Electromagnetic Field 50 Hz: its Influence on Living Organisms on the Cellular Level

Basic tests which have a practical application

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Abstract—**Experimental studies have proved that magnetic field of 50 Hz frequency is not neutral to living organisms and may induce in them a variety of measurable changes. However, these issues have been poorly recognized so far and further investigations seem desirable. The paper presents a new approach to the surveys carried on in current time with the use of exposure site which had been specially designed and manufactured in the Technical University of Wroclaw. The studies were carried on in cooperation with The University of Wroclaw.**

Keywords: 50 Hz, free radicals, fluorescent probes, calcium, free radicals, apoptosis, real time observation

I. INTRODUCTION

For about a hundred of years, in a human environment, a new physical factors appeared influencing human organism and alternating magnetic field 50 Hz is one of such factors. It is strictly connected with the use of alternating current electric energy of industrial frequency. All electric devices generates electromagnetic field starting from an electric bulb through everyday live appliances like vacuum cleaner or shaver and coming to electric power transmissions. In our country, there is 12 thousand kilometers of overground electric power lines of the highest voltages-400 and 220 kV.

High voltage overhead power lines as well as substations are 50 Hz electromagnetic field emission sources evoking the biggest fear. People are troubled with the question whether longer stay in a short range of these sources influences their health and may have negative consequences in future [1].

Relative to its frequency, electromagnetic field may be measured with the use of various magnitudes. Electromagnetic field of 50 Hz frequency is a quasi stationary – extremely low-alternating field (ELF-very low frequencies) hence it can be analysed as two independent components: E (v/m) electric component and H (A/m) magnetic component or magnetic field B induction evaluated with teslas (T).

Electromagnetic field of 50 Hz frequency is characteristic for wave qualities and in this case the wave is 6000 km long so it cannot be compared with any living organism size. This is why electric and magnetic components are examined independently.

Similarly to majority of organisms living on earth, the human being does not sense the presence of static magnetic or electric fields. Human organism can detect electromagnetic waves only in a very narrow range (300-760 nm) which are registered by retina or infrared radiation senses as heat by skin receptors. Senses of majority of living organisms are not adapted either to magnetic or electric field detection.

What for our sight and other sense seems emptiness, is filled with a large amount of various forms of energy. It is even better not to see that as the scenery would be surely terrifying. The man staying in such a radiance range is usually unprotected and unconscious of its presence. Fortunately, only some few forms of energy found in natural environment have a destructive influence on human organism.

All interdependencies between electric and magnetic fields are defined with Maxwell's equations (1964). The basic conclusion resulting from them is the ascertainment of electromagnetic waves presence in nature.

This is the establishment moment for new technologies in the area of communication or information exchange and transfer resulting in filling natural environment with a large number of electromagnetic radiance sources of the frequency 50 Hz and higher.

EM waves do not need any material environment and in absolute vacuum they disperse with the speed ~300.000 km/s. In any other environment, EM wave has lower speed which is caused by the fact that the matter disturbs EM waves dispersal by absorption, hence the statement that living organisms absorb electromagnetic waves.

II. IMPACT OF MAGNETIC FIELDS ON LIVING ORGANISMS

In the case of living organisms, part of the wave energy is absorbed and transformed into other forms of energy. Living

organisms are complex systems which consist of solids and liquids. In large part, they are composed of organic compounds undergoing various rearrangements as a consequence of biochemical reactions. All tissues constituting living organisms present both magnetic and electric qualities.

The character of electromagnetic field influence on living organisms largely depends on the frequency of the field in the range of which they are located. Thermal character evident in temperature rise of an object exposed to such an activity (microwave oven) has a dominant influence in the group of electromagnetic fields of higher frequency (e.g. microwaves range).

At lower frequencies, alternate electromagnetic fields induce current flow through living organisms. Flowing current originates from the vector constituent of current density evoked by alternating electric field as well as from the vector of current density resulting from alternating magnetic field. Integer current will be the total of the two constituents. Besides, due to the influence of external electromagnetic field, the following phenomena can be observed in living organisms: magnetisation, action upon diamagnetic molecules, action upon liquid crystals in organisms, action on water, influence cellular depolarisation, action on piezoelectric and magnetostrictive elements, Lorentz'z force, Zeeman's effect [2].

In view of the above actions, legislators of majority of countries have been introducing regulations aiming at the restriction of human exposure to these fields activity. Unfortunately, postulated legitimate values vary one from another (60-1280 A/m) and in some countries (e.g. Ukraine) they have not been established at all. In Poland, legitimate intensity of magnetic field of grid frequency of 50 Hz amounts to 60 A/m in locations accessible for humans without any time limits [3]. It results from insufficient level of knowledge concerning electromagnetic fields influence on living organisms.

The effects of low frequency alternating magnetic fields action on living organisms depend on the field intensity. For example, magnetic field of induction value over 10 mT located in the head area evokes visual disturbances in the forms of photopsy, scotomy, metamorphopsy. Along with magnetic field induction increase, the symptoms intensify. At the value over 100 mT, temporary blindness takes place which results from alternating magnetic field action on retina. It can be compared with the effect of unarmed eye looking straight on to the intense bright light source. Also, constant magnetic fields do not remain neutral to organism. Very many various biomagnetic reactions (reaction time slow down, encephalographic record alterations) have been observed.

On the other hand, positive aspects of alternating magnetic field action (50 Hz) on human organism have been noted. Some epidemiological surveys reveal that long term stay in a juxtaposition of an electric power transmission can be strictly connected with the increased risk of some kinds of carcinoma e.g. leukaemia. One of the first papers discussing the problem was the article published in 1979 by Werthemeier and Lepper who presented high prevalence of leukaemia in children inhabiting the area near an electric power transmission [10]. In 2002, International Agency for Research on Cancer; IARC ascertained that environmental exposure to the action of magnetic fields of extremely low frequencies (ELF-EMF) can be included into the group of possibly carcinogenic factors and

fig.1. Experimental station DSZ-ML01 designed for in-vitro studies on confocal microscope by Zeiss Meta LSV 510 in current time.

reckoned them to class 2B. Also, constant magnetic field was included to class 3 which defines it as possibly carcinogenic factor [11]. World Health Organization recognized an urgent need for intensive and thorough research project to provide unique scientific explanation of electromagnetic field influence on health.

III. EXPERIMENTAL STATION

So far, probable biophysical mechanism explaining low-alternate magnetic fields influence on living organisms has not been explained. Various methods and experimental objects are searched for to do so. So far recognized research methods are not perfect. However, current time measurements as well as *in-vitro* examinations on cellular level seem very much advanced. So far described experiments are characteristic for very many defects e.g. biological material exposure system which cannot provide the action of homogeneous magnetic field of 50 Hz. It results from e.g. the presence of many ferromagnetic elements in the applied exposure systems which disfigure the field lines course. This brings problems in eliciting repeatable results by other research teams.

This is why, In the Institute of Power Engineering of the Technical University of Wrocław, the trials to solve the problem have been made. Exposure system devoid of earlier defects has been constructed. Prototype DSZ-ML01 of a unique exposure station cooperating with a confocal microscope by Zeiss Meta LSV 510 (fig.1) was built. The system was constructed basing on Hemhotz's tubes system which was localized in juxtaposition of biological material. Special lens (Special ceramic objective for electrophysiologie Plan-APOCHROMAT 63x) by Zeiss was used which did not reveal ferromagnetic features. The exposure station is characteristic for the possibility of generation of homogeneous magnetic field up to the value 10 mT with preserving stable temperature in the conveyed experiments. Currently, the studies are carried on this prototype of experimental station. Influence of 50 Hz magnetic field on free radicals, calcium level, apoptosis, ageing and DNA recombination is being studied.

IV. CONCLUSINS

The results of multidirectional and interdisciplinary studies may be practically applied to economics and medicine. Basic research may help to explain the mechanisms of low-alternate electromagnetic fields influence on living organisms which will enable:

-definition of boundary values of the field intensity significantly influencing physiologic processes of living organisms.

-presenting the proposals for unifying the conditions and methods of magnetic fields exposition useful in environmental and hygienic regulations

-assessment of electromagnetic field 50 Hz influence on living organisms under electric power transmissions and the influence of magnetic constituent 50 Hz in laboratory conditions as well as defining the interdependence between measured physical parameters and they actual action on living organisms.

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