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# ELECTROMAGNETIC RADIATION ABSORBERS BASED ON AN AQUEOUS SOLUTIONS

***Introduction***

In recent years, the level of electromagnetic pollution has increased significantly. New sources of electromagnetic pollution have been added to natural background radio radiation: cellular and satellite communications, navigation and radar systems, radio installations, household and medical radio equipment, etc. Long-term and regular exposure to electromagnetic radiation (EMR) on the human body has a negative impact on the brain, blood vessels, blood, lymph nodes, vision, provokes the formation of tumors, etc. Without ensuring a safe level of EMR, such equipment is harmful to human health. One way to reduce the level of electromagnetic impact on biological objects is the use of radio-absorbing materials (RAMs). A promising approach is to use materials containing water or aqueous solutions of organic and inorganic compounds (salts, glycerin, alcohols, etc.) [1]. Water is a natural absorber of electromagnetic wave energy in a wide range of frequencies [2, 3].

***Goal***

Develop heterogeneous polymer RAMs containing water or aqueous solutions of organic and inorganic compounds. Study the mechanisms of EMR energy absorption by water-containing composites.

***Material and methods of research***

The objects of the study were sheet composite RAMs based on polyethylene (PE, GOST 16803–070). Sodium chloride was used as a filler. Samples were formed by thermal pressing on a hydraulic press with electrically heated plates at a temperature of 170 °C and a pressure of 10–12 MPa. The thickness of the samples was 3 mm. The filler concentration varied from 1 to 20 mass %. The experimental samples (separately) were kept in vessels with distilled water for 10 days, during which time the processes of water molecules diffusion into the structure of the polymer composite, sodium chloride dissolution, «washing out» of the salt from the polymer matrix, and filling the resulting pores with water occurred. Thus, water-containing composite materials with different water phase contents were obtained.

Using an R2–61 panoramic meter, the attenuation of EMR energy by water-containing composites was measured in the frequency range from 8 to 12 GHz. The experimental setup is shown in Figure 1, where 1 is the SHF-generator; 2 are the connecting cables; 3 is the energy attenuation indicator; 4 and 5 are the transmitted and incident wave detectors; 6 is the matched load; 7 is the RAM sample under study; 8 is the waveguide; 9 is the co-axial-waveguide junction.

***The results of the research and their discussion***

The ability of a material to absorb electromagnetic radiation depends on its electrical and magnetic properties. The most informative characteristics of a medium's response to an external electromagnetic field are frequency dispersions.

Complex quantities of permittivity and magnetic permeability, as well as the tangents of the dielectric and magnetic loss angles. Water is a dielectric, and therefore, dielectric losses are most pronounced when electromagnetic radiation interacts with water. Dielectric losses are caused by the inertia of the polarization of the substance's components. They are relaxation-related in nature.

The presence of phase differences and leads to dielectric losses and, ultimately, to the absorption of electromagnetic radiation energy.

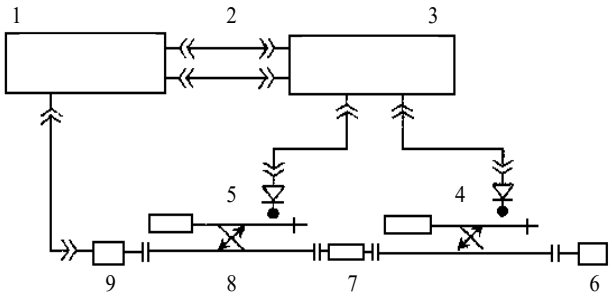



*Figure 1 – Schematic diagram of the setup for measuring the attenuation of EMR energy passing through a substance*

The results of measuring the attenuation of EMR energy by experimental water-containing samples in a waveguide line in the range of 8–12 GHz are presented in Table 1.

Table 1 – Attenuation of EMR energy (dB) by water-containing samples of different concentrations (from 1 to 20 mass %) in the frequency range from 8 to 12 GHz

| Water concentration, mass % | Frequency, GHz | | | | |
|---|---|---|---|---|---|
| | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 |
| 0 | 0.15 | 0.17 | 0.20 | 0.18 | 0.20 |
| 1 | 1.0 | 1.15 | 1.20 | 1.25 | 1.25 |
| 5 | 2.7 | 2.85 | 3.0 | 3.15 | 3.2 |
| 10 | 5.2 | 5.25 | 5.3 | 5.4 | 5.6 |
| 15 | 6.6 | 6.8 | 6.95 | 7.1 | 7.3 |
| 20 | 5.0 | 5.1 | 5.25 | 5.3 | 5.4 |

The obtained data show that the highest efficiency in terms of EMR energy attenuation in the frequency range from 8 to 12 GHz was demonstrated by samples with an initial sodium chloride filling of the polymer matrix of 15 mass %. Dissolution of the salt and its subsequent replacement with water led to a significant reduction in the EMR energy transmitted through the sample. Further increases in the filling level led to a sharp decrease in the mechanical strength properties of the composite, as well as a loss of integrity and sealing of the pores formed in the polymer matrix during the leaching of the salt.

***Conclusions***

A method for producing polymeric water-containing RAMs has been developed. The mechanisms of EMR energy absorption by water-containing composites have been studied. The optimal concentration of the aqueous phase (15 mass %) in the polymer matrix has been determined, providing significant attenuation of EMR energy passing through the composite (from 6.6 to 7.3 dB) in the frequency range of 8–12 GHz.

**LITERATURE**

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