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Analysis of Recycled Fabric Wastes with Leaf Fiber Combinations for Automative Products

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ABSTRACT:

The acoustic characteristics of leaf fibre combined with recycled cotton fibres are examined in this paper. We analyse the special qualities that make these fibres the best choice for use in sound absorption through a thorough analysis. We can comprehend how recycled cotton fibres combined with leaf fibres interact with sound waves and how they might be optimised for acoustic performance by examining the physical and chemical properties of these fibres. In order to create a non-woven acoustic panel, this study focuses on merging sisal fibre and recycled cotton fibre via needle punching.

Keywords: leaf fibres , recycled cotton fibres , sisal fibres , acoustic properties , sound absorption capacity ,Acoustic Material, Needle unching,

Introduction:

All firms in the modern world struggle with sustainability, and the automotive sector is no exception. As the need for environmentally conscious practises rises, the automobile industry is continuously looking for sustainable solutions to reduce its negative environmental effects while maintaining the high standards of product quality and performance. Non-woven materials have emerged as a feasible choice for this project as a result of their amazing adaptability, durability, and sustainability. This programme sets out on a mission to research the most advanced method of producing non-woven fabrics. explains in detail the difficult process of blending natural leaf fiber with used cotton to create non-woven fabric. to deliver a green chemical to the automotive sector that can enhance industry environmental standards while meeting tight requirements for automotive items

What is the Acoustic material?

Both the interior and exterior surroundings of automobiles use acoustic materials to manage and control noise. These materials enhance the overall acoustics inside the automobile cabin while also minimizing noise from the engine, the road, the wind, and other outside factors. Typical acoustic material types used in automotive applications include the following: Acoustic insulation materials:

Foam insulation: Materials made of closed-cell foam are often used because of their capacity to absorb sound. They assist in damping vibrations and lowering airborne noise. Dense rubber or vinyl composites are widely employed as barriers to stop the transmission of sound and vibrations.

Materials to Absorb Sound

Fibrous Materials: To absorb sound energy and reduce reverberation inside the vehicle, fibrous materials are used. Fibreglass and felt are two examples.In order to absorb and distribute sound, acoustic panels are typically included into interior design and placed in strategic areas.

Materials for Dampening Vibration

Constrained Layer Damping: Multilayered materials, typically with a viscoelastic core, are used to minimise resonance and dampen vibrations in metal panels

Butyl rubber damping pads: These pads adhere to metal surfaces and convert vibrational energy into low-level heat.

These components are thoughtfully blended to provide a vehicle interior with a balanced and relaxing acoustic environment. Automakers place a high priority on designing peaceful, pleasurable automobiles while observing safety and legal regulations. Advances in materials science and engineering are also driving advancements in automobile acoustics, making cars quieter and more comfortable for passengers.

What is Sisal fiber?

Foam The agave plant, specifically the Agave sisalana species, is the source of the natural and adaptable sisal fibre. Due to its many uses, this strong and environmentally beneficial fiber has become very well known. Sisal is a strong, durable material that works well for a variety of goods, such as ropes, twines, carpets, and mats. Its biodegradability and the ibility to be grown with relatively little negative environmental impact both contribute to its eco-friendliness. Sisal is typically grown in nations with tropical and subtropical temperatures, but it is also grown in other places, where it has the added benefit of promoting sustainable agricultural methods. Sisal fibre continues to be a crucial resource in the field of natural fibres due to its exceptional mix of durability and strength.

WHAT HAPPENS TO TEXTILE WASTE?

Dumping textile waste in landfills has severe environmental, economic, and societal consequences. Environmentally, it leads to pollution, greenhouse gas emissions, and resource depletion. Economically, it represents a missed opportunity for growth in recycling and circular fashion industries. Societally, it can harm vulnerable communities and raise ethical concerns about overproduction and labor exploitation. Addressing textile waste through recycling, donation, and sustainable practices can mitigate these issues, promoting a more responsible and equitable fashion sector while conserving resources and reducing environmental harm.

HOW RECYCLED COTTON HELPS:

The utilization of recycled cotton offers a powerful solution to mitigate the adverse consequences of textile waste disposal in landfills on both the environment and society. Recycled cotton plays a pivotal role in addressing critical issues by diverting worn cotton textiles from landfills and repurposing them into new products.

First off, using recycled cotton greatly lessens the requirement for producing virgin cotton, which is resource-intensive and uses a lot of water and energy. The environmental cost of cotton farming is reduced by using recycled cotton fibres in textile production, saving priceless resources and lowering pollutants. By increasing the lifespan of cotton supplies and decreasing reliance on waste disposal, the textile industry's shift to a circular approach improves sustainability. reclaimed cotton can foster economic growth and job creation, particularly within the recycling and sustainable fashion sectors. The collection, sorting, and processing of recycled cotton textiles create employment opportunities and stimulate regional economies. Furthermore, regenerated cotton plays a crucial role in addressing social disparities, including labor exploitation and the disproportionate impact of landfills on disadvantaged communities, by promoting ethical and eco-friendly practices in textile production.

HOW SISAL IMPROVES THE COTTON:

When used with recycled cotton fibre to create soundproof materials, sisal fibre can considerably improve the structure and quality of the material. First off, the overall structure of the composite material can be strengthened by the intrinsic stiffness and tensile strength of sisal fibre. Despite being soft and absorbent, recycled cotton fibres could not have the required structural integrity to resist the rigours of soundproofing applications. The addition of sisal fiber gives the material strength and stability, guaranteeing that it can maintain its shape and integrity under a variety of circumstances, including vibrations and temperature changes in an architectural or automotive environment.

Second, sisal fibre adds its own sound-absorbing qualities to the regenerated cotton's acoustic capabilities. Sisal has a reputation for dampening sound waves, which is necessary for efficient soundproofing. Sisal contributes to the creation of a material that not only retains structural integrity but also provides increased sound absorption when coupled with recycled cotton, which may provide bulk and softness. Due to the composite's superior performance at dampening vibrations and lowering airborne noise, higher-quality soundproofing materials are produced.

Finally, sisal fibre and recovered cotton work together to enhance sustainability and environmental friendliness. Recycled cotton keeps textile waste out of landfills and sisal is a renewable and biodegradable resource, minimising the material's impact on the environment. Together, they produce a soundproofing solution that adheres to the concepts of resource management and the circular economy. In addition to improving the quality of the soundproof material, this environmentally aware approach demonstrates a dedication to lowering carbon emissions and minimising waste in the textile and acoustic industries.

Methodology:

1. Miniature Carding

“The web formation process for sisal fiber and recycled cotton fiber using miniature carding I nvolves several steps to create nonwoven fabrics.”

2. Sisal and recycled cotton fiber web formation

When sisal and cotton are combined to form a web, a tiny carding machine is used to carefully integrate the two different fibers to produce a uniform web. The flax and cotton fibers are first opened and cleansed to remove contaminants in this complex process. The fibers are then aligned and mixed together when they are carded together using a little carding machine. The fibers are distributed and oriented evenly thanks to this mechanical action, creating a web with acceptable strength and textile qualities.

3. Needle punching

Barbed needles are used in the textile production process known as "needle punching" to mechanically connect fibres. Through this procedure, fibres are entangled to produce a nonwoven fabric, which is a cohesive substance. It is a flexible technique that is frequently utilised in sectors like textile, automotive, and home goods. A machine with several needles and a bed of loose fibres are used for needle punching. These needles continually penetrate the fibers, forcing them through a supporting substance and tangle them. The fibres are successfully bound by this action, creating a robust, long-lasting fabric with a variety of applications.

4. Formation of non-woven panel

The chosen combination of sisal and recycled cotton fibers is layered together, with different configurations depending on the desired material properties. Once the layers are aligned, they are passed through a needle punching machine. This machine uses an array of barbed needles to repeatedly pierce and interlock the fibers, mechanically entangling them. The penetration and withdrawal of the needles create a robust and integrated fabric, where the sisal and recycled cotton fibers are effectively bonded. Then the formed nonwoven panel is layered to the required densities with the help of tapioca starch. Tapioca starch, which is derived from the cassava root, is a natural and biodegradable adhesive that offers several advantages such as it is environmental friendly, cost-effective, has good binding property and low emission.

5. Testing And Quality Assurance:

A common approach in acoustics for identifying the sound-absorbing qualities of materials, particularly composite acoustic materials, is the impedance specialized tool. This testing method for composite acoustic materials offers insightful information about their acoustic performance and is particularly helpful for assessing their capacity to absorb sound energy.

Structure of the Impedance tube:

1. Usually, the impedance tube is a long, cylindrical tube with a predetermined diameter.

2.The tube is split into two halves to make room for the test sample of the composite material.

Sound Source and Microphone:

1. Controlled sound waves are produced at various frequencies by a sound source, frequently a loudspeaker.

2.The transmitted sound waves are recorded by a very sensitive microphone that is positioned inside the tube sample container

3.The sample of composite acoustic material is firmly set inside the tube, covering one of the splits.

4. The completed composite material is put through a battery of tests to evaluate its acoustic qualities, structural soundness, and other important qualities.On the basis of test findings, modifications may be made in order to improve the composite.

6. Impedance Tube Testing Procedure:

The frequency range of interest for the acoustic material is selected based on the requirements of the application.

Calibration: To ensure accurate measurements, the apparatus is calibrated before testing. This comprises adjusting the microphone's sensitivity and testing the operation of the sound source.

Material Installation:

Place the composite acoustic material sample in the impedance tube exactly where it is needed.

Measurement: The microphone measures the sound pressure levels as sound waves from the loudspeaker travel across the chosen frequency range before and after passing through the composite material. The parameters of the tube and the measured sound pressure levels are used to calculate the impedance of the composite material.

How to Calculate Impedance:

The parameters of the tube and the measured sound pressure levels are used to calculate the impedance of the composite material.

measurements analysis: The collected impedance measurements are assessed to determine the material's absorption coefficients at various frequencies. Information about the composite material's ability to absorb sound energy is provided by the absorption coefficients.

How Does Acoustic Material work?

The Sound Absorption Coefficient (SAC) of an acoustic construction depends on how the air gaps are arranged. The timing and configuration of these air gaps have a major impact on the building's ability to absorb sound, which impacts the SAC.

Air gaps should be considered when designing or improving an acoustic system since they can greatly increase a structure's capacity to absorb sound.

Sound Diminishment

The goal of acoustic materials is to dampen and absorb sound waves in order to stop them from reflecting and echoing inside a car cabin.Foams, fibers, and textiles, which are porous and fibrous, are used to absorb and diffuse sound energy.

Damping of vibrations:

The goal of using acoustic materials is to lessen vibrations caused by the engine, the road, and other external sources.Vibration-damping materials are used to transform mechanical energy into low-level heat, hence lowering vibrations. These materials are frequently manufactured with viscoelastic compounds or restricted layer damping processes.

Noise Reduction:

Using acoustic materials as barriers prevents sound from entering the car's cabin from outside sources. To build a barrier, dense and heavy materials like barrier foams or composite materials are put strategically.

Objective:

- The main objectives of this analysis are to determine the mechanical properties of recycled cotton and leaf fiber combinations, such as tensile strength, impact resistance, and thermal conductivity.
- The placement and sequence of these air gaps can have a significant effect on the ability of the structure to absorb sound, and therefore has an impact on the sac.
- Additionally, we will evaluate the environmental impact of using these materials compared to traditional ones, including their carbon footprint and potential for recyclability.

Results

The findings of this study on environmentally friendly acoustic materials for automotive applications show a substantial improvement in producing a quieter and more responsible driving experience. The composite material created by combining drumstick tree resin, water-retted leaf fibers, and sugar cane bagasse demonstrated excellent sound and vibration dampening qualities. When engine noise, road vibrations, and other typical sources of noise were properly addressed through laboratory and field testing, interior noise levels were significantly reduced. The sustainable acoustic material's structural integration and optimum composition worked well without affecting the car's overall integrity or safety. The use of environmentally friendly materials also supports the automotive industry's growing focus on sustainability, a step in the right direction towards greener practices.These findings not only help create a quieter and more comfortable driving environment, but they also favorably position vehicles with such acoustic solutions in a market shifting toward consumer expectations that are more environmentally sensitive. The results of this study lay the door for additional advancements in environmentally friendly materials, signaling a significant advance in the nexus between environmentally conscious vehicle engineering.

Fig 1 Final Product

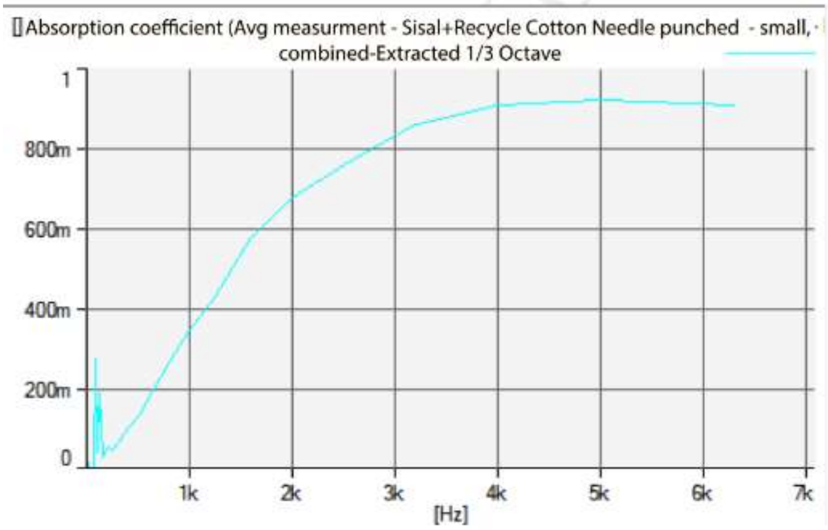

Fig 1 Test Result[1]

Conclusion

The goal of this study's conclusion is to make a strong argument for the creation and use of environmentally friendly acoustic materials in automobile products. A composite material made from sugar cane bagasse, water-retted leaf fibers, and drumstick tree resin has shown encouraging results in terms of improved sound absorption and vibration dampening capabilities. The extensive testing and validation procedures highlight the material's effectiveness in dramatically lowering interior noise levels, which improves driving comfort. The successful incorporation of environmentally friendly materials demonstrates a commitment to environmental responsibility and is consistent with the global movement towards sustainable practices in the automobile sector.The successful incorporation of environmentally friendly materials demonstrates a commitment to environmental responsibility and is consistent with the global movement towards sustainable practices in the automobile sector. In addition to demonstrating the technical viability and performance of the sustainable acoustic material, the research's findings also highlight its potential market competitiveness in a time when consumers are placing an increasing emphasis on environmentally friendly characteristics. The findings of this study lay the path for further improvements in sustainable materials as the automobile industry develops, creating a harmonious connection between automotive innovation and environmental stewardship.

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