Analysis of Different Absorbers used in Designing of an Anechoic Chamber

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Abstract: *The need for indoor testing of electromagnetic radiating devices has led to a number of companies providing chambers and absorber products supporting a range of electromagnetic testing requirements. This paper mainly focuses on the study of low-cost RF anechoic chamber having different absorber products like plain sheets, tapered sheets, bio-materials to compare the results with the industrial graded anechoic chamber. Different materials would produce varying results which would help us to identify and choose the accurate and precise absorber. This comparative study will help institutions, organizations to choose suitable radar absorbing materials for fabrication of low-cost RF anechoic chambers.*

Key Words: **Absorbers, Radio, Chamber, Microwave, Telecommunication, Reflections**

1. INTRODUCTION

The increasing growth of the telecommunication and RF industry led to manufacturing more anechoic chambers. An anechoic chamber is a test facility which uses absorbing material along its wall, ceiling and floor to create an electromagnetically quiet environment. The instruments or devices are needed to be tested without being affected by the wave reflections. The interior surfaces of the RF anechoic chamber are covered with radiation absorbent material (RAM). While designing an anechoic chamber, we consider three important features. These features are the shape, the size of the enclosure, the absorber and how the absorbers are assembled. Absorbers are one of the main components in an anechoic chamber and used to eliminate reflected signals. Electromagnetic absorbing materials are very important to ensure the accuracy of RF anechoic chamber testing performances. There are many enhanced absorber technologies available in the market. There are many shapes that can be fabricated as an absorber such as pyramidal, truncated pyramidal, wedge, convoluted, hybrid, flat and honeycomb absorbers. Microwave absorbing materials that are used in the anechoic chamber can reduce reflections of high-frequency energies. The microwave absorbers in this frequency range are used in many applications such as telecommunication, military, high-speed electronics and automotive.

2. Absorbers Characteristics

Every absorbing material has its own characteristics which give different results when they are implemented in an anechoic chamber depending upon the parameters like frequency, losses, input and output power etc. Different absorber materials are used for the microwave range (1GHz to 40GHz) and for the low-frequency range (30MHz to 1000MHz), respectively. The most common material used for the low-frequency range (30MHz to 1000MHz) absorber is the ferrite tiles, an electrically-thin absorber material. Ferrite tiles have also been widely used in many EMC test chambers. In the microwave frequency range (1GHz to 40GHz), foam materials such as polyurethane and polystyrene are widely used as the microwave absorber. The microwave signal is reflected and absorbed in the anechoic chamber. A proper model of RF microwave absorber must be developed based on various parameters such as the absorber reflection loss, the magnitude and phase, for various angles of incidence. The dielectric constant of a material affects the velocity of microwave signals when it moves through the material. A larger value of dielectric constant results in the microwave signals to travel at slower velocities. A larger dielectric constant material results in a denser material.

2.1 Polyurethane Characteristics

The polyurethane foams are used as insulating and core materials for furniture, cooling and freezing systems, in housebuilding, shipbuilding etc. It is extensively used in an anechoic chamber. The use of rigid foams results from their low heat conduction coefficient, low density, low water absorption, relatively good mechanical strength.

2.2 Ferrite tile characteristics

Ferrite tiles, flexible absorber sheets and pyramidal absorbers are made for absorbing electromagnetic radiation. Ferrite tiles and pyramidal absorbers, for example, are used to create anechoic chambers or boxes. Flexible absorber sheets are generally used to absorb radiation at the radiation source in electronics enclosures. Microwave absorber foam can be used at higher frequencies than traditional shielding and can also be used with other EMI/RFI shields to extend the frequency range.

It is well known that minute air gaps between ferrite tiles reduce absorption of ferrite absorber, and the Square Coax is able to evaluate the reflection of ferrite tiles including the air gaps.

2.3 Dielectric absorbers

Dielectric absorbers have no magnetic properties (i.e. $\mu=1$). The loss mechanism is purely dielectric. The loss can arise from a variety of sources within the dielectric. Dielectric absorbers are usually made in a low-cost foam form but can also be used with elastomers. Advantages are low cost and weight. Disadvantages are higher conductivity preventing usage in contact with electronic equipment and their lack of performance in most cavity resonance applications due to their lack of magnetic absorption.

3. Specifications of an anechoic chamber

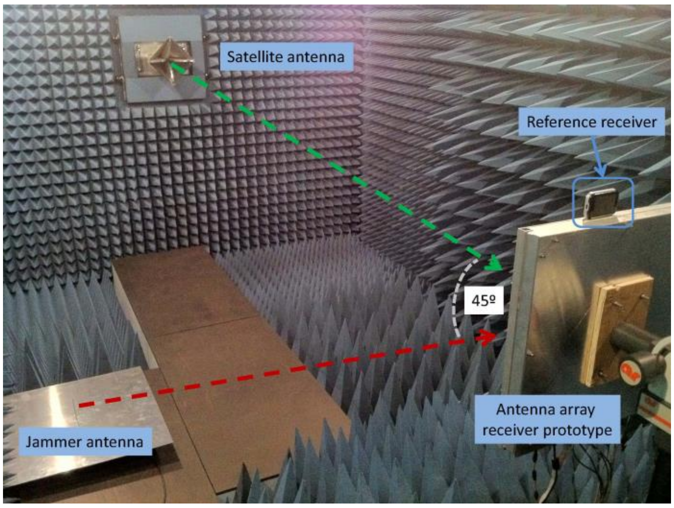

Fig-1: Anechoic Chamber Internal Setup

Dimension: 2m (L) x 1m (W) x 1m (H)
Frequency Range: 1Ghz-10Ghz
Site Attenuation less than ±4dB
Test Distance: 1m

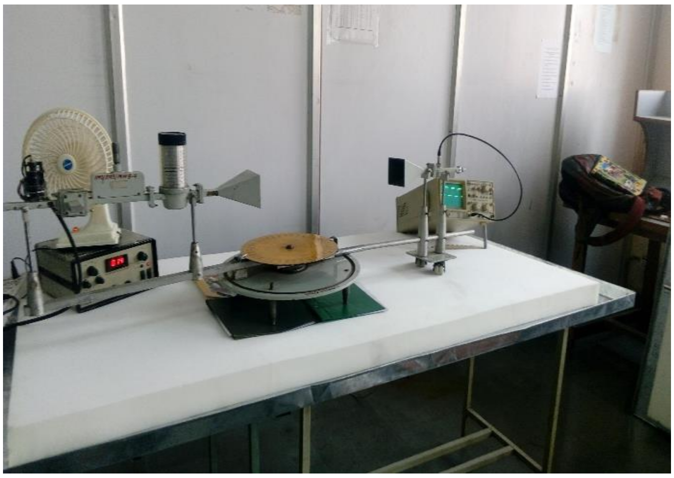

Fig-2: Transmitter-Receiver Setup

3.1 PU Foam as an absorbing material

We have used plain sheets of PU Foam which utilizes a lining of absorbing material along its wall, ceiling and floor to create an electromagnetically quiet environment.

3.2 Metamaterial-based RF Absorber

The metamaterial perfect absorber (MPA) – has been effective due to the fact that it can achieve complete absorption of electromagnetic waves.

4. Radiation Pattern and Tabulated Results For PU Foam

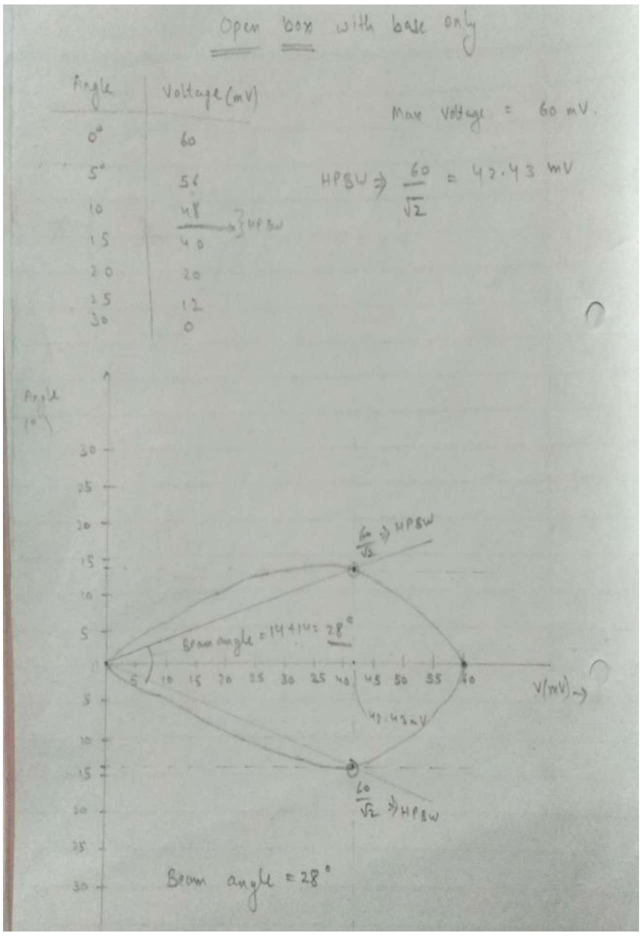

Fig-3: Open Box with Base Only

Table-1: (With Base Only)

Angle (ϴ)	Voltage(mV)
0	60
5	56
10	48
15	40
20	20
25	12
30	0

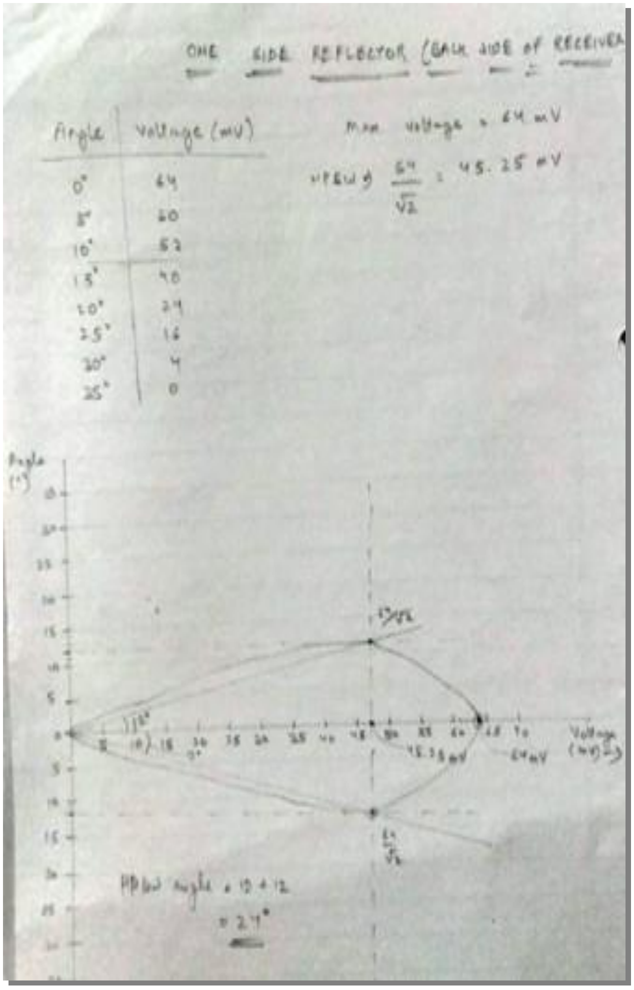

Fig-4: Reflector at Back Side of Receiver

Angle (Θ)	Voltage(mV)
0	64
5	60
10	52
15	40
20	24
25	16
30	0

Table-2: (One Side Reflector)

5. Conclusions

In this paper, we have calculated results from plain PU foam sheets used as an absorber using a transmitter-receiver setup with a turntable. Open area with base and back side of reflector have been used in the first phase of the analysis. In an upcoming phase, the main focus would be on completely isolated box using pyramidal absorbing as an absorber. Shielding will also be the part of the second phase. Biomaterials as an absorber would be the experimental phase which would tell if it is better than conventional microwave absorber.

6. Acknowledgement

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7. References

[1] Progress in electromagnetic research, PIER 104, 145-166, 2010

[2] Potential types of Biomaterial Absorber for microwave signal absorption

[3] H. Nornikman, P.J. Soh, A.A.H. Azremi

[4] Absorbing Materials, Wikipedia

[6] Wit Witkiewicz, Andrzej Zieliński PROPERTIES OF THE POLYURETHANE (PU) LIGHT FOAMS

[7] Metamaterials Electromagnetic Wave Absorbers, Claire M. Watts, Xianliang Liu, and Willie J. Padilla

[8] How RF Anechoic Chambers Work, Glen Dash, Ampyx LLC

[9] Absorbers Analysis for Anechoic Chamber, Razali Ngah, Imran Ibrahim and Wan Khairuddin Wan Ali