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Technical note

Negative impact from the application of natural fibers

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ABSTRACT

Natural fibre reinforced composites have been widely explored in many engineering applications in recent times due to its comparative advantages in terms of recyclability and sustainability. Of most interest in many engineering applications is its ability to offer lighter weight component as against synthetic and metallic materials. In recent times, metallic and synthetic materials are currently being replaced in many automobiles industries while natural fibre reinforced composites continue to enjoy reasonable patronage in this industry. In this study, the overall application of natural fibre was discussed with focal point on global consumption of natural fibre in automobile industries and its attendant implication on the environment and biodiversity. Part of the conclusions drawn from this study emphasised the need to preserve the nature from impending extinction.

1. Introduction

Natural fibres are a group of hair-like materials which primarily consists of plant and animal and its primary advantage revolves round the fact that it is environmentally friendly and more economically viable as against synthetic fibres. Natural fibres industry remains a huge market globally most importantly in automobile industries where natural fibre constitute about 40% of its raw materials (Reddy and Yang, 2005). This trend continues to put pressure on farmers to divert more attention on the production of automobile components parts as against several other economic crops. Part of the conclusion drawn from Shen et al., 2009 depicted steady growth in the production of world fibre from 1920 to 2006 as evident in Fig. 1. This growth in the world fibre production continue to find relevance in all facet of human endeavour in view of weight reduction these materials portend to offer. Key of such application is the replacement of metallic component of automotive part with natural fibre as evident in the replacement of metallic bumper with natural fibre reinforced composite bumper. In the light of the above, this steady increase in the world fibre production is being reflected majorly in automotive parts and other key area of vehicle components. According to Leão et al. (2006), Brazil seems to have reached its climax as a major supplier of automotive part considering the attendant gap recorded in environmental preservation. Some researchers have predicted that Brazil may experience major environmental disasters if urgent steps are not taken to replenish the gap currently ravaging this country in view of its huge supply of natural fibre globally.

In recent times, it has been affirmed that automobiles industry alone requires sisal fibre in the range of 170,000 ton/yr in parts formation while the replenishing approaches may not deliver 50% of these fibres in the next 50 years (Faruk et al., 2012). According to Ayrilmis et al. (2011), coir fibre also enjoys remarkable interest in the automotive part formation as a result of its hard-wearing quality and high hardness. According to other authors (Zhang, 2008; Ward and Shackleton, 2016), the demand of natural fibres appear to have cut across continents as evidenced in Fig. 2. In China alone, the prediction for composite and lighter weight materials demand is likely to reach 110million tons by the 2020 while Europe demand may also reach 80million tons most importantly in the manufacturing of automotive parts (Biron, 2013b). This further shows that the demand of natural fibre may escalate in view of its weight saving property. This prediction is likely to put more pressure on the already bastardised ecosystem in some of these nations considering the enormous fibre that will be cultivated for this purpose (van Gameren and Zaccai, 2015).

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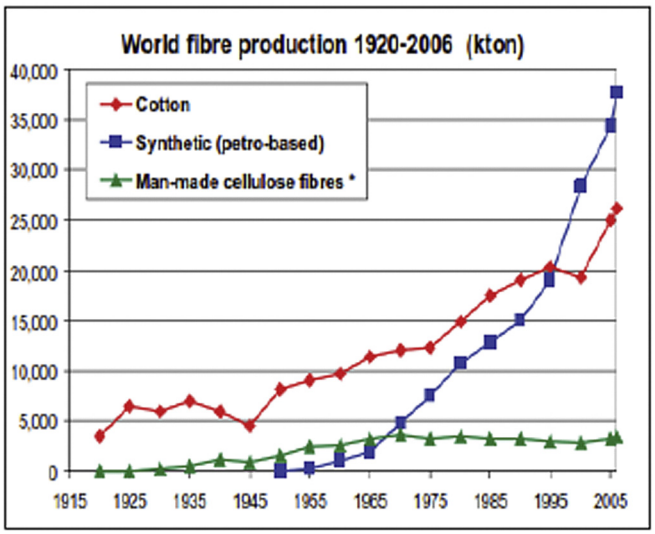

Fig. 1. Volume of fibre production over the last century (Shen et al., 2009).

The emergence of wealth of literature concerning the processing, microstructure analysis and properties of natural fibre reinforced composite as it relates to their application in automobile industry is a clear indication that these materials are probably on the verge of intense pressure which may further worsen environmental crisis. Recent studies have shown that if the global average temperature were not reverted at 2 °C above the preindustrial conditions, the earth would face a dire negative repercussions with over three billion people likely to face drought and increase in coastal flooding occasioned by depletion of forest reserve (Reid et al., 2010). The implication of this vulnerability further subject terrestrial biosphere into a pool of carbon which may raise the earth warming temperature to about 3 °C, subjecting the atmosphere into a spiral of extreme warming for over 100,000 years (Lynas, 2008).

2. Prediction of world natural fibre composite demand

Natural fibre composites market is predicted to experience a boom at compound annual growth Rate (CAGR) of 10.2% during 2015–2019 going by successes recorded in energy reduction in most automobile industry (Van der werf and Turunen, 2008). This growth rate is seen as hypothetic in the last two decades as evident in the criticism that trailed this projection at the time. Various vested interests in the natural fibre and its composite is an indication that the demand for the fibre may outweigh its production if pragmatic steps are not taken to sustain the market. The major driving force of natural fibre market are growing need for energy conservation, and this has made the natural fibre composites materials in automotive industry more pronounced with a projection of attaining a record high in the next decade. Application of natural fibre in human endeavour is equally growing in leaps and bound with automobile industry taking large chunk of the percentage. The share of composite consumption in automobile industry is over 35% as shown in Fig. 3 in which some authors (Krause et al., 2013; Reddy and Yang, 2005) affirmed that about 30% of these composite materials are sourced from natural fibre related materials while the remaining 5% may be from synthetic materials. Although, natural fibre composite have been widely acknowledged for payload reduction in view of its lightness, there appear not to have been a robust strategy to mitigate the resultant effect of huge decline in global forest in view of these demands. In a related manner, Table 1 depicts the volume of natural fibre emanating from member countries with China, USA and India accounting for 25 million tons of raw cotton consumed globally. While these countries (China, USA and India) have technological tools to mitigate the shortfall that may arise as result of deforestation and other related vices, the same may not be reported for Equador and Philippines with 0.1million tonnes annually with no clear replenishing strategy to combat the resultant effect of global warming (Krause et al., 2013). To further strengthen the projected demand in natural fibre

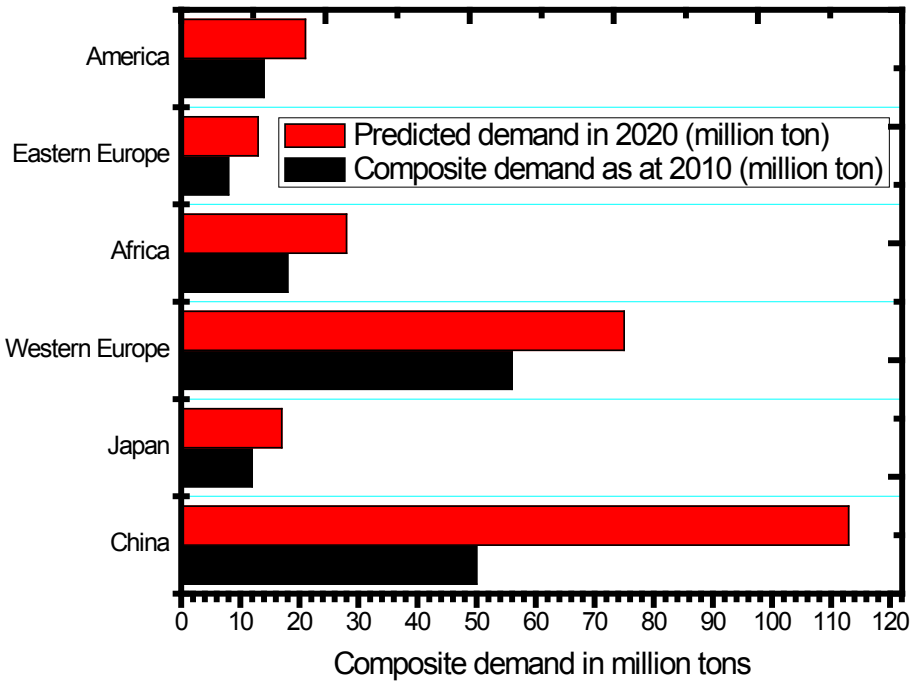

Fig. 2. The forecast and relevance of composite materials among member countries: Data for this graph were sourced from Biron (2013b).

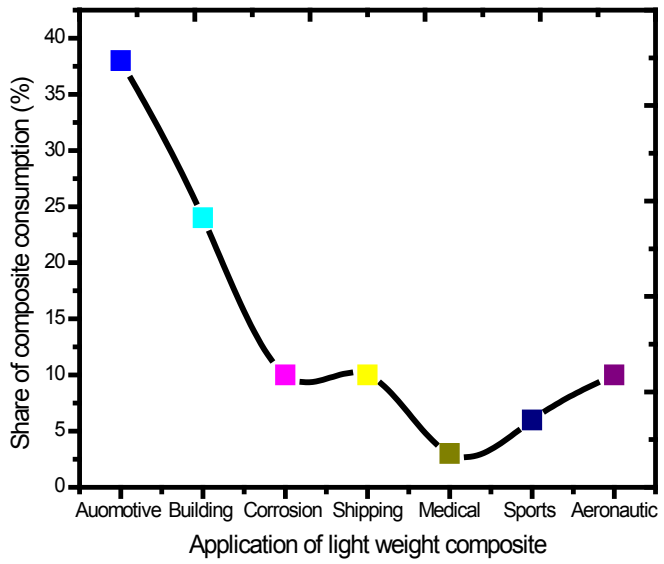

Fig. 3. Proportion of natural fibres in engineering application. Data for this graph were sourced from Biron (2013a).

Table 1
Global production volume of some selected natural fibre (in million metric tons). Adapted from Krause et al. (2013).

Natural fibre	Million (tonnes)	Main producer countries
Cotton	25	China, USA, India
Kenaf	0.45	China, India
Flax	0.50	France, Belgium
Sisal	0.3	Mexico
Abaca	0.1	Equador, Philippines.

composites, Table 2 shows that flax and hemp fibres alone have been extensively explored in textile and coating application in automobile industry and the regeneration process from this application have resulted in heavy pollution which is another source of concern in view of its impact on environmental sustainability.

3. Environmental and emerging concerns

Depletion of natural forest amidthreat to biodiversity remain the most daunting challenges as natural forest continues to disappear with resultant effect on climate change and global warming and according toDirzo et al. (2014), the environment is currently evolving "amid a global wave of anthropogenically driven biodiversity loss". Application of natural fibre reinforced composite in automobile industry is growing in leap and bound and there appear to be no public awareness on emergence of huge deficit in global forest as researches are only focussed on weight reduction and energy conservation in the application of natural fibre. To date, much of this biodiversity extinction has been aggravated by intense pressures on forest and further encroachment into animal habitat and this biodiversity loss may be further compounded as automobile parts is now completely being replaced by natural fibre. According to Phalan et al. (2011), greenhouse gases is defined as those gases that absorb infrared radiation in the environment, trapping heat and simultaneously releasing these warm gases on the surface of the Earth. Generally, the major greenhouse gases (GHGs) associated with deforestation and human activity on natural forest are carbon dioxide (CO_2), methane (CH_4), and nitride oxide (N_2O). Although, many researchers (Snyder et al., 2009; Ward and Shackleton, 2016) attributed 60% emission of greenhouse gases to fossil fuel combustion, recent surveys affirm that almost 40% of other emission of greenhouse gases may have been caused by human activities primarily deforestation. As depicted in Fig. 4, invasion into virgin forest for technological advances have raised the CO_2 emission in the United States to a record high as shown. In the light of the above, replacing metallic component of automobile part with natural fibre may not completely reduce greenhouse emission as widely believe but will create a vicious circle with emergence of deforestation and biodiversity extinction. As a result of huge demand in natural fibre in automobile industry, human actions in agricultural sectors have shifted in the last two decades to cultivation of short term agricultural products primarily for economic advancement in which natural fibre reinforced composite featured prominently (Ashori, 2008). In the same vein, several other authors (Ramesh, 2016; Pritchard et al., 2014) have corroborated earlier prediction that sudden huge demand in natural reinforced composite may have influenced the rate of emission of CH_4 over the last 25 year. This deficit in green environment may hit a worst scenario in 2050 as long as the automobile industries continue to expand its structure using natural fibre reinforced composite. This gap is anticipated to intensify as technology innovation puts increasing pressure on Earth's biological systems and finite natural resources.

Table 2
Potential major products of some selected natural fibre and its corresponding by-products. Adapted from Krause et al. (2013).

Natural fibre	Market product	By-Product
Flax & Hemp	Textile fabric composites Specialist paper Non-woven	Seeds, Shives
Jute and Kenaf	Carpet backing Hessian, Sacking	Stalks
Abaca	Specialist paper, tea bags	Leaves, juice

4. Global perception to climate change and future outlook

Climate change has been described as a global phenomenon, which is majorly driven by fossil fuel consumption and extinction of natural forest (Upgupta et al., 2015). Mitigating the rate of global warming remain a global challenge and core of the conservation

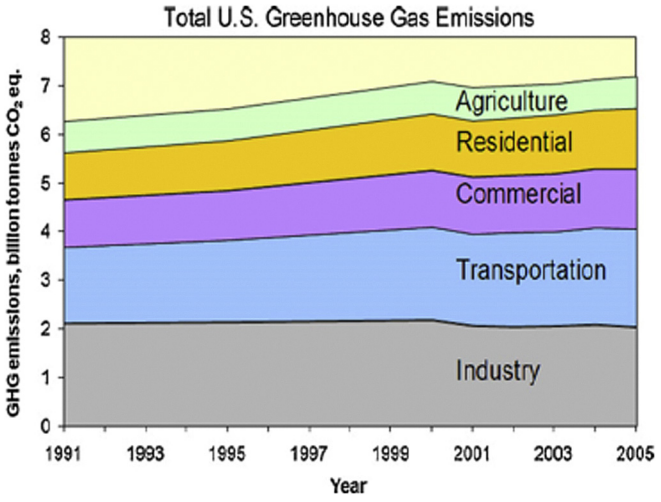

Fig. 4. Prediction of greenhouse gas emission from U.S economy by sector, in billion (10^9) t of CO_2 equivalents.

strategy is green environment and new intervention policy. These approaches have been x-rayed in many literature either on a regional basis or nationally focused but the resonance continues unabated. Although, adoption of natural fibre as automobile part is predicted to have the potential of reducing the entire payload of vehicular body to 50% when compared with metallic body part (Browne et al., 2006), the overbearing effect of deforestation and the resulting global warming are seen as a time-bomb which may push the world into another decade of spiral heating. Climate change is reported to be a major threat for species and ecosystems, as the biodiversity loss continues across all sphere of the earth. Natural forest disappearance amid technological expansion forcefully move species outside their existing boundaries into a colonised regions with reduction in abundance or even extinction of native species. Most concept of energy saving in automobile industry with the application of natural fibre as illustrated lately in many literature still leave a lot issue to be addressed. The future outlook for global warming and green environment as key deficit in application of natural forests has not been thoroughly addressed as automobile industries continue to anchor its energy saving on natural reinforced composites. A new concept may be needed, not necessarily the application of natural forest in energy conservation drive in automobile industry, but for new conservation practice built outside natural forest application. This concept may be broaden to involve supporting legislative and policy changes, with a well-defined and global outlook with better coordination to free the natural forest from unnecessary technological invasion. Fossil fuel demand in automobile industry may be properly addressed by looking outside natural fibre as the implication of its usage outweigh its fossil fuel energy conservation. It is also very important to evolve right policies in the management and conservation approach of natural forest, as this limit unprecedented decline in global forest.

5. Conclusion and recommendations

This study attempted to appraise the application of natural reinforced composite under the context of energy conservation and the grave implication of diverting natural forest while its initial purpose of preserving the environments is being defeated. Climate change amid biodiversity extinction remain unresolved problem as the earth is predicted to experience another face of temperature rise in the next decade (Xu et al., 2015). Part of the discussion from this work focusses on the global application of natural fibre in automobile industry and the emerging challenge that may likely evolve. Key of the resultant effect as reported revolves round global warming with intense temperature rise. To this end, minimising energy consumption using natural reinforced composite need to be properly defined so that natural conservation mechanism is not depleted. Reducing earth temperature rise is a technological challenge that researchers need to tackle head-on in the face of greenhouse gas emission. According to Felton et al. (2016), recent foray into natural forest by automobile industry may further compound the environmental crisis resulting into deeper global warming with increasing water level. In the light of the above, the authors believe that natural forest must be preserved and sustained with no technological interferences. Automobile industry can explore synthetic materials in component parts formation which is largely comparative to natural fibre in terms of weight saving to save the world from global warming.

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