Final resting place

Because rotor blades are made of composites, they pose challenges in recycling. The industry is working on alternatives to thermal combustion.

Rotor blades leave behind a considerable quantity of waste after a service life of about 20 years or if they are damaged before then. Photo: dpa

With a weight of up to 10 tonnes, rotor blades leave behind a considerable quantity of waste after a service life of about 20 years or if they are damaged before then. The issue is not just the sheer quantity of waste that is produced at the end of a wind turbine's life, but also the materials involved. Rotor blades frequently create waste containing plastics from glass or carbon fibre-reinforced epoxy resins.

So far, rotor blades have usually been chopped up, shredded and incinerated. Especially if polyvinyl chloride (PVC) is used, however, this can lead to problems, since hydrogen chloride is created during the combustion process – a caustic gas that reacts with water to form hydrochloric acid. The wind energy industry is therefore searching for alternative recycling processes.

One possibility is turning the rotor blades that have been sorted out into garden furniture. However, the chemical recycling process presents a challenge – separating the matrix plastic from the carbon and glass fibres is not easy, explains Wolf Stötzel, specialist at the German Wind Energy Association (BWE) in Berlin.

Looking for alternatives

This is an issue that Siemens plan to address at their rotor blade production facility in Aalborg, Denmark. Claus Rose, environmental health and safety (EHS) division officer at Siemens Wind Power, expects the volume of plastic waste to amount to 50,000 tonnes by 2020 and as much as 225,000 tonnes per year by 2035.

This is reason enough for Siemens to participate in the Danish GenVind initiative, a cooperation between companies and research institutes across industries that is also involved in the issue of rotor blade recycling. From the wind energy industry, companies such as Vestas and LM Wind Power are participating alongside Siemens. Academic institutions are also part of the initiative, such as the University of Nottingham from the UK and Aalborg University. "About six million euros is available for the project with GenVind. It started on December 1, 2012 and is scheduled to end in 2016," reports Karin Borg, who is responsible for the project at Siemens. The project aims to recycle rotor blades at the end of their product life.

"Incineration is not really what we have in mind," says Borg. Instead, one ideal possibility would be to use blades as insulation material, for instance. To this end, wind turbines are sawn, shredded and ground into small pieces. The optimal procedure is one focus of the research, and it depends on which industry is to make use of the recycled material. Logistics is another challenge. The key question here is whether a central crushing station or a decentralized disposal system makes more financial sense.

PPG Fiber Glass from the Netherlands is also supporting Siemens in its quest to improve rotor blade recycling. Chemist Jaap van der Woude points out that composites cannot simply be reconverted to their original materials. Resistant fabrics are formed during the fabrication process that must withstand the harshest weather conditions for many years. So far, the resulting materials could only be chemically

Due to the composites used in them, it is not exactly easy to dispose of disused rotor blades.
Photo: dpa

separated with enormous effort. The process for separating fibres from the matrix is also complex. "We are still working on the basics," van der Woude says.

Cement industry provides options

The Industry Association for Fibre-Reinforced Plastics (AVK) in Frankfurt states that thermal use of plastics in incineration plants is the most established process for recycling composites so far. One rationale for this is the high calorific value of 18 to 25 MJ/kg, compared to 43 MJ/kg for crude oil. In Germany, the Life Cycle Management Act requires a calorific value of at least 11 MJ/kg materials used in energy-related processes in waste incineration plants. Waste incineration often tends to have a negative image. According to the industry association, it is nevertheless common practice, especially for cost and availability reasons. However, the ashes produced need to be disposed of at a landfill site.

Another option, mentioned by both van der Woude and AVK, is using old rotor blades in cement admixtures. For this purpose, the material is cut into small pieces and pretreated. By adding other recycling materials, parameters like calorific value, humidity and ash content are modified. The resulting product is used in the cement industry as raw material and fuel substitute for manufacturing cement clinker. Producing cement is known to be a very energy-intensive process, but this can be mitigated by using glass fibre-reinforced plastics (GFRP). About 1/3 of the material input is used as fuel and about 2/3 as raw material in this technically mature process.

The benefits of the procedure are the unlimited market and the favourable environmental balances, but the complex logistics poses difficulties, with rotor blades up to 75 m long needing to be cut up into 25 mm particles. One of the companies that has specialized in this is Zajons Zerkleinerungs GmbH. Large-scale components from glass fibre-reinforced plastics are sawn on site, broken up into small pieces and transported to the plant. There, it goes through a dry mechanical process to manufacture the cement substitute material. However, the company is currently insolvent.

Vestas is also focusing on recycling. When asked about end-of-life scenarios for rotor blades, Christina Buttler of corporate communications responds, "Yes, we have already tested rotor blade recycling and now use it when necessary. Rotor blades are cut or chopped up. Recycling is then done thermally." Vestas also plans to process single pieces as an addition in fibre cement manufacturing.

Customers want more

The technologies with greater social acceptance, however, are those that aim to recover the fibres. For these processes, pyrolysis is required, which means heating the fibre plastic mix in the absence of air up to a temperature of approximately 800 °C, producing a pyrolysis oil that can be used for chemical purposes and to generate energy. Plastic is thus separated from the thermally resistant silicon dioxide fibre, which can then be reused. This procedure, however, sends costs spiralling and is only profitable for expensive, thermally resistant fibres. The impact on the environmental balance is also a complex matter, van der Woude adds.

So far, the wind power industry has modelled itself on the automotive industry. Motor cars can be entirely recycled except for three percent. Wind turbines are still a long way off this target, although responsible companies have already covered a large part of the distance. There is still time to improve on current procedures.

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