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Lubricating wind

Choosing the Right Wind Turbine Lubricant

By Fred Mitchell, ExxonMobil Lubricants & Petroleum Specialties Co.

One of the most prolific sources of renewable energy is wind power. Generating electricity by the circular turning blades of a turbine propelled by wind, the prevalence of this renewable energy source has, over the past several years, grown dramatically. Wind accounted for more than 30 percent of new generation capacity added in the United States in 2008, up from nearly 1 percent in 2002, according to estimates from the American Wind Energy Association (AWEA).

To make sure newer and older wind turbines operate reliably and produce the maximum amount of electricity, personnel maintaining wind turbines must use the proper lubricants. But the characteristics of a well-balanced wind turbine lubricant are complex and can be confusing when trying to differentiate between products on the market.

This article outlines the performance characteristics that maintenance professionals should consider when selecting a wind turbine lubricant for the main gearbox. By evaluating these product attributes, maintenance professionals can make a more informed decision when it comes to selecting the right lubricant.

Lube Points

A wind turbine has several main lubrication points. They include the main gearbox, ancillary pitch and yaw gearboxes and hydraulic controls for braking and pitch control. Also needing lubrication are main bearings used for pitch and yaw and generator bearings.

The main gearbox is usually the most challenging to lubricate. It is the heart of most wind turbines because it drives the generator. Because of their advanced designs and critical importance to system performance, it's no surprise that main gearboxes can be very costly. When factoring in all expenses, replacing a gearbox for a 1.5 MW turbine can run more than $250,000 including the price of a new gearbox, crane rental, manpower and lost revenue.

Gearboxes typically come from the factory filled with synthetic lubricant designed for the turbine to operate about three years. However, the standard warranty length for most gearboxes is one year. Once the gearbox is no longer under warranty, maintenance professionals will be responsible for choosing the replacement lubricant, often called the "second fill" or "service fill."

The need to minimize weight at the top of wind towers has produced compact gearbox designs that incorporate the case hardening of the gear surfaces. Case-hardened gears exposed to unpredictable winds and loads found in wind turbines (carburized, nitride, induction and flame hardened) are susceptible to micropitting and require a gear lubricant that protects against this type of wear.

Micropitting is a surface fatigue phenomenon primarily seen in gears and rolling element bearings. Starting within the first few hours of operation, micropitting can cause numerous surface cracks. The cracks propagate at a shallow incline angle to the surface (usually less than

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30 degrees), forming extremely small micropits with a magnitude typically less than 10 microns (µ); by comparison, the width of a human hair is about 40µ. The micropits aggregate to produce a continuous fractured surface. Individual micropits have a size of 5µ to 20µ and a depth up to 10µ, making them invisible to the unaided eye. While a micropit may seem small, they can reduce gear tooth accuracy and even lead to gear breakage.

To minimize the chance of unscheduled downtime and gear replacement, maintenance personnel can use an oil specifically formulated to prevent micropitting. A gear lubricant's micropitting protection is measured using the FVA 54 Micropitting Test.

An oil's micropitting protection is rated based on its performance during the two sections of this industry-standard test: six sets of increasing loads for 16 hours each and a high load endurance test conducted for 80 hours. Both tests are conducted at 1,500 rpm. C-faced gears specifically designed to micropit are used. Based on tooth profile deviation, percentage of micropitting area and weight loss, the oil is given a numeric score and a high/normal/low endurance designation. All major gear manufacturers recommend that maintenance professionals use an oil with a rating of at least "= 10 high."

Keep in mind that micropitting protection of a second-fill lubricant will not fix gears that have already started to develop micropits. However, the performance feature should be addressed after gears have been replaced to help promote efficient production and prolong the life of new gears.

The correct lubricant also addresses anti-scuffing and bearing protection. Scuffing, characterized by material transfer between sliding tooth surfaces, occurs when the gear oil is not thick enough, creating metal-to-metal contact between gears. If scuffing persists, gears will need to be replaced prematurely.

The FZG Scuffing Test (DIN 51354-2 mod) measures the scuffing resistance and anti-wear performance using standardized gear-sets under various temperatures and speeds. Lubricants are rated based on their fail stage or FLS. Maintenance professionals should use an oil with "FLS>14."

One of the most common causes of gearbox downtime is related to bearing failure due to poor lubricant quality and application. The FAG FE8 Four-Stage Test for Wind Turbine Gear Oils measures a lubricant's performance on a bearing under varying load, speed and temperature conditions. The four test stages include wear test, mixed friction, life test and sludge. Based on the collective results, lubricants are rated on a scale of 1 to 5. A score of 1 indicates the lubricant provides superior bearing protection.

Viscometrics

Viscometrics refers to a lubricant's ability to maintain its viscosity over a range of cold and hot temperatures. Wind turbines are exposed to demanding operating conditions. From day to night and summer to winter, turbines can operate at temperatures as cold as –49 F and as hot as 176 F. To determine if a lubricant can withstand temperature changes, maintenance professionals can evaluate a product's viscosity index. The viscosity index is tested by using ASTM D2270 and indicates a lubricant's resistance to change viscosity with temperature. Maintenance professionals should look for products with a score of "160" or higher.

Synthetics offer significant viscometric advantages over their mineral-oil based counterparts and provide excellent lubricity over a wide range of temperatures. For this reason, synthetic-based products are more prevalent for gearbox oils.

Filterability

Because maintaining clean oil will increase component life dramatically, American Gear Manufacturers Association guidelines have set some stringent requirements for gear oil cleanliness in main gearboxes. An oil's filterability (namely its ability to pass through filters and not clog them under actual field operating conditions) is oftentimes overlooked.

Standard filterability tests typically evaluate only new dry oil, which may or may not be indicative of what conditions are like while in operation. Documentation gathered at large wind farms indicate that the total cost of ownership expense to replace filters as little as twice as often as recommended by manufacturers can run well over $275,000 a year.

It's also important to understand how an oil's additive package affects its filterability. Filterability is generally talked about in terms of micron (µ) rating. Often, 2µ kidney loop filters and 5µ main filters are used to clean the oil and protect wind turbine gearbox components. Care must be taken that micron rating and filter material are properly understood and treated. Sometimes, additives can be filtered out or have the tendency to drop out of an oil especially if the oil holds water. Filterability varies in an oil depending on if it's wet or dry.

To understand this relationship, consult your lubricant manufacturer and filter suppliers determine the oil that works best with the filters in your system.

Water Tolerance

Oil and water should not mix in a gearbox. However, keeping oil completely separate from water is practically impossible because of how wind turbines operate. While the blades are turning, gearboxes operate at temperatures as hot as 203 F. When the blades stop turning, the gearbox cools and draws in moisture or humidity from the air. As it "breathes," water enters the gearbox.

Using an oil with poor water tolerance can cause residue to form and oil to break down. To prevent these water-related issues from occurring, find a gear oil that does not have a tendency to retain water, yet provides adequate equipment protection in the presence of small amounts of water.

An oil's water tolerance characteristics are evaluated by ASTM D1401, which measures the lubricant's ability to shed water. This measurement is given in terms of time (minutes). Maintenance professionals should look for an oil with a score of "15 minutes" or less.

Wind turbine gearbox oil presents one of the most challenging industrial lubricant applications in the modern industrial world and requires cutting-edge technology. Lubricant manufacturers spend millions of dollars formulating and qualifying lubricants for these demanding applications. By evaluating the performance characteristics outlined here, maintenance professionals will gain valuable insights needed in selecting wind turbine gearbox oils that will help increase productivity, minimize downtime and reduce maintenance and component costs. pe

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ExxonMobil and COT-PURITECH Complete Gear Oil Conversion in 32 enXco GE 1.5MW Wind Turbines

Exemplifying its ability to deliver high-performance synthetic lubricants that can meet the most demanding applications, ExxonMobil announced that its synthetic Mobil SHC XMP 320 gear oil has been selected for a second-fill application in GE wind turbines operated by enXco, a leading owner and operator of wind turbines in North America.

Used in more than 20,000 wind turbines worldwide, Mobil SHC XMP gear oil is designed to deliver exceptional, long-lasting performance, reduce wear on critical parts and minimize component replacement, which can translate into valuable cost savings and reduced maintenance expenditures.

As part of Mobil's Integrated Lubrication Services Program, COT-PURITECH conducts its proprietary gearbox flushing procedure to remove existing contamination and virtually all of the residual oil from the gearbox and lube system.

Recently, enXco, an EDF Energies Nouvelles Company, had 32 of its 1.5 megawatt GE turbines converted to Mobil SHC XMP 320 synthetic gear oil at their Minnesota-based Chanerambie and Viking Wind Farms. At these sites, enXco generates enough energy to power thousands of homes in the southwestern region of Minnesota.

The entire four-week conversion process was executed by ExxonMobil's exclusive service provider of Integrated Lubrication Services, COT-PURITECH, with ExxonMobil Field Engineering and analytical support. A proprietary gearbox flushing procedure, part of COT-PURITECH's Wind Turbine Lubrication Services, was performed to remove existing contamination and virtually all of the residual oil from the gearbox and lube system, which remained from the previous synthetic lubricant used during original fill.

"Developed through years of experience and working closely with leading gearbox and turbine OEM's, COT-PURITECH's proprietary gearbox flushing procedure was performed for enXco to help ensure optimal gearbox performance and to minimize possible compatibility issues," said George Mazzaro, market manager, COT-PURITECH Wind.

"enXco's selection of our premium Mobil SHC XMP 320 gear oil for many of its GE wind turbines is just another example of how our first-rate application expertise and lubricant technologies continue to help our customers maximize productivity and gain a competitive edge," said Brad Prickett, industrial sales engineer, Mobil Industrial Lubricants.

For more information about Mobilgear SHC XMP 320 or any other Mobil products and services call 1-800-MOBIL25 or visit www.mobilindustrial.com.

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