Measurement and Simulation of Microwave Absorber from Burned Rice Husk

By Basuki Rahmat

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Mohammad Basuki Rahmat, Afif Zuhri Arfianto
Dept. of Ships Electrical Engineering
Shipbuilding Institute of Polytechnic
Surabaya, Indonesia
mbasuki.rahmat@gmail.com

Eko Setijadi, Ahmad Mauludiyanto
Dept. of Electrical Engineering
Institut Teknologi Sepuluh Nopember
Surabaya, Indonesia
ekoset@ee.its.ac.id

Valian Yoga Pudya Ardhana
Faculty of Science and Technology
Universitas Qamarul Huda Badaruddin
Lombok Tengah, Indonesia
valianypa81@gmail.com

***Abstract*—Burned rice husk is produced from the rice husk which is processed using a certain method to produce burned rice husk. The process of changing the rice husk into burned rice husk is aimed to increase the carbon content. With the increase in carbon content, the ability to absorb the micro wave increases. We choose the rice husk material because Indonesia produces 15 tons of rice husks for every rice harvest annually. Therefore, it is possible to explore the potential of rice husk and/or burned rice husk into a microwave absorber material.**

The material containing carbon is chosen because carbon can cause the material to become a good conductor, with low density, and low elasticity. This characteristic causes the rice husk to influence the reflection and absorption of waves. In addition, carbon also functions as a resistive material that converts the current into heat and evenly spreads around it. The assessment of rice husk as an absorber has been conducted and resulted in a conclusion that the rice husk serves as a good absorber of micro wave. With higher carbon content, it enables the burned rice husks to have much better absorber ability than the rice husk.

This paper presents the measurement and simulation of burned rice husk material as microwave absorber. By comparing the ability of rice husk and burned rice husks, it is concluded that burned rice husk hasbetter ability to absorb.

Keywords—technical english, android application, polytechnic students

I. Introduction

Absorber is a material that can absorb micro wave energy. Micro wave lies within the frequency range of 300 MHz to 300 GHz [1] .The nature of micro wave is to penetrate the material, to reflect or to be absorbed by the material[2]. Micro wave is further forwarded via plastic material, glass, ceramic. Micro wave is absorbed by water and food. Therefore, the principle of self-heating is widely used in water and food using micro wave with microwave oven appliance[3]. On the other hand, the metal material will reflect the micro wave.

The materials like polystyerene or polyurethane are not environment friendly. So, alternative agricultural materials like banana leaves, coco peat, coconut shell powder, Rice husk etc. are used. Burned rice husk are utilized as a microwave absorber for its carbon content. Carbon is an important element which assists the absorption process of microwave because it has resistive nature so that it changes the flow into heat energy and removes heat in its surrounding

The applications of absorber are numerous, among others, as a radar signal-absorbing material, to make an anechoic chamber, as well as a solution to reduce electromagnetic interferenc [4]. The ability to absorb waves is influenced by the dielectric constant value of the material. The higher the constant value of dielectric material, therefore the better the material ability to absorb micro wave[5]. There are a lot of methods to find out dielectricity characteristic of the material, e.g. Perturbation Technique, Transmission Line Technique, Resonator and Transmission line, open-ended probe technique, TDR (reflectometry) method and Free-space Transmission Technique[6]. Measurement of the dielectric characteristic serves a factor to define the physical characteristic and chemical property which are closely related to the ability to store energy and energy losses [7].

The dielectric property (permittivity) may be defined as a measure of material polarization when it receives an electric field. Permittivity is expressed as follows [6]:

$$K=\varepsilon/\varepsilon_0=\varepsilon_r=\varepsilon_r'-j\varepsilon_r'' \quad (1)$$

Where K is a free permittivity space (dielectric constant). Permitivity (Ɛ) is a dielectric constant. It states the interaction between material and electric field. The dielectric constant is equivalent to the relative permittivity (Ɛr) or equivalent to the ratio of absolute permittivity (Ɛ) with free space permittivity($Ɛ_0$).The real part of permittivity (ε_r') represents the measure of how much energy the outer field is stored in the material. And the imaginary part ($j\varepsilon_r''$) is expressed as a loss factor i.e. a measurement of the size of dissipation or loss of material occurs.

The absolute permittivity value of vacuum space ($Ɛ_0$) is determined under the formula of :

$$C_0 \mu_0 \varepsilon_0 = 1 \quad (2)$$

Where: C_0 = light speed
μ_0 = magnetic constant

Tests were carried out to determine the value of dielectric constant of burned rice husks. The performance of materials in absorbing microwaves was tested at a frequency of 2 GHz 4 GHz with a free space measurement method to obtain a loss reflection value. this value is then used to calculate the dielectric constant. [8] [9].

II. Materials And Methods

The measurement method used is illustrated in the following figure[10] :

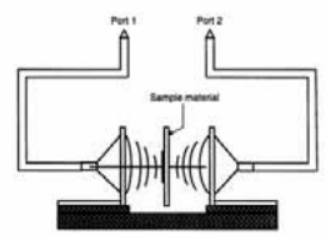

Figure 1. Free-space transmission technique

In the picture, there are two ports. port 1 and port 2. Both ports are ports of the Networ Vector Analyzer. Port 1, is the 1st port of the Vector Network Analyzer (VNA) which is connected to the horn antenna as a transmitter. And port 2, is the 2nd port of the VNA connected to the horn antenna that serves as the receiver. The tools needed to conduct the test are (1) Vector Network Analyzer, this experiment uses Anritsu VNA Master, Model: MS2034B, (2) absorber retainer, (3) two horn antennas. As shown in the figure, the absorber which acts as the under-test material (MUT) is placed between the two antennas that serves as the transmitter and receiver[1]. The antenna used is shown in figure2. Specification of antenna dimension is 24.5 cm (length) x 14 cm (width), with the operation working capacity at a frequency of 1 GHz to 18 GHz. The dimension of absorber is 30 cm x 30 cm x 1 cm.

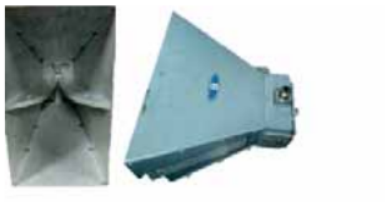

Figure 2 Horn Antenna

The VNA, the network analyzer used in the experiment is shown in figure 3.

Figure 3 VNA Network Analyzer

The absorbent material (MUT) is burne rice husk. There are two MUTs used. One is unrefined rice husk. the other is the original burned rice husk which is pureed first. The MUT image is shown in Figure 4. Furthermore, the measurement starts to get the S11 and S21 values.

Figure 4 Burned rice husk

The absorber (MUT) is placed between 2 horn antennas, as shown below:

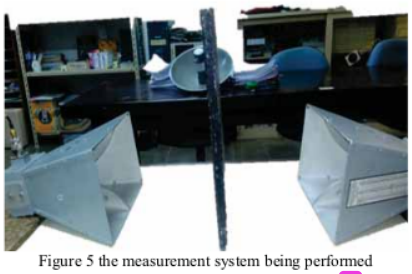

Figure 5 the measurement system being performed

Board absorber is placed perpendicular to the base and sustained with a retainer. The retainer serves to prevent the sample from falling.Without a retainer, the position of MUT will change. This may result in inaccuracy in measurement. MUT is placed between the transmitter and receiver antennas. The distance between the antenna and the MUT is adjusted by calculating the far field from the antenna. The formula used is [8]:

$$R_{far\text{-}field} = \frac{2D^2}{\lambda} \quad (3)$$

where D is the largest dimension measured by the size of the diagonal antenna. The horn antenna used is 24.5 cm long and 14 cm wide. Thus the value of D can be measured by the following formula:

$$D = \sqrt{24.5^2 + 14^2} = 28.22 \text{ cm} \quad (4)$$

λ means size and minimum and maximum.

$$\lambda_{max} = \frac{c}{f_{min}} = 30 \text{ cm}, \quad (5)$$

$$\lambda_{min} = \frac{c}{f_{max}} = 7.5 \text{ cm} \quad (6)$$

Thus, the value of a distant radiation field can be determined as follows:

$$R_{far\text{-}field\ (Min)} = \frac{2D^2}{\lambda_{max}} = 53.02 \text{ cm} \quad (7)$$

$$R_{far\text{-}field\ (Max)} = \frac{2D^2}{\lambda_{min}} = 114.3 \text{ cm} \quad (8)$$

III. SIMULATIONS

A. Simulation

Simulation is conducted by using Computer Simulation Technology (CST). The measurement method is re-modeled in this software by adjusting the dimension of the absorber board. Micro waves are generated through the horn port, thus scattering parameters (s11 and s21) will be obtained. The parameters required for this simulation are the dielectric constant value of the material (calculated through a calculation after obtaining s-parameters from the VNA), the frequency range used, and the actual dimension of specimen.

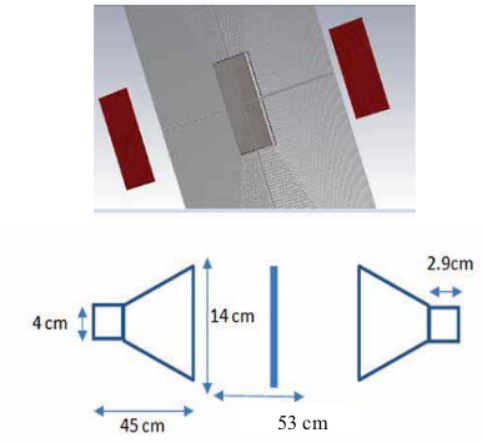

Figure 6. Simulation of free space technique system in CST

B. Discussion

This experiment conducted several variation of absorber material as a MUT. The first was with the non-sieved burned rice husk. The second was the burned rice husk was grounded and sieved to obtain burned rice husk powder. Both boards were made using a mixture of 157BQTN resin and rice husk with a ratio of 1: 1. This means that 1 kg of rice husk was mixed with 1 kg of resin. The result of MUT measurement in S11 and S21 value is illustrated in the following graph.

The Fig. 7 shows that the crucial value is at the frequency of 2.14 GHz, 2.81 GHz, 3.47 GHz. At frequency of 2.14, it appears that the sieved burned rice husk has a reflective characteristic and forwards the signal better. This clearly shows that the subtlety of the material influences the value of S11 and S21.It means that the smoother the material, the better the damping characteristic. The damping percentage on sieved burned rice husk absorber and non-sieved burned rice husk is shown in the following graph. this is shown in figure 8

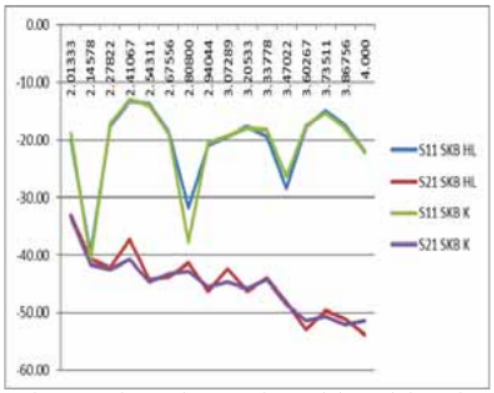

Figure 7. Graph S11 and S21 Smooth Grounded Burned Rice Husk (sieved) and coarse rice husk (original).

Figure 8. Graph of Absorber Damping percentage of Burned rice husk.

IV. CONCLUSION

The free space technique method is suitable to determine the value of dielectric material. Burned rice husk has a high dielectric value. Therefore, it can absorb more electromagnetic wave signals. The treatment of burned rice husk before serving as an absorber has a significant impact. The smoother the burned rice husk, the higher the percentage of damping.

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