

## «ELECTROMAGNETIC INDUCTOR-BIOLOGICAL ENVIRONMENT» COMBINED SYSTEMS

**Anna Shymanska, Ph.D., Iryna Tymofeieiva, student, Iryna Maliar, student**  
*Igor Sikorsky Kyiv Polytechnic Institute, Department of Electromechanics*

**Introduction.** Wide interest in the study of the magnetic field using problem for the prevention, therapy and rehabilitation of both the human body as a whole, and its individual organs and systems is caused by a number of causes, in particular: the magnetic field passes through the human body virtually unchanged, which allows you to direct and focus it act directly in the place of the required influence; magnetotherapy is a contactless method that extends the limits of its application; the method is maximally physiological, which allows minimizing the side effect; it is easily combined with other methods of physiotherapy. The magnetic properties of individual materials and phenomena of magnetism have been known since ancient times, and at the same time it initiates the use of a magnetic field for the purpose of treatment. Hippocrates, Galen, Avicenna, W. Hilbert had their own recipes for the use of magnets for the treatment of various diseases [1]. Advances in the study of electromagnetism, achieved by H. Oersted, A. Ampere, M. Faraday, and J. Maxwell, significantly influenced the development of magnetotherapy. Today, magnetotherapy is one of the promising methods of treatment, and the development and improvement of magnetic therapy devices is an actual direction of interdisciplinary research, in which it is necessary to apply knowledge in physics, biology, medicine and electromechanics.

**The aim of the work.** The aim of this study is to analyze the principle of the formation of the class of electromagnetic inductors representatives which are used in the apparatus of magnetic therapy, taking into account that the biological element serves as a secondary element of such systems.

**Materials of research.** When using electromagnetic fields for therapeutic purposes other than physical characteristics (tension, induction, flow, magnetic permeability, gradient of intensity, frequency and field shape) it is necessary to take into account also their biotropic properties that determine the primary biologically significant mechanisms of the action of the physical factor on the human body (field intensity, gradient, vector, frequency and shape of the pulse, duration of influence). From a magnetic point of view, the human body is an inert material, since its main component is water. In general, water is a diamagnetic, that is, it is slightly repelled by a magnetic field. Under the action of a magnetic field (MF), the electrons of water molecules can slightly adjust their movement, while creating the MF in the opposite direction and much weaker than the primary field. Among the physicochemical effects of MF influence on a biological object is an orientational reorganization of radicals, hemoglobin, catalase, vitamins and water molecules [1].

An electrically active part of the cells that convert chemical energy to an electrical one is a cell membrane that is an equivalent distributed electric circle in which the charge is redistributed.

Magnetotherapeutic methods affect the body at the submolecular, molecular and subcellular levels. The most susceptible to the influence of MF are the nervous, endocrine, cardiovascular and hematopoietic systems. In the human body there are substances that are part of different structures (oxygen, iron salts, hydroperoxides and radicals) having their own magnetic moment and complexly interact with the external magnetic field, while changing the condition of diseased cells, resulting in therapeutic effect.

In magnetotherapy, there are practically no thermal effects in the tissues of the internal organs, good tolerance for the elderly, patients with cardiovascular diseases and allergies is noted. This allows for the use of magnetotherapy in cases where the effects of other physiotherapy are contraindicated. Magnetotherapy causes the development of nonspecific adaptation reactions that mobilize body reserves to correct livelihoods through appropriate mechanisms of nervous, humoral and immune regulation: improve circulation of blood, thereby increasing its energy performance, which, in turn, leads to stimulation of natural factors protecting the body, contributing to its recovery.

Magnetic fields change the concentration of biologically active substances, enzymes, proteins, nucleic acids, affecting free radicals, which accelerate the aging of cells and their destruction. The action of magnetic fields extends to liquid crystals (cholesterol, lipoproteins) and to metal proteases. The information-energy effect of magnetic influence on biological systems is achieved by improving microcirculation and increasing the permeability of membranes in the zone of influence, increasing the rate of biochemical reactions and metabolic processes, regenerating damaged tissues, stimulating the excitation of neuromuscular processes, reducing edema, reducing the conductivity of nerve fibers .

Magnetotherapy aligns the energy of the body, triggering powerful processes of self-regulation. As a result, stagnant phenomena disappear, blood circulation and metabolism improve. The endocrine system begins to intensively produce a variety of active substances, much more effective than pharmaceuticals. The complex of these reactions helps the body to recover independently. Also, MF is effective in decreasing and eliminating pain, since this involves muscle relaxation, blood circulation and lymph in the microvessels are improved, the output of lactic acid and toxic substances is accelerated, more oxygen and nutrients are injected into the damaged cells.

The questions of research of magnetic therapy and devices for its implementation are mainly concerned with the medical section physiotherapy. In this case, the magnetic field inductors are considered as a source of MF with known characteristics, and qualitative changes in the object of influence of MF are considered as a response of its individual tissues, organs and systems to the effect of external stimulation (Fig. 1, a).

It is possible to correctly determine the limits of structural variability of the studied class only by applying the genetic approach to its analysis. From a genetic point of view, magnetic field inductors in magnetic therapy devices and their object of influence should be considered as a complex complex system with heterogeneous

components "Electromagnetic inductor-biological environment", which functions as a complex unit (Fig. 1, b).

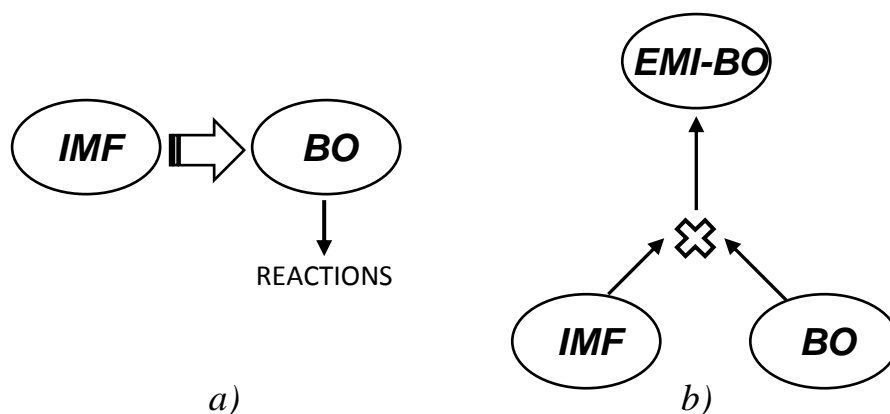


Figure 1 – Interaction of the inductor of magnetic field (IMF) with a biological object (BO): a) traditional way of presentation; b) the combination of subsystems of different genetic nature in a complex system.

In terms of the theory of the genetic approach to the structural organization of complex systems, the basis of which was developed and tested on the Igor Sikorsky KPI Electromechanics Department, combined systems that is the systems which combine the original structures of different genetic nature, while retaining the structure and functions inherent in each of the subsystems [2].

The interdisciplinarity of the genetic approach to the analysis of classes of complex combined systems with components of different genetic nature [3] allows us to apply the proposed and tested earlier methods of directed structural synthesis and system analysis in determining the structural potential of the genetically permissible diversity of the class "Electromagnetic inductor-biological environment".

**Conclusions.** Magnetotherapy is an effective and promising physiotherapy with minimal side effects, however, the results of generalized research on the structural diversity of inductors for the respective devices have not been revealed. Magnetic field inductors in magnetic therapy devices and their object of influence should be considered as a complex complex system with heterogeneous components "Electromagnetic inductor-biological environment", which functions as a unit, and to determine the structural potential of genetically acceptable class diversity it is expedient to apply proposed and tested earlier methods of directed structural synthesis and system analysis of classes of complex combined systems with components of different genetic nature.

#### References

1. Улащик В. В. Магнитотерапия: теоретические основы и практическое применение / В. С. Улащик и др. - Минск: Беларуская наука, 2015. – 379 с.
2. Шинкаренко В.Ф. Словник із структурної і генетичної електромеханіки / В.Ф. Шинкаренко, А.А. Шиманська. – К.: НТУУ «КПІ», 2015. – 112 с.
3. Шинкаренко В.Ф. Розпізнавання генетичних програм функціонального класу складних електромеханічних систем за інформацією його довільного представника / В.Ф. Шинкаренко, Ю.В. Гайдаєнко, Л.М. Кобзенко, П.В. Отрішко // Електромеханічні і енергозберігаючі системи, № 1, 2014. – С. 57 – 65.