BASED FREE-SPACE MICROWAVE MEASUREMENT SYSTEM (FMMS) FOR PERMITTIVITY DETERMINATION OF PLAIN WATER APPROACH AT 18 GHZ TO 26 GHZ FREQUENCY RANGE (K BAND)

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ABSTRACT

Free-space microwave measurement system (FMMS) using microwave non-destructive testing (MNDT) method involves measurement of reflection (S_{11}) and transmission (S_{21}) coefficients in free-space. MNDT is a method that determining the material characteristics without permanently changing its properties. The main objective of this project is to characterize the complex permittivity, loss factor and loss tangent of three types or samples of plain water which are piped water, reverse-osmosis (RO) water and mineral water. The samples were measured by using FMMS equipment via the method of MNDT at frequency 18 GHz to 26 GHz (K band). In order to measure all the characteristics, the reflection (S_{11}) and transmission (S_{21}) coefficients parameters was executed using FORTRAN software. The results are obtained in the range of frequency 19.18 GHz – 25.9 GHz only. From the result obtained, the mineral water show the average highest measured of complex permittivity than the piped and RO water which is close to the measured reported data complex permittivity of 80 at 20°C [7]. For the three types of plain water, the difference in complex permittivity can be observed at higher frequency.

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CHAPTER 1

INTRODUCTION

Microwave nondestructive testing is the method that used for measuring the electromagnetic properties of the materials. It can be performed in many ways such as free space and rectangular or coaxial waveguide. Nondestructive testing can be described as the testing method that the material under the test is not destroyed or permanently changing its properties. The material under the test is tested in order to determine their characteristics. There are many application of microwave testing that can classify as non destructive testing.

The microwave non-destructive testing methods are also widely used for geometrical sized and quality control of different material such as liquids, polymers, fiberglass, ceramics, water etc. The control maybe performed either during the fabrication of product with a view to change some technological parameters or other after the fabrication with view to reject bad quality of product. Microwave radiations are highly directive and because any of the short wavelengths involved, the devices used often very compact. While many applications are in high power communication and radar system, low power applications are just as common. The choice of microwave is wide and includes low power solids-state devices.

In order to evaluate these kinds of materials, free space method has been used because it is more precise, accurate and reproducible MNDT measurements on materials under high or low temperature conditions due to contactless feature of the measurements. Another significant advantage of free space methods is that the measurements can be made when incident, reflected and transmitted signals are circularly/elliptically polarized electromagnetic waves. The electromagnetic properties that can be measured by using the free space methods are complex permittivity and permeability, reflection coefficients, transmission coefficients and etc.