EuCIA European Composites Industry Association

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Composites and sustainability – the big picture

Sustainability is becoming an ever more compelling argument in the materials selection process. Fibre reinforced polymer composites are strong, lightweight and durable materials which are seeing increasing adoption in the transportation, construction, renewable energy and many other markets. Sustainability in their use phase is often a key driver for the selection of composites over traditional materials. Composite structures deliver a long service life combined with low maintenance requirements, and lightweight composites result in lower energy consumption throughout a product's life. But this is only part of the picture. To fully exploit the sustainability benefits of composite parts it is essential to consider the whole life cycle.

At the European Composites Industry Association (EuCIA) seminar Lightweight, Durable and Sustainable Composites, Ben Drogt, consultant – composites, innovation & sustainability, at BiinC, emphasised this point.

“Sustainability is about the complete life cycle of the product,” he asserts. “The life cycle of a composite part has three phases: making the part, using the part, and end of use. And I use the 'term end of use' rather than 'end of life' since because of the durability of composite materials, very often the end of use of the part is not the end of life.”

End of use solutions

Composite parts frequently have a very long life time. In one of the first commercial applications of composites, the US Coast Guard introduced composite-hulled boats in the 1950s, and some of these vessels are still in the water today. Often, the composite material survives the use of the part and end of use solutions are required.

Putting the issue of composites waste into perspective, Drogt estimates that EU production of composite materials is less than 0.05% of total EU waste production. The collection of end of use composites waste from these much larger waste streams is one issue the emerging composites recycling industry is facing. The second challenge involves converting the waste into a material which can be used again. And finally, applications for the recyclate need to be found and these must have value.

"These three different competencies – logistics, technology and application development – have to be assembled to create a positive business model," Drogt explains. "At the moment, collection and processing are costs, so we need to find applications with value in order to obtain revenue from end of use waste which is normally sent to landfill or incineration."

Much progress is being made on technologies to recycle waste composite material. Pyrolysis and solvolysis techniques can separate the fibres and resins for reuse, whilst mechanical recycling produces a by-product which can be used as a filler or reinforcement in other materials. But Drogt points out that the environmental impact of the recycling process must also be taken into account. Mechanical recycling is a more energy efficient process than chemical recycling, for example.

One established, commercial end of use solution for composite waste involves co-processing the material in cement kilns. In this process, composite waste is ground into coarse material that serves both as a fuel and a raw material in cement production. This technology, which is approved by the European Commission as a recycling process for composite waste, helps to reduce the carbon footprint of cement manufacturing. Depending on the quantity of composite regrind included and the specific cement plant technology, this reduction can be as high as 16%.

This recycling route has been proven using end of use composite wind turbine blades. In wind energy, composites enable improved blade designs which enhance turbine efficiency and lower the cost of wind energy, and this sector has become one of the highest volume markets for composites.

Landmark applications lead the way

Composites are the material of choice for turbine blades. They are the only materials to offer the combination of properties which make it possible to the manufacture of the immense blades of 70 m and more in length which are being deployed today. The energy used to manufacture and install a turbine is quickly repaid. A life cycle assessment on Vestas' V110 model, which is equipped with 54 m blades, states that during its life this 2 MW turbine generates 31 times the energy used to manufacture the turbine itself. This market for composites will continue to grow as countries around the world support the development of clean energy programmes using sustainable energy sources. Excellent mechanical properties, low weight and high durability, combined with the design freedom possible with composites, are also leading to their adoption in emerging renewable energy technologies such as tidal and wave power.

Transportation is another sector where composites are making an impact in terms of sustainability. Composite materials weigh less than metals which leads to lower fuel consumption and reduced CO_2 emissions. The B787 Dreamliner was hailed as the world's first 'plastic' commercial aircraft. Around 50% by weight of the aircraft's structure is composite material. The resulting weight reduction, combined with improved aerodynamics and engines, delivers a 20% saving in fuel consumption. Corrosion-resistant composites also require 44-65% less maintenance hours than aluminium, which brings cost and environmental advantages.

Similarly, the automotive industry is turning to composites as part of lightweighting initiatives to improve fuel efficiency and lower emissions. And composites are playing a key role in the development of electric cars, a fast growing market worldwide. The BMW i3 – the car maker's first fully electric vehicle and the first medium-series production car with a full composite structure – was another landmark application for composites. In the i3, which is 20% lighter than its competitor the Nissan Leaf, lightweight composites compensate for the extra weight of the batteries, improving vehicle performance and extending range. Composites are also enablers for the ultimate low emission vehicles – solar-powered cars – which are now moving beyond the realms of R&D and on to the road.

In construction and infrastructure applications the durability of composite materials is a major factor in their favour. A doubling of the service life of a structure will halve its environmental impact. The minimal maintenance requirements of composites are a further differentiator over traditional construction materials. Drogt cites the example of the Spieringsluis, a composite lock gate which was installed in the Netherlands in around 2000, replacing a tropical hardwood structure. Although no longer in use it has been in the water for 17 maintenance-free years. The low weight of composites also delivered energy savings during operation, and in transporting and installing the parts. This application gave Dutch authorities the confidence to implement bigger infrastructure projects, including bridges, where composite decks enable rapid installation, leading to significantly reduced traffic disruption and consequently lower environmental impact. The Eye Catcher Building built in the late '90s is a Danish project where lightweight composites also demonstrated fast construction and low maintenance benefits. Composites also provide excellent thermal insulation, improving the energy efficiency of buildings.

In these examples, as in many further applications, sustainability during the use of the part is a key driver for the choice of composites. But to complete the sustainability picture, the production of the part must also be considered. Recognising the need for composites manufacturers to assess the environment impact associated with the production phase of their products, EuCIA commenced its Eco Calculator project three years ago.

Environmental design

Composites are complex materials. Reinforcement, resin and additives can be combined in innumerable ways to provide the optimum combination of properties required for a specific application. There are also many different processing techniques available to convert the materials into parts. However, it is the energy-intensive production of the materials that dominates the environmental impact of this phase of the life cycle.

Developed in collaboration with EY and BiinC, with input from EuCIA members, the Eco Calculator is an online tool for use in calculating the environmental impact of the production of composite products from 'cradle to gate.' Designed for ease of use – no in-depth knowledge of life cycle assessment techniques is required – it is supported by extensive data on composites materials and processes which EuCIA has collected over the past two years. The Eco Calculator was launched one year ago, and is free of charge to users. The tool is still under development and EuCIA is encouraging users and industry players to contribute to the data collection process.

The Eco Calculator allows companies to quantify the manufacturing part of the life cycle, but this data needs to be viewed alongside that for the use and end of use phases to determine if composite material is the right choice for sustainable application.

Drogt also believes a new approach to sustainability is needed – 'environmental design.'

"We need to design and engineer for minimal life cycle impact," he says. "The optimal design would achieve the best balance between the environmental impact of the production, use, and end of use phases of the life cycle."

Design for reuse is also essential, he adds. A 'second life' should be defined for the part or material at the design phase and this should become an integral part of the business case. Finally, the part should be designed for disassembly to make it easy to reuse the components or collect waste for recycling.

As the principles of the circular economy gain traction globally EuCIA believes that the benefits of versatile, sustainable composites will be recognised and exploited in an increasing number of applications and industry sectors.

"Communicating the sustainability of composites is a long term strategy for EuCIA," explains Roberto Frassine, EuCIA's President. "We strongly believe that sustainability and the circular economy are key to the future development of the composites industry."

A video of the Lightweight, Durable and Sustainable Composites seminar is available online. This is free to view for members of EuCIA member associations, and €50 for non-members. Please register at www.eucia.eu/forms/eventoctoberonline/.

About EuCIA

The European Composites Industry Association (EuCIA), headquartered in Brussels, represents European national composite associations as well as industry-specific sector groups at EU level. With the support of its members EuCIA is promoting a good trading environment in an innovative and growing European composites industry.

The mission, objectives and activities of EuCIA are structured under three key pillars:

- We Know – Industrial education and sharing of best practices;
- We Show – Being active at EU level and influencing decision-making;
- We Grow – Industrial growth and membership expansion across Europe.

More than 10,000 companies and an estimated 150,000 employees are actively involved in composites production across Europe.

Further information

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