DIELECTRIC PARAMETERS OF SOILS AS FUNCTION OF FREQUENCY

Valéria Nagy, Róbertné Kovács

University of Szeged, Faculty of Engineering, Department of Mechanical Engineering
H-6725 Szeged (Hungary), Moszkvai Bld. 9.

valinagy78@mk.u-szeged.hu; veszelov@mk.u-szeged.hu

ABSTRACT

Engineering applications may include such investigations, which play important role in the innovative agriculture. Investigations have to be carried out to isolate the effects of specific characteristics through laboratory and field experiments. The most important soil characteristics are moisture content, salinity, organic matter content, bulk density, texture and structure. Of course, these parameters can be measured using conventional techniques, too. One relatively recent innovation in soil investigations is utilising electromagnetic methods (electromagnetic waves) to measure soil parameters. Dielectric characteristics of soils can be evaluated from both an agricultural and a technical perspective. Undoubtedly, the most significant and easiest to isolate is soil moisture. Dielectric test method can be potentially utilised in agricultural researches. Furthermore, technical education, research, development and innovation provide opportunities for resilience and reinvention.

This paper presents how the dielectric parameters of soils characterize and describe the properties of soils, evaluate the effects of soil properties on microwave complex dielectric constants and contains a dielectric model. Relationships between the dielectric parameters and moisture are the basis for the microwave sensing of soil moisture. Open-circuit coaxial transmission-line method was used to determine the electromagnetic (dielectric) parameters of different soil types (different texture and moisture) as function of frequency. The measurements were carried out in the microwave frequency range between 200 and 2400 MHz. Measurements were made with DAK 3.5 dielectric measuring system.

Dielectric measurements were help to evaluate the dependence of the dielectric constant. The results show the relationship between soils physical parameters and their electrical properties (dielectric parameters). The effects of dry density or degree of compaction on the dielectric constant of different soil types (ranging from sand to bentonitic clay) must be experimentally investigated and evaluated. There are significant variations for the real part and large variations for the imaginary part of dielectric constant among soils in the test frequencies ranging from 200 to 2400 MHz. The real part of the dielectric constant for high-moisture cases correlate energy store of electric field and the imaginary part for all soils correlate the extent of electrical energy converted to heat and characterize moisture conditions. The new models can be used for soils with similar characteristics.

Soil characterisation, soil fundamental parameters such as water content and density are usually required to be measured and monitored continuously to ensure successful agricultural activity. A review of the results of this paper shows an alternative way of measuring soil water content and density in agricultural discipline. The effects of dry density on the soil dielectric constant depend on the soil type. In addition, microwave measurements should be supplemented and supported by experimental observations and agricultural field work. These results can be used as a database for future in agricultural investigations and interdisciplinary researches.

In addition to technological impact assessments, ecological impact assessments should not be neglected in the course of engineering activities.

Keywords: soil, microwave, dielectric parameters, innovation