level of electric intensity

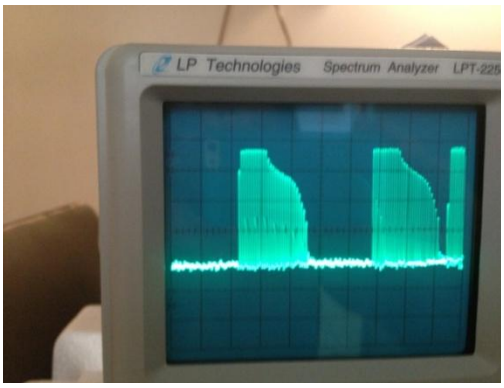

Figure 4. The oscillogram of the broadcasting amplitude manipulated signal

In graphical form are the results of the measurements are given in Table 1 and Table 2 below. The results, from the measurement of the electric intensity and the calculated values of the magnetic induction on the three bases of the trapezoid small, large and mid-segment in parallel placement of the measured antenna and the electrical line of force in the near field, are present in Figure 5 and Figure 6. Figure 7 and Figure 8 shows the results, from the measurement of the electric intensity and the calculated values of the magnetic induction on the three bases of the trapezoid small, large and mid-segment in perpendicular placement of the measured antenna and the electrical line of force in the near field. Figure 9 and Figure 10 shows the results, from the measurement of the electric intensity and the calculated values of the magnetic induction on the three bases of the trapezoid small, large and mid-segment in parallel and perpendicular placement of the measured antenna and the electrical line of force in the near field. The functions shown in the figure from 5 to 10 were obtained as discrete values in the result of the measurements of the electrical intensity in a finite number of points. If the obtained discrete values of the functions are connect with the segment, could be regarded that the made a simple interpolation, so that they can take into account the relative values of the variables and between points of measurements. This is shown by points 1 and 2 on the charts. In mathematics certainly has quite analytical methods for interpolation, which may be used in the requirement for greater accuracy in the interpolation.

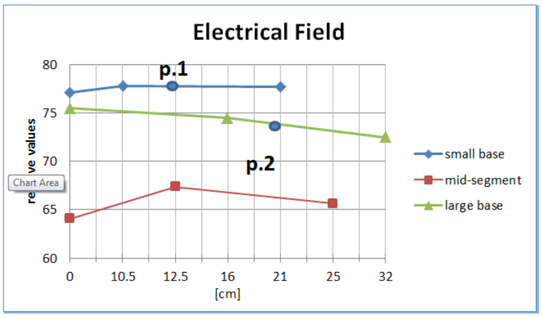

Figure 5. Relative values of the electrical intensity of the three axes: small, mid and large segment in parallel placement of the measured antenna

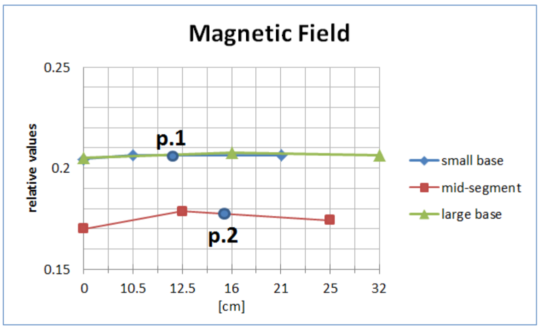

Figure 6. Relative values of the magnetic induction of the three axes: small, mid and large segment in parallel placement of the measured antenna

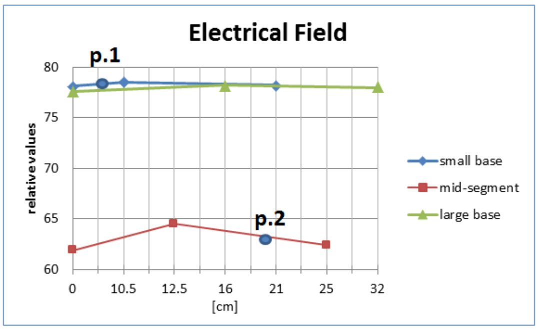

Figure 7. Relative values of the electrical intensity of the three axes: small, mid and large segment in perpendicular placement of the measured antenna

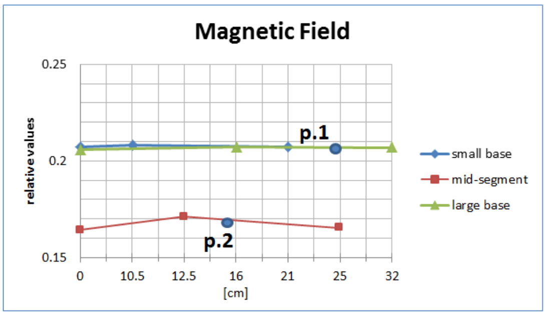

Figure 8. Relative values of the magnetic induction of the three axes: small, mid and large segment in perpendicular placement of the measured antenna

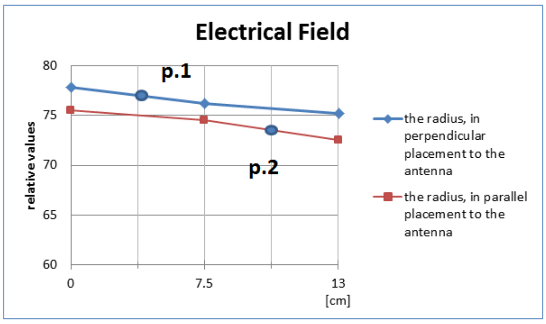

Figure 9. Relative values of the electrical intensity at the radius in parallel and perpendicular to the measured antenna

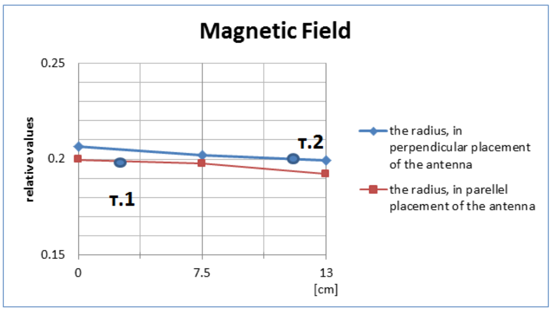

Figure 10. Relative values of the magnetic induction at the radius in parallel and perpendicular to the measured antenna

Experimental measurements of the strength of the electric field in the very near field in actual clinical conditions were made in the conventional mode, used in the course of therapy, namely, continuous transmission mode and a mode of amplitude manipulation of the electromagnetic field.

4. CONCLUSION

In conclusion we can say that the study of the characteristics of electromagnetic field in the nearby area along with the study and optimization of the space-time configuration of the electromagnetic field are very important and crucial for achieving the desired therapeutic effect. These waves have similar physiological action with the other high frequencies currents, but they penetrate to greater depths. Ultra-high frequency waves have a good therapeutic effect in: transient disorders of cerebral circulation, stroke, vascular incidents in the central nervous system, chronic arterial insufficiency of lower extremities. Improves microcirculation, rheological properties of blood, detection of shunting, increased cell permeability.

References

[1] D. Dimitrov, Medical systems for influence of electromagnetic fields on human, education book, TU-Sofia, 2007

[2] W. Y. Riadh, "Electromagnetic Fields and Radiation (Human Bioffects and Safety)", Marcel Dekker Inc. Canada, 2001, ISBN 0-8247-0877-3

[3] S. Laybros and P. F. Combes, "On Radiating Zone Boundaries of Short, λ/2 and λ Dipoles", IEEE Antennas and Propagation Magazine, 45, 5, October 2004, pp. 53-64.

[4] Boyadzhiev S., Lazarova V., Rassovska M., Yordanova I., Yordanov R, Comparison between RF and DC Magnetron Reactive Sputtered Molybdenum Oxide Thin Films for Gas sensors, Journal of Optoelectronics and Advanced Materials – Rapid Communications (OAM-RC), Vol. 4, ISS. 10, October 2010, pp. 1485 – 1488, ISSN: 1842-6573.