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Analysis of the Effect of Sound Dampening on Ship Engines Based on Tofu Dregs Composite Material *(Glycine Max (L) Merill)*

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ABSTRACT

Noise in the engine room of a ship is a significant problem that can affect the health and comfort of crew members. This study aimed to evaluate the potential of tofu dregs as a sound insulation material in the form of a composite of carbon black and talak duco. The research method included making composite specimens with variations in composition, followed by testing the sound absorption coefficient using the impedance tube method. The results showed that the specimen with 30% tofu dregs, 45% carbon black, and 25% talak duco produced the highest sound absorption coefficient of 0.24. These findings show that tofu dregs have potential as an environmentally friendly and economical sound insulation material and can be used to reduce noise in ship engine rooms. This study contributes to the development of natural fiber-based insulation materials in the maritime industry.

Keywords: Tofu Dreg; Sound Insulation; Composite; Noise; Ship Engine Room; Sound-Absorption Coefficient.

1. Introduction

The use of natural fibers as insulation materials has been widely researched because they are environmentally friendly and effective in reducing noise. Sound insulation is an important aspect for reducing the impact of noise in various environments, including ships. High noise levels not only disturb the comfort of crew members but can also have a negative impact on their health and productivity. Therefore, it is crucial to develop effective and sustainable insulation materials is very important. Traditional insulation materials such as rockwool and glasswool are often used, but there is an increasing interest in natural materials such as bagasse, coconut fiber, and banana fiber, which have been shown to be effective in dampening sound [1][2][3].

Tofu pulp, a waste from the tofu manufacturing industry, is a natural fiber that has not been widely used as a sound insulation material. Tofu dregs contain fibers that have the potential to be used as sound absorbers. Previous research has shown that tofu dregs have a high sound absorption coefficient, with a sound absorption value of 0.99 at a frequency of 8000 Hz [4][5]. This indicates that tofu dregs can significantly contribute to noise reduction.

In the maritime industry, noise in ship engine rooms is one of the main sources of noise pollution that must be addressed. Workplace noise standards, as stipulated by the SNI and national regulations, set the noise limit at 85 dBA for work environments. In some cases, noise in a ship's engine room can exceed this limit, and thus, effective insulation materials are needed to reduce the sound intensity [6]. By utilizing abundant and underutilized tofu waste, we hope to provide a sustainable and economical sound-insulation solution.

This research focuses on creating a composite based on tofu dregs fiber combined with carbon black and Talak duco. The aim was to evaluate the effectiveness of this composite in reducing the sound in ship engine rooms. With this approach, it is hoped that insulation materials can be found that are not only effective, but also environmentally friendly and have affordable production costs. The results of this study can contribute to the development of natural fiber-based insulation materials in the shipping industry.

2. Method

Material

The main materials used in this study were tofu dregs, carbon black, and Talak duco. The choice of the composite material composition was carried out considering the need to effectively dampen sound. This composition was designed to optimize the sound absorption coefficient with test object size specifications according to the ASTM E1050 standard, namely, a

cylindrical shape with a diameter of 85 mm and a thickness of 20 mm. Table 1 shows the variations in the specimens used in this study.

Table 1. Variations in Specimen Composition

Specimen	Tofu Dregs (%)	Black Carbon (%)	Talak Duco (%)
A	45	30	25
B	30	45	25
C	45	30	25
D	30	45	25

Research Procedures

The research process was conducted through several stages, including material preparation, specimen preparation, and testing of the sound absorption coefficient.

a. Material Preparation

The tofu dregs were dried and then ground to obtain the appropriate texture. Carbon black and Talak duco were weighed according to the composition specified in Table 1. All the ingredients were mixed until they were homogeneous to form a composite mixture.

b. Specimen Making

The composite mixture was placed in a cylindrical mold and pressed to ensure compactness of the material. The specimen was then dried at room temperature until it reached a sufficient strength for testing.

c. Sound Absorption Coefficient Testing

Tests were performed using impedance tubes according to ASTM E1050 standards. The acoustic tube was divided into two parts, and the specimen was placed at one end of the tube [7][8]. Sound waves were generated and directed towards the specimen, and measurements were performed using a sound level meter. The sound intensities before and after passing through the specimen were recorded to calculate the sound absorption coefficient.

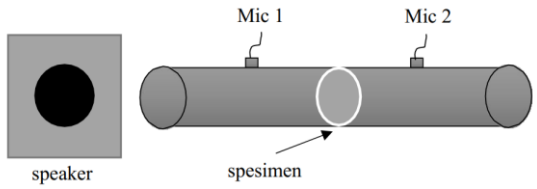

Figure 1. Assembly of experimental equipment

A research flow diagram showing the stages from material preparation to testing is shown in Figure 2.

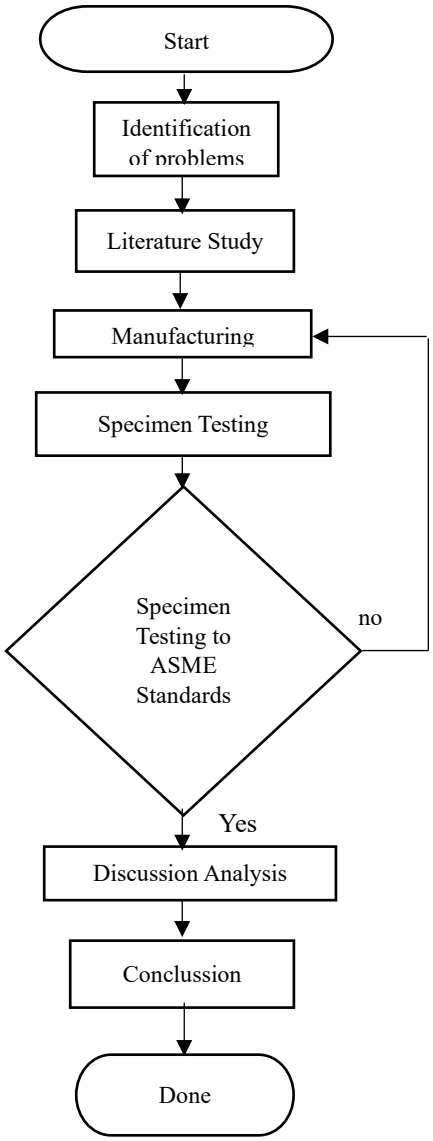

Figure 2. Flow Chart Research

With this method, it is expected that accurate data can be obtained regarding the ability of the tofu dregs composite to reduce sound, which can then be applied to ship engine rooms to reduce noise.

3. Results and Discussion

Specimen Making Results

Composite specimens made according to Table 1 are shown in Figure 4.

(a) (b)

(c) (d)

Figure 3. Results of making test objects with a composition ratio between black carbon tofu dregs and duco talack (a) 45:30:25 (b) 30:45:25 (c) 45:30:25 (d) 30:45 :25

Noise testing was performed in accordance with the ASTM E1050 standards. The test was performed in an echo-free room on the test material. These data were used as a reference for the noise levels in the engine room of the KM Pandelangan ship. KM Pandelangan is a type of traditional fishing boat used to catch fish in Branta, Pamekasan.

Table 2. Noise data at KM. Pandelangan

No	Testing Point	Noice (Dba)
1	Ujung Buritan	94,2
2	Starboard	93,7
3	Portside	92,6
4	Kamar Mesin	101
5	Depan Kamar Mesin	99,2
6	Ujung Haluan	80,7

The data above are divided into several ranges of sound sources, as shown in Table 3.

Table 3. Range of Sound Sources

Range of Sound Sources **(Dba)**		
Testing **1**	**Testing 2**	**Testing 3**
70 - 80	81 - 90	91 - 100

The noise test was performed in accordance with the ASTM E1050 standard. This test is carried out in an echo-free room on the test material.

Composite specimens were prepared from tofu dregs, black carbon, and talak duco according to the composition variations listed in Table 1. These specimens were tested to determine the sound absorption coefficient, and the results are listed in Table 4.

Table 4. Sound Absorption Coefficient of Each Specimen

Spesimen	Sound Absorption Coefficient (α)
A	0,18
B	0,19
C	0,20
D	0,24

Analysis of Test Results

Tests were performed in an echo-free chamber using the ASTM E1050 standard impedance tube method. The test results show that specimen D, with a composition of 30% tofu dregs, 45% carbon black, and 25% talak duco, had the highest sound absorption coefficient of $\alpha = 0.24$. This shows that the addition of the talak duco significantly increased its sound absorption ability.

Discussion

This research shows that Specimen D, with the highest sound absorption coefficient of $\alpha = 0.24$, is superior to previous research using similar materials. For example, Arliando (2015) found that tofu dregs have a high ability to absorb sound, with an absorption coefficient reaching 0.99 at a frequency of 8000 Hz [6]. Although the absorption coefficient obtained in this study is lower, this is expected due to the different testing frequencies and the specific application in ship engine rooms operating in the lower frequency range

In addition, research has used palm frond fiber composites, which achieved a sound absorption coefficient of 0.15 at certain frequencies [6]. Our research results show that tofu-dreg-based composites are more effective in absorbing sound at low to medium frequencies than palm frond fiber materials. This shows that tofu-dreg-based materials are a better alternative for sound insulation applications in maritime environments, especially in ship engine rooms that require materials with higher absorption capabilities.

This difference can be caused by variations in the structure and density of the material [9][10][11], as well as the influence of additional materials, such as carbon black and talak duco, used in this study. This combination not only increases the density of the material but also affects the material's ability to absorb sound energy and convert it into heat, which is the main purpose of sound insulation materials.

Practical Implications

With the highest sound absorption coefficient achieved for specimen D, the application of this composite in ship engine rooms can significantly reduce noise and meet the applicable noise standards. The use of tofu dregs waste also offers environmental and economic benefits, thus supporting sustainable industrial practices. The results of this research show promising potential for the development of natural fiber-based insulation materials, especially in the maritime industry, where noise is a major problem.

4. Conclusion

This research shows that tofu dregs, as waste from the tofu manufacturing industry, have great potential as a sound insulation material when combined with carbon black and talak duco. The test results showed that a

composite with a composition of 30% tofu dregs, 45% carbon black, and 25% talak duco produced the highest sound absorption coefficient of 0.24, which was quite effective in reducing noise in the ship's engine room. By utilizing tofu dregs, this research not only provides solutions to noise problems faced in the shipping environment but also supports efforts to reduce waste and use environmentally friendly materials. These findings are expected to make an important contribution to the development of natural fiber-based insulation materials and to encourage innovation in the maritime industry.

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