STANDING TALL AND LIGHT

When it comes to wind power, size pays off: Materials from Evonik are helping to make rotor blades longer, which increases turbine output.

If you want to get as much electricity out of wind power as possible, and as continually as possible, you have to reach for the skies. That's because the higher you go, the stronger and more reliably winds blow—and the energy yield also rises disproportionately as rotor blade length increases. For example, a wind turbine with rotor blades 45 meters long generates around two megawatts of power. Rotor blades with a length of 70 meters generate four megawatts, and top models can even produce more than seven megawatts. Wind turbines are therefore getting taller and taller and are increasingly being installed at greater heights, and often offshore as well.

However, the strain on the rotors, and their weight, also increase in proportion to the desired energy yield. The rotor tips on a 4.5-megawatt wind turbine with 70-meter long rotor blades move faster than a Formula 1 race car at full speed, reaching 400 kilometers per hour in some cases. However, each of the three rotor blades weighs as much as a semitrailer and bends up to ten meters in the wind.

The only way such structures can withstand that kind of torture over many years is through the use of very special materials, such as those developed by Evonik Industries. These materials have to be extremely stable in order to withstand the forces they're exposed to, yet they also need to have sufficient flexibility to ensure they won't break when they bend. They should not become soft at high temperatures or brittle at low ones, and they must be resistant to long-term exposure to UV radiation, sand, salt, rain, and ice.

In order to ensure this and thus help create more efficient wind turbines, the materials specialists at Evonik focus on two key factors: stability and weight.

Among other things, extremely large glass fiber mats impregnated with epoxy resin are used to make giant rotor blades stable. VESTAMIN® IPD is the key reactive component for hardening the epoxy resin. "Although each epoxy resin rotor blade only contains a few percent of VESTAMIN® IPD, the blades couldn't be made without it," says Michael Vogel, who is responsible for VESTAMIN® marketing. The material is the industry standard for the high degree of mechanical stability needed (at high temperatures as well), and it also ensures a long service life for the rotor blades. As used in the hardening process, it helps lead to greater reactivity and shorter production times as well. In the case of a 45-meter turbine blade, around five metric tons of epoxy resin with just a small percentage of VESTAMIN® IPD and the glass fiber mats is hardened in giant molds in just one process step. The mats often slip when they're being laid up and this used to require a lot of manual labor in the rotor manufacturing process. ▶

A total of 1.5 metric tons of adhesive is required to keep the half shells of a rotor blade over 80 meters long permanently together.

Source: Evonik

COMPLETE FACILITY FOR CHINA

Location:
Shanghai, China

Commissioning:
May 2014

Products:
Isophorone and isophorone diamine

Production capacity:
50,000 metric tons per year

Most important markets:
Wind power and coatings

Investment sum:
Over €100 million

PRECISION WORK ON A GRAND SCALE: **Before a rotor blade leaves a manufacturing facility, it is examined closely for defects and cracks. Even minor material weaknesses can lead to costly breakdowns during peak-load operations**

▶ A special Evonik adhesive known as ALBIPOX® has eliminated this problem. Robots can now lay up the mats, which lowers production costs and makes the design more stable. There was still another problem, however: "Components of that size are not precisely dimensioned, and glue lines as thick as a thumb often have to be sealed with the adhesive," says Dr. Stephan Sprenger from the Composite Industry Team. As much as 1.5 metric tons of adhesive is used to hold the two half shells together. Silica from Evonik—more specifically AEROSIL® R208 (as a thickener) and VESTAMIN® IPD (for reactive components)—make the adhesive stable enough to ensure the half shells remain permanently affixed to one another even under peak loads.

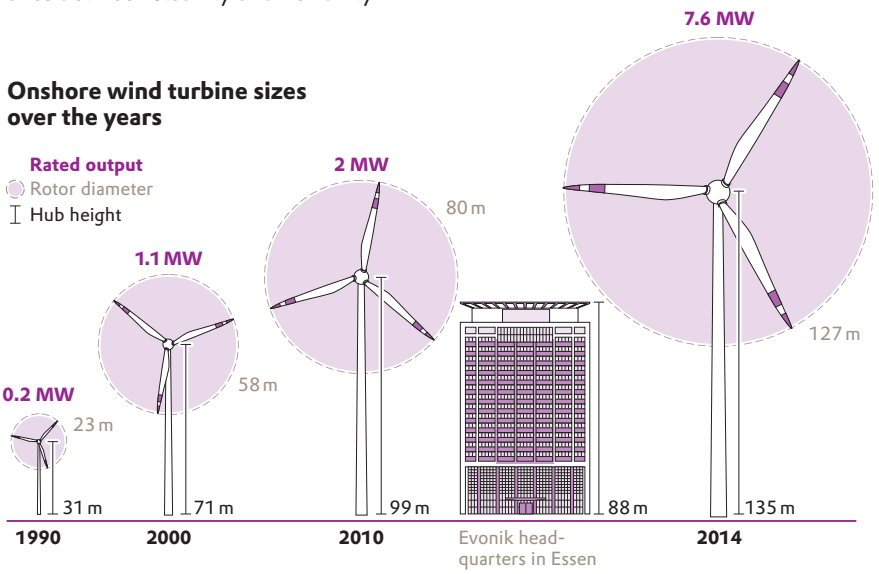
The epoxy resin impregnated into the glass fiber mats also contains silane-based Dynasylan®, which ensures the right balance between stability and flexibility. Because stability cannot come at the expense of increased weight, the shell and spars are manufactured with the very light ROHACELL® structural foam. "Our material is used by leading manufacturers of rotor blades," says Christoph Menzel, a wind power project manager at ROHACELL®. For example, the German-Polish company EUROS used ROHACELL® to develop the longest fully certified rotor blade at the moment (81.6 meters). These types of rotors will be used at offshore facilities with an output of seven megawatts.

ROHACELL®, which is incorporated into sandwich structures, is not only light itself; its very fine pore structure also ensures it absorbs extremely little epoxy resin during the production process. This can reduce the weight of each rotor blade by as much as one metric ton. ROHACELL® is also very temperature-resistant. The epoxy resins can therefore be hardened at temperatures of up to 130 degrees Celsius, which is much higher than the limit for comparable products. This shortens the hardening time by 20 percent and makes the production process much more cost-effective.

Evonik has also solved problems associated with rotor blade coatings. Because UV radiation would turn epoxy resins brittle over the lifespan of a wind turbine, the coatings used have to remain effective for many years. That's why they contain Evonik specialties such as VESTANAT®, AEROSIL®, and Dynasylan®. NANOPOL® nanoparticles protect them against salt and sand. This protection against the ravages of time pays off for wind farm operators, especially when one considers that it takes two days to replace a rotor blade at sea and it costs around €2 million to rent a special ship for this period.

Evonik is also now bringing its specialized knowledge of techniques for extreme lightweight construction—and the associated products—to the Chinese growth market. In order to meet growing demand in China, Evonik invested more than €100 million in the construction of a new production facility for isophorone and isophorone diamine (i.e. VESTAMIN® IPD), which is very important for lightweight construction. The new isophorone complex in Shanghai began operating in the first half of 2014. China is already the world's biggest market for wind power plants by far, and the country plans to double its wind power capacity to 200 gigawatts by 2020. Large offshore wind farms are part of this plan. These will also be very tall—but thanks to Evonik, lighter than ever before.

Onshore wind turbine sizes over the years



Sources: Fraunhofer IWES, Evonik, ENERCON