UTILIZATION OF INSULATION FOAM BASED ON HDPE PLASTIC WASTE AS SOUND ABDORPTION PROPERTIES

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ABSTRACT: This paper research is to study on the utilization of insulation foam based on HDPE plastic waste as sound absorption properties. The objective of this study is to determine the optimum ratio of HDPE plastic waste mixed with polyurethane foams as sound absorption properties for car seat application. In this study, the samples were prepared of HDPE plastic waste mixed with polyol and diphenylmethane diisocynate (MDI) as PUFs component in the process of mixing and curing. Four samples at different ratios of plastic waste to polyurethane foam components (2:1:1, 4:1:1, 6:1:1, and 8:1:1) were tested for sound absorption, impact strength, tensile strength and bending strength properties. Sample 6:1:1 achieved the highest SAC value of 1-1.5 kHz. The highest impact strength test used was 1.86 kJ/ for the 6:1:1 ratio of the sample. Experimental results showed that the tensile strength and bending strength increased with an increased composition ratio of 0.31MPa and 0.26MPa respectively. All findings suggested that the 6:1:1 composition ratio is the optimum ratio of HDPE plastic waste to PUFs to be applied as sound absorption properties for the application of car seats.

Keywords: *NVH, polyurethane foam, HDPE plastic waste*

1. INTRODUCTION

In the automotive assessment, noise, vibrations and harshness (NVH) have gained significance. Interior noise, in particular, has received increased attention and numerous practical methods have been suggested for noise reduction. The automotive noises are generally classified into two types, namely structure-borne noise and airborne noise, which are caused by the engine, the transmission, the tires, road and other [1]. Since high-frequency noise is dramatically reduced by the increasing distance of propagation, the sound absorption material can be improved effectively and use as insulation foam [2]. There are three methods for controlling and reducing noise in the inside of a vehicle which are reducing noise and vibration sources, applying barriers to block sound entering the passenger compartment and applying sound absorbers in the exterior and the interior of the vehicle to dissipate sound and thus reduce the overall sound level [3].

In addition, the plastics production growth has exceeded other materials produced significantly over the last 65 years. The HDPE is the third largest plastic in municipal solid waste, contributing around 17.6 percent in plastic waste classes to the different applications. Studies show that polymer foams can be strengthened with waste material to strengthen their mechanical, thermal and acoustic properties [4]. HPDE plastic waste mixed with polyurethane foam for sound absorption properties in this research, to improve the material's mechanical properties.

2. METHODOLOGY

The HDPE plastic material, which was used in order to improve the mechanical properties of polyurethane foam, was collected such as the engine oil and detergent container. Because of long primary and shorter secondary chains, HDPE has the highest resistance to density than other polyethylene. Therefore, the study aimed at improving the mechanical properties by using plastic waste to the polyurethane foam matrix. For the formation of the polyurethane foam, Polyol and diphenylmethane diisocyanate (MDI) are the two main components used that obtained Zheegen Enterprise Sdn. Bhd. Materials like catalyst, stabilizer, blowing agent and cured agent are part of the polyol chemical of the foam mixture. The mixing ratio is 1:1 per weight of these chemicals. The polyurethane foam composite material has a cellular structure with pores that are closed.

The mixing of HDPE plastic waste to a polyurethane formulation which are isocyanate and polyol forms made for the sample of composite polyurethane foams were produce. By mixing polyol, a 1:1 ratio at room temperature of 24° C was produced by a process designated below. The foam polyurethane was used to produce a sample. Different plastic waste ratios were initially built into polyurethane foams. Table 3.1 below showed the ratios of plastic, polyol, and MDI. Plastic wastes were 2:1:1, 4:1:1, 6:1:1 and 8:1:1 with different ratios as tabulated in Table 1. To achieve a homogeneous composition, the stirring process takes about a few seconds. The specimens were then left by moisture in the air for the healing process under the atmospheric environment.

Table 1: The ratio of HDPE plastic waste in the mixture

Samples	Ratio	HDPE (g)	Polyol volume (ml)	Diphenylmethyl diisocyanate volume (ml)
A	2:1:1	2	20	20
B	4:1:1	4	20	20
C	6:1:1	6	20	20
D	8:1:1	8	20	20

3. RESULT AND DISCUSSION

3.1 SOUND ABSORPTION TEST

Figure 3.1 shows the result of sound absorption in the samples by using the impedance tube machine with samples that has different ratios of plastic waste in the polyurethane foam. The graph reported that the higher the sound absorption coefficient by the polyurethane foam may be enhanced by more plastic waste particle filler in the polyurethane foams. The highest value of sound absorption coefficient between 1000 to 1200 Hz has been achieved by the Sample C with ratio 6:1:1 with highest Sound Absorption Coefficient (SAC) of 0.964. While, Sample A with ratio 2:1:1 have lowest SAC with its peak value only at 0.737.

By modifying polyurethane foam by adding with fillers to obtain an intercalated nanocomposite structure, sound damping of PU foam can be improved. As shown in Figure 4.1, with the increasing plastic waste ratio, the sound absorption coefficient value also increased. Thus, the composite materials obtained have better sound absorption properties compared to rigid polyurethane foam [5]. In addition, it can be analyzed that polyurethane foam with addition fillers such as grinded HDPE plastic can enhance the sound absorption properties. It is because HDPE itself have properties that contribute the capabilities to absorb sound. However, if too much filler added such as in Sample D with ratio 8:1:1 have lower SAC than Sample C. It is because too much filler that reduce the polyurethane foam structure to forming as the polyurethane foam is the main cause to absorb sound. As the conclusion, the absorption of sound energy decreases when the ratio of plastic waste was too much as proven by Sample D. Furthermore, lowest energy for reflection indicates higher absorption of sound resulting in good sound energy absorption.

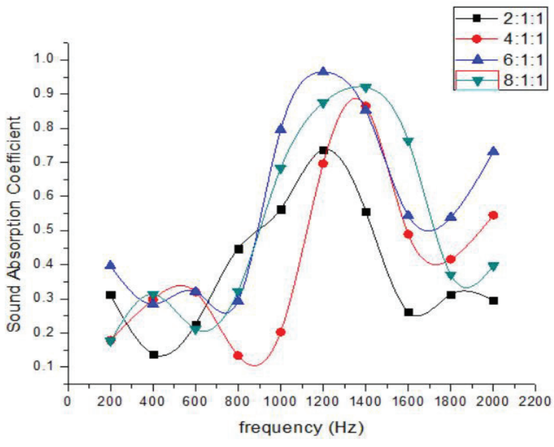

Figure 3.1: Result of Sound Absorption test of difference ratio of HDPE plastic waste with polyurethane foam

4. CONCLUSION

In conclusion, this study's objectives have been achieved. Combination of HDPE plastic waste with polyurethane foam and its hardener had got the optimum composition ratio of plastic waste is 6:1:1 and it can be used as sound absorption properties for car seat applications. The mechanical and physical test for use as insulation foam was conducted and evaluated based on different composition of plastic waste mix with polyurethane foam. An impedance tube was used to measure the matrix's sound absorption coefficient (SAC). Test maximum 6:1:1 achieved the highest SAC value which is 0.964 between 1000 to 1200 Hz. The sample of plastic waste mixed polyurethane foam can therefore be used as sound absorption properties for the application of car seats. From this study, it is possible to reduce the environmental problems and maintain the sustainability of natural resources.

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