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Systematic literature review on thermal and acoustic characteristics of natural fibre polymer composites for automobile applications

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Abstract

Due to their extensive qualities, application of natural fibre reinforced composite materials is expanding in automobile sector. The vehicle industry has identified the benefits of natural fibres and natural-fibre composites (NFC), which are generated by combination of different natural fibres with various types of polymers. Latest progressive developments in noise management via sound absorption affords the chance to examine various porous materials, such as fiber-based composites. Due to porosity in nature, composites made by using natural fibres have a comparatively high sound-absorbing capacity. This paper presents a comprehensive literature analysis over usages and acoustic as well as thermal properties of polymer composites reinforced with natural fibres. In composites, natural fibre reinforcing has proven to be an efficient substitute for synthetic fibres. Current engineering uses for natural fibre composites include building materials, vehicle, geotextiles, railway,

electrical industry, defence and packaging sector. This work can advise composite manufacturers, designers, and users while selecting composite materials for thermal as well as acoustic applications such as interior components, brake ducts, covers of engine components, heat shields etc. among others.

Introduction

Any nation's growth and development depend on a swift, efficient, and cost-effective form of transportation. Recent research is being performed in the area of better-designed, faster, less expensive, and more visually pleasing automobiles. As a result, lightweight materials such as plastics and composites are combined in a variety of ways to produce various vehicle structural components [1]. Composites are lightweight, low in density, corrosion resistant, strong, and stiff materials compared to traditional materials.

In current scenario, the usages of natural fibre composite based materials are increasing in automotive sector. Automobile industries utilise the benefits of natural fibre composite based materials, such as lightweight, durability, high specific energy absorption capacity, improved aesthetic value, manufacturing simplicity, and design enhancement.

Natural fiber-reinforced composites are utilised in construction for making partition boards, panelling, ceiling, building, transportation, packaging, consumer items and military applications among other industries [2]. To minimise vehicle fuel consumption, exhaust emissions, improve the functionality of existing parts, and implement design advances, it is crucial to develop lighter automobile parts. [3] Depends on the type of reinforcement employed, composites can give weight reductions which ranges from 15 to 40 percent. The inside door panels, front fenders, tailgate, and roofs of automobiles contain natural fibre composites. favoured because to their lightness, sound absorption capacity, flexibility, versatility, and easy adaption, design flexibility, component consolidation, dimensional stability, nonmagnetic and nonconductive, low thermal conductivity and radar-transparent and features. As shown in Fig. 1 still the application of polymer in automobile sector is very high as compared to NFC [1], [4].

Composites with diverse construction characteristics exhibit a vast range of qualities. Consequently, the composite materials qualities can be further enhanced by including the suitable selection of component materials and selecting appropriate fibre density, fibre orientation, fabrication method, composite material composition, etc.

Natural fibre composites will reduce weight, resulting in decreased emissions, fuel consumption, and capital savings, even facts support it, if we reduce 100kg in vehicles weight results in a 0.71 g/100km fuel savings. Composites offer enhanced energy absorption, reduced noise, impact resistance and reduction in vibration in addition to weight reduction [5]. Different types of natural fibers are depicted in the Fig. 2. The use of non-biodegradable synthetic fibres in car covers or external wrappings composed of sound-absorbent material is one of the noise-reduction strategies that have been implemented over the years.

Traditional sound absorption materials include synthetic fibres glass fibres, polymer foams and fabric fillers; however, these artificial fibres are non-biodegradable and contaminate the climate during their creation and disposal. Consequently, the search for a substitute with less influence on the

environment. Experiments have demonstrated that natural fibre composites are crucial for minimising noise pollution. These biodegradable materials are good in absorbing sound and no negative impact on environment. [8]. Now a days, the researcher has focused on natural fibres for reinforcements in the composite matrices rather than synthetic fibres. It results in enhancement in the mechanical qualities of composites without increase in the price of automotive components like dashboards, door handles, panels of roof and door [9]. The recyclable nature of natural fibres minimises the environmental load specifically, without the need for a specific chemicals or manufacturing cycle to achieve this result.

Recently, hybrid fibres have also gained immense popularity as polymer composite reinforcements for many vehicle components. Natural/synthetic, synthetic/natural or natural/natural fibres are combined in a single matrix for the creation of hybrid composites. Hybridization improves the thermal, mechanical and physical properties of composites. Individual fibre composites achieve a superior mix of qualities than hybrid composites [10]. Natural fibre hybrid composites are very cost effective and having superior thermal and mechanical durability, indicating that they could limitedly replace and decrease the utilization of synthetic fibres as polymeric composite reinforcements. Natural fibres are utilised in a range of applications, posing a challenge for researchers to discover procedures for obtaining high-quality fibres that fulfil the necessary standards so that they can be used to strengthen polymer composites.

Section snippets

Applications of NFC in automobile sector

The literature survey on recent investigations on natural fiber reinforced polymer composites for automotive applications is discussed in this section. Utilisation of different natural fibers in polymer composites for automotive applications has been reported by various researches. Automobile interior components are made from natural fibres like kenaf, jute, flax, oil palm, hemp, ramie, bagasse, sisal, banana, abaca, coir, coconut, rice husk, cotton, wool, wood, and soy, among others. The ...

Fiber reinforced composite fabrication techniques

Fiber reinforced composites can be fabricated by using various methods depending upon the fiber type and materials of matrix which we have to process. The characteristics of the chosen resin or polymer as well as fibers are crucial in determining which method to employ. ...

Thermal properties and stability

The analysis of thermal characteristics is a valuable technique for evaluating the structure and property relationship and to check how much thermally stable the natural fibre composite material is [11], [29], [30]. Thermogravimetric analysis (TGA) and Differential scanning calorimetry (DSC) is used for the evaluation of thermal characteristic of composite material [31]. The temperatures at which hybrid composites breakdown range from 30 °C to 8000 °C [29].

By conducting experiments on the ...

Acoustic properties

Natural fibers are renewable, biodegradable, low in cost, environment friendly and also noise absorbing materials. Hence, they are useful for automobile sector as a sound absorption and reinforcement material for various components. Reducing in noise and vibration enhances the value of automobile through customer satisfaction which leads to profit for manufacturers ultimately. Sound absorbing property is required in various components like door panels, trunk liners, floor covering, package ...

Conclusion

According to the review of literature, natural fibre reinforced polymer composites are promising materials for specific automobile applications. The hybridization of fibers may further enhance the properties of composites. Different conventional and advanced fabrication techniques can be employed to get the desired composites.

Recent years have seen a surge in the use of natural fibre composites in a range of automotive interior applications. The thermal and acoustic properties of various ...

CRedit authorship contribution statement

Sarita Choudhary: Conceptualization, Methodology, Writing – original draft. **Jyotirmoy Haloi:** Supervision. **Manoj Kumar Sain:** Supervision. **Praveen Saraswat:** . **Vikas Kumar:** Data curation. ...

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. ...

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...Polymers, which also act as adhesives between the filler and fibers, increase the mechanical strength of the composite structure [43]. Polymer binders and polymer composites have higher acoustic and thermal resistance than other binders in the construction industry. [21,68,71–76]. Since most of the materials used in these polymer composites are petroleum-based, they are harmful to the environment...

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[Evaluation of the potential of Yushina alpina bamboo fibers from Cameroon for the manufacture of biocomposites](#)

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...In the transportation sector, different types of biocomposites are manufactured using bamboo. Various types of components such as interior door panels, sun visors, instrument panels and clusters, etc., which are not primarily load-bearing structural elements, are manufactured using biocomposites [8–14]. With regard to bamboo, Getu et al. [15] developed and characterized a composite reinforced with sisal and bamboo....

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