Customer Success Story:
Wind turbine gearbox manufacturer

Market segment:
Wind power

A lightweight with a heavyweight's strength

Location:
Europe

Challenge:
Reducing weight of the gearbox lubricant filtration system with fewer components and interfaces to eliminate misalignment issues

Solution:
The custom designed filter system equipped with Eaton's TWF Twinfil™ 4000 and 6000 filter systems with 01.NR.1000 return-line filter elements and 2-stage Twinfil filter elements

Result:
A compact filter that increases reliability and efficiency to the gearbox and its lubrication system

The custom designed TWF Twinfil filter system is fulfilling the requirements of the gearbox manufacturer. Essential was the success in reducing the weight of the filter systems by 78%, which was key to reduce the overall weight of the gearboxes.

Background

Wind energy is one of the fastest-growing renewable energy resources globally; it is free, sustainable and inexhaustible. However, due to their continuous energy production and often remote locations gear-driven wind turbines are a very demanding application that requires extreme reliability and durability. At the same time, manufacturers strive to build bigger, safer, more efficient and powerful turbines to provide the world with more affordable electricity.

At the top of the wind turbine's tower is the nacelle, which houses all the generating components such as the generator, gearbox, drivetrain and brake assembly. For gear-driven wind turbines, the gearbox is a critical system. It steps up the relatively slow rotational speed of the blades, or extruders, to a higher speed, roughly 60 times more, needed to generate electricity. Generally, turbines start producing energy at wind speeds above 5 to 7 mph (2 to 3 m/s). At speeds below this threshold, the turbine is not generating electricity, and the rotor is just idling.

On top of the nacelle are wind instruments, such as an anemometer and wind vane, which work out where the rotor has to point into the wind, and the correct pitch angle of the blades. For optimal performance of the turbine in any wind condition, the pitch of each of the common three blades is controlled independently by a gearbox.

Challenge

Pitch control is essential, especially in very windy conditions, to keep the gearbox from getting overloaded and to avoid imbalance. Depending on the direction and strength of the wind the gearboxes rotate each of the extruder blades to optimize power generation. There is usually a shock sensor inside the nacelle to measure vibration, which increases with wind speed. If the vibration reaches a specific limit, the turbine goes into a safe 'pause' mode until the wind dies down. However, large moments and forces are applied by the turbine rotor onto the drivetrain. To prevent stress points and failures, designers adjust the gearbox to support the loads and stress. Therefore, seals and

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lubrication systems must operate consistently, even in wide temperature variations; otherwise, dirt and moisture may collect and build-up inside the gearbox. Since oil contamination can cause gear failure and lead to breakdowns, potentially resulting in high repair costs, lost energy production or even destruction, the maintenance, monitoring and filtration of gear oil is an essential part of preventive maintenance programs.

The need to continuously optimize the power-to-weight ratio and energy yield of wind power gearboxes while simultaneously reducing the cost of producing wind energy led a global designer, manufacturer and supplier of gearboxes for wind turbines to reach out to Eaton for a customized solution. Known for its robust research and development operations, strategic partnerships and technological leadership the company has installed thousands of gearboxes with a total capacity greater than 50,000 megawatts. Their main objectives were to reduce the weight of the filter system, reduce the number of components and interfaces needed while providing full filtration quality and corrosion protection. Serviceability and low initial investment were equally important factors.

Solution

Eaton's custom designed TWF Twinfil filter system was engineered to meet the requirements. The result was a new generation of a gear lubricant filtration system that reliably met performance specifications.

The previous generation filter system was made from carbon steel and cast iron, which was C_4H painted. Any paint damage, therefore, would result in severe corrosion. By using anodized aluminum instead, the corrosion risk was minimized.

Also, with a density of 168 lbs/ft³ (2,699 kg/m³), anodized aluminum in place of carbon steel and cast iron, with a density of 491 lbs/ft³ (7,873 kg/m³), reduced the weight of the TWF Twinfil filter system by at least 882 lbs (400 kg), depending on the size. With the lower weight of the filter system the overall weight of the nacelle, a key design parameter in this project, was reduced significantly.

The custom design combines the filter's four mounting blocks into a single connection, virtually eliminating misalignment issues. The simplified mounting design also uses fewer sealed connections to reduce the risk of leaks. In addition, the new design integrates all valves into the system and connects the mounting plate to the manifold block. The new bayonet closure that replaces the previous flange cover permits rapid filter element changes, which improve serviceability by minimizing both maintenance and operating costs.

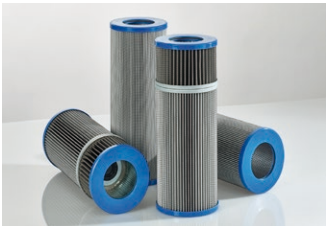
The TWF Twinfil filter system relies on glass fiber fleece 01.NR.1000 return-line filter elements and a 2-stage Twinfil filter element. The latter combines a fine 10 µm filter made of high-performance glass fiber fleece with a coarse filter made of stainless steel wire mesh with a nominal fineness of 25 µm. These two parts are separated by a bypass valve that allows an opening pressure of 51 psi (3.5 bar). The valve is designed to protect the fine filter from any damage due to high viscosity at low temperatures or provides permanent filtration by the fine filter when closed. In the end the TWF Twinfil filter system provides up to three different levels of fineness depending on the used filter elements, is suitable for a working pressure up to 363 psi (25 bar) and effectively removes particles from lube oils down to 6 µm, reliably and consistently throughout the filter's life at a maximum flow rate of 66 gal/min (250 l/min).

All system components work properly from a cold start to the +158 °F (+70 °C) maximum operating temperature without any adverse effect on the overall gear-oil supply. The flow dividing valve reliably controls the flow rate to the cooler or directly back to the gearbox.

Result

The custom designed TWF Twinfil filter system is fulfilling the requirements of the gearbox manufacturer. Essential was the success in reducing the weight of the filter systems by 78%, which was key to reduce the overall weight of the gearboxes. In this pilot project Eaton was providing more than 80 units of TWF Twinfil 4000 and 6000 filter systems for the different wind turbines in the park. Both have proven to de-aerate oil under all operating conditions, enhancing the reliability and efficiency of the gearbox and its lubrication system by assisting users in maximizing output while minimizing downtime and operating costs. An additional benefit for the gearbox manufacturer is that the new TWF Twinfil filter system meets all the relevant safety certifications for wind turbine applications worldwide.

Eaton's **TWF Twinfil 4000 filter systems** are especially designed for gear lubrication systems in wind turbines. Each of the "filter pipes" holds one of Eaton's 01.NR.1000 filter elements and a 2-stage Twinfil filter element.



Eaton's **01.NR.1000 return-line filter elements** and 2-stage **Twinfil filter elements** are the perfect match for demanding challenges in lubrication oil filtration in wind power gearboxes.

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11-2021

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