Second-generation composites from recycled wind turbine blades

The demand for wind and other forms of clean energy is increasing in the US and throughout the world. Wind energy is also expected to provide 14.9% of the global electricity demand by 2020. Under this scenario, a significant amount of wind turbine blades (WTBs) will continue to burden our current landfills until a viable recycling strategy is found. Repurposing or recycling of end-of-use wind turbine blade material will provide both economic and environmental attributes.

While some components of the wind turbine are recyclable (such as the metal parts in the tower and gearbox), recycling the blades has been difficult due primarily to the thermoset binder used in the synthetic fiber (primary glass) composite. In most WTBs, approximately two-thirds of the total weight of the blade is made of glass fiber composite (GFC). Most GFC-based WTBs have a predicted life expectancy of 20 to 25 years. Estimations predict that the amount of end-of-life WTB materials will account for 100,000 tons per year in Europe in 2030. Furthermore, reusing the blades is not recommended due to design limitations that are quite challenging and costly. Options to incinerate or disposal has negative environmental contributions and disregards the potential recycled wind turbine blades (rWTBs) have as a feedstock for second generation products. There is a potential to recycle the glass fiber from the thermoset matrix via chemical or thermal treatments, however the resulting fiber is often lower in mechanical properties than virgin fibers and are very difficult to disperse into many matrices due to their crimped and entangled form.

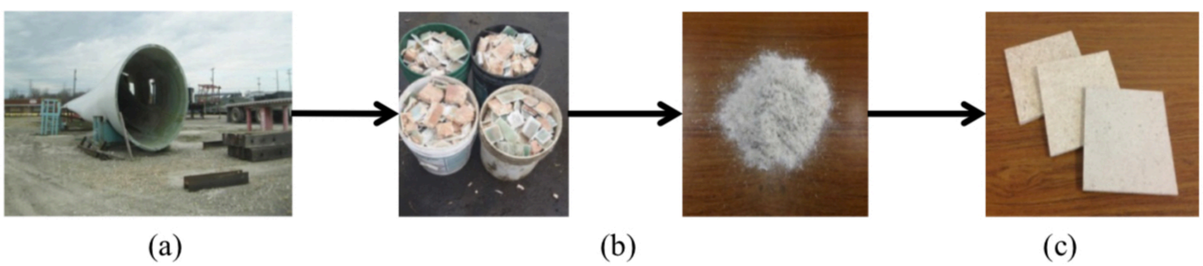

Fig. 1. End-of-life wind turbine blade, (b) mechanical comminution process, (c) hot pressed rWTB composites.

rWTB is a viable material for making second generation composites. Any added energy, labor and chemicals will significantly add cost to a material that is already considered a waste product. Mechanical techniques that employ shredders, hammer-mills, knife-mills, etc. provide a low- cost option to deliver a reliable feedstock. However, the methods and classification procedures within the mechanical refining process are vital parameters to address to achieve the maximum potential of the rWTB materials while maintaining minimal energy and costs.

Much research with recycled synthetic fiber composites has been targeted to liberate the glass fiber from the composite matrix or reuse of shredded composites (SC) in new thermoset polymer composites in order to reduce the amount of virgin glass fiber in existing composite. However, just a few studies considered the SC as the predominate component (above 90%) within the composite. Therefore, with an increase in renewable wind energy via turbines, an underlying problem of the turbine blade disposal is looming in many areas of the world. These wind turbine blades are predominately a mixture of glass fiber composites (GFCs) and wood and currently have not found an economically viable recycling pathway. This work investigates a series of second-generation composites fabricated using recycled wind turbine material and a polyurethane adhesive. The recycled material was first comminuted via a hammer-mill through a range of varying screen sizes, resinated and compressed to a final thickness. (Fig. 1)

Obtained results from both of the mechanical and physical test show considerable characteristics of rWTB material in manufacturing the second-generation composites. Generally, the composite panel made with rWTB materials had improved water resistance properties than the wood-based particleboards. The obtained results from composite panels made from rWTB material demonstrate that it is feasible to recycle the wind turbine blade to fabricate value-added high-performance composite. A finished product from the recycled blades could have a variety of applications, from floor tiles to plastic road barriers.

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