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THERMAL IMPACT OF ELECTROMAGNETIC WAVES ON HUMAN SKIN

In modern world a person is exposed to intense impact of high-frequency electromagnetic waves. The sources of electromagnetic interference are household items: mobile communication, radiotelephony, and also industrial facilities: radio repeaters, high-performance radios, radars, power lines, etc. The question arises whether these radiation sources are safe, and if there is danger, then what is it? This study can reveal only one part of the question, namely, what the thermal effect of electromagnetic disturbance on human skin is.

In this regard, we consider normal incidence of an electromagnetic wave (EMW) with the frequency f and an average power flow density π on human skin. We have to determine a mathematical model of human skin and find the distribution of the electric field E, the average power of absorbed heat loss P_{ios} and temperature T in the skin.

Nowadays there are very few devices that could explore the propagation of electromagnetic fields in human skin. It is still more difficult to study the distribution of thermal structures caused by the occurrence of an electromagnetic field through the skin. In most cases these devices are not precise and very complex in their construction. Thus, researches carried out by means of such devices are characterized by lots of deviations. These methods of work can cause some complications in subsequent studies. Let us consider various models of thermal imagers. These devices have a number of features of its own. If we want to explore a small area of skin with the help of a thermal imager we will face two major problems: large distortion in the results and a high price of materials for the device designing. So, we can assume that practical research of thermal effects of electromagnetic fields on human skin is not beneficial. That is why we can rely on studies using theoretical calculations.

For theoretical calculations of the electromagnetic field passing through the human skin, we need to build a model of an experimental object. First, we analyze the object, and then we determine the characteristics of its elements. Afterwards we make a functional model based on known characteristics.

The skin is represented as a layered structure that has five layers: the stratum, the epidermis, dermis, hypodermis and muscles. Each of the skin layers has its own dielectric constant and thickness. These values for each layer are known in advance and in almost all normal cases are the same. That is why we will simply use ready results. As a result, we get a general model of human skin, which we can use for further research.

In most cases of SHF and EHF radiation in biology and medicine the object is located in close proximity, and occasionally in direct contact with the source of radiation, i.e. in the antenna Fresnel zone. In this case, the Gauss - Hermite beams of zero order describe the fields with a high degree of precision.

Even if the beam aperture is equal to the beam wavelength, transverse field distribution can be considered the same, which is typical for regular transmission lines. Thus, to find the distribution of the complex amplitude of the electric field È each layer can be represented as an equivalent segment of a regular transmission line. Taking into account these considerations, we will continue our research.

Knowing heat losses distribution, solving stationary inhomogeneous heat equation, we can determine the temperature distribution in human skin. Numerical solution of this equation is not difficult. However, it makes sense to simplify the task in order to get an overview of the temperature distribution in the skin. We assume that the temperature distribution is uniform over the cross section of the beam of electromagnetic waves. This is even more true to fact the higher the ratio of the transverse heat conductivity is. The latter, probably, is higher due to blood flow.

The proposed method of calculation allows us to investigate the skin properties in a wide range of parameters. However, one must keep in mind the following: the nature of frequency dependence is determined by thickness of skin layers, values of their permittivity and conductivity. Our work can be of great benefit to the study of thermal effects on human skin caused by devices that radiate electromagnetic waves.