Composite solutions that last

Cefic UPR Position Paper on Composite recycling

Composites - Great track record for durability

Due to inherent benefits such as the light weight, durability and design flexibility, composites can build on a track record of sustainable performance compared to traditional materials like steel, wood and concrete. Therefore, composites are the material of choice for many demanding applications in transportation, wind, marine, building & infrastructure, industrial and consumer markets.

Composites are composed of a fibrous reinforcement material (typically glass or carbon fiber) and a resin matrix (often a thermosetting polymer, such as unsaturated polyester resins or epoxy resins). Inorganic fillers (e.g. calcium carbonate, aluminum trioxide), can be used to adapt material properties and in some cases to reduce material cost.

Outlook

Europe needs to invest in more research and innovation to diversify and scale up composite recycling technologies, to develop new, high-performance materials with improved sustainability, and to design methodologies to enhance circularity and recycling abilities of composites. This is recognized by the European Commission and in line with the EU Circular Economy Action Plan.[1] The composites sector seeks to find solutions to improve the circularity of their products and to do so, requires close cooperation with the supply chain.

While innovative solutions for composites circularization will undoubtedly bring benefits to the entire composites supply chain in the longer term future, at the same time existing treatment routes like cement co-processing must be deployed more widely to deal with the current waste streams. Critical in ensuring that the best recycling or end-of-life solutions are selected, the scientific understanding of the environmental impacts associated with the choice of materials and with the different waste treatment methods should also be improved. This includes refinement of life cycle assessment data (LCA) and methodologies. The UPR Sector and EuCIA have been active in developing and refining LCA impact tools such as the Eco Impact Calculator for Composites.[2]

Collaboration in the supply chain

While various technologies exist to recycle composites, and an increasing number of companies offer composite recycling services, these solutions need to become more widely available and cost-competitive. This requires logistical and technological solutions for disassembling, collection, transportation waste management and reintegration in the value chain.

CEFIC UPR believes composite recycling is integral to the product life cycle of composite components and products containing composite components. Therefore, as organization we play an active role in promoting composite recycling routes. In 2019, we started a collaboration with WindEurope and EuCIA (European Composites Industry Association) to further develop waste collection and recycling routes of wind turbine blades.

[1] https://ec.europa.eu/environment/circular-economy/
[2] http://ecocalculator.eucia.eu/

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Recycling technologies
In the following table the main available technologies for composite recycling are summarized (based on joint report WindEurope, Cefic, EuCIA[3]).

Mechanical recycling: use of regrind fiber and filler in new composite components	Pyrolysis or Solvolysis to convert matrix into original raw materials	Co-processing in cement kilns
Commercial at small scale	Pilots available	Commercial at industrial scale
Retention of fiber shape	Capture of fiber shape and resin raw materials	Fiber shape not maintained
Need to manage powders and fibers	Need to manage powders and fibers	Easy to manage regrind, also in scale up
Only possible to re-use as small percentage in new formulations for surface-critical applications	Will require separation of liquid fractions that can be reused	Re-use of valuable raw materials plus energy recovery: reduction of CO_2 footprint
Not economically competitive (yet) with use of virgin raw materials	Not economically competitive (yet) with use of virgin raw materials	Economically viable at present
Re-use not envisioned in critical applications with high fatigue resistance requirements (like wind turbine blades)	Demonstrated in small scale equipment	So far only suitable for glass reinforced composites
Use in non-traditional composites applications, with positive LCA effect	LCA impact to be confirmed	Early studies indicate positive LCA effects

Cefic UPR believes that presently the main technology for recycling composite waste is through cement co-processing, which is commercially available for processing large volumes of composites waste (albeit not in all geographies yet). At the same time, Cefic UPR strongly supports increasing and improving composite waste recycling through the development of recycling technologies which produce high value recyclates or enable the production of new composite components.

The alternative technology of mechanical recycling is well understood and is being used already over 25 years. Yet it has been shown that recycled fibers and powers cannot easily compete from a financial perspective with virgin raw materials.

New technologies like Pyrolysis and Solvolysis are being evaluated at smaller scale, but will require further technology and process development. Cefic UPR actively promotes additional programs and collaboration in the composites supply chain to enable the commercialization of alternative recycling routes.

Recycling through Co-processing
Co-processing is the simultaneous use of composite regrind as raw material and as a source of energy in cement manufacturing, to replace natural mineral resources (material recycling) and fossil fuels such as coal, petroleum and gas (energy recovery). In this process, the composites regrind used for co-processing is both an alternative fuel and raw material (AFR).

Glass fiber thermoset composite parts - originating from part manufacturing or end-of-life components - are cut in smaller sections and processed into small chunks. The resulting regrind is combined with other feedstock materials into an input stream with consistent

[3] https://cefic.org/media-corner/newsroom/cross-sector-industry-platform-outlines-best-strategies-for-recycling-wind-turbine-blades/

composition and caloric value. Using this feedstock as raw material it has been calculated that the CO_2 emissions of cement clinker operations can be reduced to levels up to 16 % (or 0.9 kg CO_2 eq./ kg of composite, assuming the composites regrind is at the maximum level of 75 %)[4].

Composite recycling though co-processing in cement kilns is fully compliant with the European Waste Framework Directive (WFD) 2008/98/EC providing viable waste management route for the composites industry. Co-processing is both recycling of material and energy recovery.

The glass fiber shape is not maintained during the process, which from a waste hierarchy perspective may be less preferred. Therefore, further development and industrialization of alternative thermal or chemical recycling technologies may provide composite-using sectors with additional solutions for end-of-life.

More information

If you would like to discuss in greater detail, please contact Esther Agyeman-Budu (eab@cefic.be). More information on CEFIC UPR can be found on https://www.upresins.org/.

[4] https://eucia.eu/userfiles/files/20130207_eucia_brochure_recycling.pdf