THE RADIOWAVE PARAMETERS OF THE SPREAD MEDIA WITHIN SOUNDIND FREQUENCY BAND OF ULTRA WIDE BAND RADAR

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Abstract. *The results of experimental researches of the radiowave characteristics of ground-soils from various territories of former USSR are analyzed. The schedules of radiowave parameter dependence of some ground-soils from moisture and frequency are resulted. The results of researches can be used for the data decoding of radio-physical sounding subsurface media.*

The modern remote methods of radio-physical sounding and monitoring of a physical condition of terrestrial spread surface (ground-soils and water media) are based on the use of experimental data and physicis-mathematical models, allowing to connect data of remote measurements with the radiowave characteristics (ε, tgδ, σ) of spread media.

The offered method of sounding is based on the analysis of the investigation media and object reaction on pulsing ultra wide band (UWB) electromagnetic radiation. In general case the spectrum of ultra wide band electromagnetic radiation includes frequencies up to hundreds megahertz or one-tens GHz, therefore its influence causes arising of practically all probable types of own fluctuations of object and media. It essentially increases informing of radar diagnostics and control of infringements in natural and technical media, for example, spread of poisonous and polluting liquid components, petroleum, industrial sewers etc.

The development of methods of interpretation UWB data sounding with the purpose of determination of a condition of the spread surface and control of objects located in sub-surface media requires knowledge of processes occurring at interaction of electromagnetic waves with media. Sounding media: ground-soils, building materials, the geo-genetic complexes of rocks and carbons represents the complex substances, which complex dielectric permeability $\varepsilon=\varepsilon_1-i\varepsilon_2$ is various, because of it is complex function as the media material, electromagnetic field frequency, density, porosity, moisture, temperatures. The exactly physicist-mathematical model, allowing to connect and to calculate influence all factors listed above on ε does not exist, because of complexity and variety of properties of mentioned media. The data about o ε of media can be received or experimentally, or using approximate theoretical models, allowing to calculate ε in such media.

Terrestrial surface represents a complex layered structure, in general case the top layer takes ground, and below clayey, or sandy soil. The turf ground are the most representative on the Earth. So on classification, offered in [1], zonal soil is totally eight, from which turf ground, including in self the marshy ground, will form a zone and take a large part of Russian territory (over 50% territory of former USSR). Electro-physical characteristics (ε, tgδ, σ) of such ground-soil has frequency and thermo-moisture dependence, that present a subject for engineering and theoretical researches.

At present there is no uniform opinion about variation ε, tgδ and σ depending on a type ground-soils in the literature, devoted of investigations of dielectric properties of terrestrial surface.

Turf ground, sandy and clayey soils, collected from territories of Far East, Zabaikalie, Western Siberia, Kazakhstan, European part of Russia for experimental researches of dielectric properties, are differed on a chemical and mechanical structure. Results of measurements of ε', ε'', tgδ have shown, that the real part of dielectric permeability (ε') of all studied ground-soils with various moisture and regardless of the kind of soil has not in the given range of the frequency dispersion.

On fig. 1 average on frequencies (10^7 - $5*10^9$ Hz) values ε' of various turf ground, sandy and clayey soils depending on volumetric concentration of moisture are indicated.

The frequency characteristics of radiowave parameters ε', tgδ at all investigated ground-soil in a frequency band (10^7 - $5*10^9$ Hz) have general character. It is discovered, that the frequency dependencies are determined by moisture content in ground-soil and availability of salts. At the dry ground-soil the frequency dispersion ε', tgδ in a given frequency band is absent. With increasing of volumetric contents of water (X>0.02) in ground-soil samples the value ε' (fig. 1) is grows, but dispersions up to $5*10^9$ Hz is not found out.

On fig. 2-4 the schedules of ε', tgδ dependencies from the logarithm of frequency (lg f) for turf soil, sand, clays are described. From schedules it is visible, that the behavior of dependencies of the real part of dielectric permeability is equally, the frequency dispersion ε' for various values of the contents of water in soils is absent.

For dry ground-soil the tgδ also has no frequency dispersion for all researched ground-soils. For the humid ground-soils the character of tgδ behavior is similar, and the difference is observed only on value depending on a ground-soil type. For humid ground-soil the tgδ in the high-frequency band of spectrum does not depend from soil. In the in comparised low-frequency band (10^7 - 10^8) Hz the UHF absorption by molecules of free water does not introduce the essential losses, but decreasing character of dependence tgδ of humid ground-soil is connected to

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influence of through conductivity, stipulated by salt ions, dissolved from ground-soil. And than higher the volumetric contents of water, that is more dissolved salts and, hence, through conductivity is increased, that results to increase of the tgδ values. For the benefit of it the fact of large tgδ value of ground-soil, with large value of conductivity (fig. 5) is confirmed. It results to the growing of tgδ with increase of volumetric moisture on any fixed frequency. With increase of frequency the tgδ, stipulated through conductivity should decrease [2], as observed on the schedules (fig. 2-4).

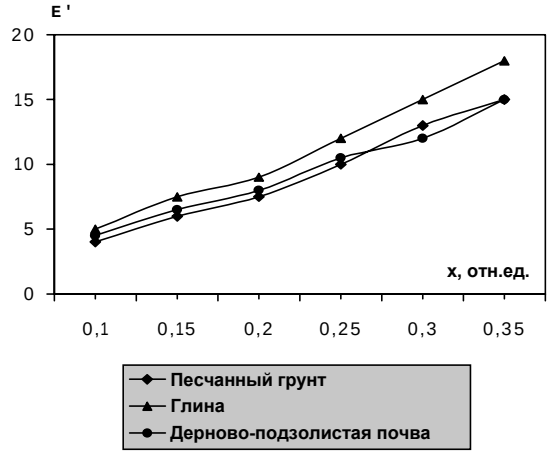

Fig. 1. Dependence of the real part of dielectric permeability for some ground-soils from volumetric concentration (X) of water

Fig. 5 The dependence TGδ from the volumetric contents of a water measured on the frequency $4*10^8$ Hz in various ground-soil.

It is necessary to note, that all above said about radiowave Parametersε', ε", tgδ of humid sub-shallow media concerns to uniform distribution of moisture and temperature in them.

The received experimental data about frequency and moisture dependencies of radiowave parameters of spread media will be used for decoding of sounding data, received by means of video pulse subsurface radar.

References

1. "Soil science". Ed. E.M. Sergeev, Moscow, MGU, 1983, 392 p. (in Russian).
2. A.R. Hippel, "Dielectrics and waves", Moscow, 1960, 438 p. (in Russian).

Fig. 2 Fig. 3 Fig. 4