Composites turn the blades

Low weight but high strength and rigidity – these properties make composites useful as construction materials in various industries, including the wind power sector. Marcus Reichl talked to composites companies supplying the wind turbine manufacturers.

The success of wind energy would not have been possible without the use of composite materials.

"In the next few years we will see a 15-20% yearly increase in the number of wind turbines," says Roman Gaugler, owner of German company Gaugler & Lutz oHG, based in Aalen Ebnet. "This is mainly due to large offshore projects and the now very loud demands for environmental protection."

The plants will have continually improved performance.

"Currently more and more 5 MW wind turbines are being ordered, and in the future we are likely to see 10 MW wind turbines with 80 m long rotor blades," he says. "Longer rotor blades mean that more material will be needed – we are counting on this."

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The wind energy industry is continuing to experience high growth rates, which is good news for suppliers of composite materials and processing equipment. (Picture courtesy of Enercon.)

Material deliveries to the wind energy sector currently account for almost 80% of Gaugler & Lutz's total sales. Its list of customers includes all the well-known German wind power plant constructors. The company has about 150 employees and specialises in the processing and fabrication of core materials for lightweight sandwich construction. Gaugler & Lutz will present an insight into its product range at COMPOSITES EUROPE 2007 (6-8 November 2007 in Stuttgart, Germany), the European trade fair for composite materials. As well as foam materials and balsa wood, the trading company supplies reinforcements for the entire composites sector and operates its own production facilities. The company's processing capabilities range from computer numerically controlled (CNC) to hand fabrication, various types of surface processing, right up to thermoforming. At the beginning of the 1990s, Gaugler & Lutz introduced the so-called kit construction of components for the wind energy sector into its product range.

Blades

The giant wind turbine rotor blades consist of two half shells with a carefully designed shape, which are then glued together. They employ cross-linked dense, rigid foam and balsa wood.

The balsa wood is grown on plantations in Ecuador and felled after six years. The approximately 1 m long tree pieces are cut into square timbers and glued together to form 1.22 m long and 5 cm wide blocks. These blocks are cut, in the opposite direction to the grain, into boards and given a fine spraying of resin solution to protect them against humidity. On one side a fine glass fabric is laid, and the material is then punched out from the other side into small square pieces.

The rigid foam elements have a density of 60 kg/m^3 and are supplied in 2450 mm x 1150 mm x 78 mm sized blocks. Afterwards

they are split into boards, then cut to size, and then numbered according to the specified format. After the edges have been trimmed the blocks are packed. Using the help of a layout plan in each box, the respective part is allocated to the correct position on the rotor blade.

"Currently, vacuum injection is the main processing method used," explains Gaugler. "It offers significantly better industrial safety, an exact dosing of the resin, there are no bubbles produced in the laminate and it adheres better to the core materials."

About 4000 rotor blades per year are produced in this way using the help of materials made by this company. The owner reveals that "at the moment the smallest measures 27, the largest around 60 m".

The industrial production of the giant blades would not be possible without the use of composites. Neither the model, the moulds for the construction of the rotor shells, nor the rotor blades could be manufactured without them. The gluing together of top and bottom shells would also not be achievable. So that the epoxy and polyurethane resins and the modelling and adhesive pastes used can be prepared in the correct composition for use, two-component dosing and mixing plants are necessary such as those manufactured by Tartler GmbH from Lützelbach, Germany (also an exhibitor at COMPOSITES EUROPE 2007).

The company has developed efficient, flexible two-component mixing plants for the economic production of wind turbine rotor blades. If seamless modelling pastes (SMP) or epoxy pastes are used in large quantities then the Nodopox 200 mixing plant is used during the construction of the models. Depending on the viscosity and composition ratio it can extrude up to 5 kg of material per minute. The dosing ratio can be steplessly controlled from 100:10 to 10:100. The dosing pumps and mixing heads are driven by frequency regulated motors.

The company's Nodopur two-component mixing systems are used in the production of the two rotor blade half-shells, which are made using epoxy resins. The machines can process up to 40 litres per minute and can intelligently control the vacuum infusion or resin transfer moulding (RTM) process. Tartler also supplies a mixing and dosing machine suitable for the adhesive paste used in the joining of the two half shells.

In the future we could be seeing 10 MW wind turbines with 80 m long rotor blades. (Picture courtesy of Vestas.)

Drive shafts

Composites not only help reduce the weight of rotor blades. FWT Wickeltechnick GmbH in Neunkirchen, Austria, produces drive shafts for wind turbines using glass reinforced plastics (GRP). About 60 units were delivered last year.

"Low weight, temperature resistance and reliable transmission of force make the material very interesting for this application," explains managing director Günther Kautz.

Another decisive criterion is the electrically isolating nature of the composite material.

The company uses filament winding technology to produce the shaft or tube. The resin bath can be heated if required to adjust the viscosity of the resin. The winding mandrel is coated with non-silicon release agent. The fibres are positioned using a CNC winding machine with four programmable axes. This guarantees an exact layout of the fibres and reproducibility of the components.

Composites not only help reduce the weight of rotor blades. Drive shafts for wind turbines are being produced using GRP.

In the filament winding process, fibres with spools weighing 1-6 kg are placed on the spool spindles. The fibres are unwound from the spindles and through the resin bath in which they are impregnated. The fibres are then wound onto the mandrel, which is coated with a non-silicon release agent. After the winding process the wound mandrel is

Composites are not only used to manufacture the turbine's rotor blades, they can also be used to produce the drive shafts. (Picture courtesy of Enercon.)

then placed into a circulating air oven and rotated. The curing cycle is resin-specific. During the process the chamber temperature is recorded using a non-contact instrument so that compliance with the curing cycle can be checked. The cure tube is cut to the required length and then pulled from the mandrel using a pull-out device. Afterwards the tube is processed further according to the customer's specifications.

"In the winding procedure all normal types of fibre can be processed such as glass, carbon and aramid fibres", says Kautz. (His company is also exhibiting at COMPOSITES EUROPE 2007.)

A growth industry

As well as the top names in the wind energy (Vestas, Enercon, LM Glasfiber), around 1500 suppliers from the plastics processing industry worldwide are customers of the company BÜFA Reaktionsharze GmbH & Co KG from Rastede, another COMPOSITES EUROPE exhibitor.

"Over the last few years the subject of wind energy has become more and more important", says the company's managing director Jürgen H. Aurer.

Currently, around 12% of the company's turnover of €70 million is generated in this sector. In addition to a special adhesive – an adhesive resin based on vinyl ester, which is used to glue the rotor blade shells together – the most important products in this segment of the market are release agents, glass fibre materials as well as the composite processing machines.

"One can say that around 1000 rotor blades are produced every year thanks to our help," Aurer reckons.

The company's vinyl ester resins are custom-made according to the requirements of the moulder. They are designed to be easy to use, have very good physical properties, especially when used with fibre reinforcements, and there are many ways of customising them according to changing requirements. They are especially suitable for the manufacture of rotor blades because they can be easily removed from the mould.

The moulder must achieve shorter and shorter cycle times.

> The moulds for the rotor blades are extremely expensive. The mould must be emptied and refilled as quickly as possible.

"The moulds for the rotor blades are extremely expensive," Aurer explains. "This means that the mould must be emptied and refilled as quickly as possible."

The managing director of BÜFA expects a rapid growth in wind energy in the next few years. Up to the year 2010, experts predict a doubling of the currently installed power generation capacity of 74 000 MW, in which the USA will undertake a leading role (see the feature on pages 14-16 for a review of the current status of the global wind energy market).

"This wind energy sector is a strategic growth segment in our company," says Aurer. "We have therefore formed our own group of experts." ■

COMPOSITES EUROPE

COMPOSITES EUROPE 2007 will be held on 6-8 November in Stuttgart, Germany, one of the world's most dynamic economic regions. In choosing this location the organisers Reed Exhibitions Deutschland GmbH, EuCIA and *Reinforced Plastics* continue their strategy of holding COMPOSITES EUROPE in the most important centres of composites application in Europe.

After the successful first COMPOSITES EUROPE, a total of more than 200 exhibitors and 4000 international visitors are expected. Over 120 international companies, institutions and organisations have already booked a stand at COMPOSITES EUROPE 2007, including EADS, AOC, Huntsman, Menzolit, Exel Oyj, Röchling, and Büfa.

Contact Cathrin Schweighöfer to find out more; tel: +49-211-90-191-224; e-mail: cschweighoefer@reedexpo.de; **www.composites-europe.com**

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Gaugler & Lutz oHG; **www.gaugler-lutz.de**

Tartler GmbH; **www.tartler.com**

FWT Wickeltechnick GmbH; **www.fwt.at**

BÜFA Reaktionsharze GmbH & Co KG; **www.buefa.de**