Donaldson
WIND ENERGY NEWS

The Leader in Wind Turbine Contamination Control Technology

Fall 2009

Power Engineering Magazine

An article on "Contamination Control for Wind Turbine Gearboxes" was published in the November issue of Power Engineering Magazine. The article was written by Donaldson (Bill Needelman, Marty Barris, and Greg LaVallee). November is the premier edition of this well-known trade journal, and will be distributed at the Power-Gen Conference and Exposition this December in Las Vegas. The paper discusses benefits achieved by keeping wind turbine gear oil clean and dry, and best practices for protecting wind turbine gearboxes from particle and water contamination. The article will soon be available at http://pepei.pennnet.com/; click on Current Issue/Power Engineering. Reprints will also be available from Donaldson-IH.

ASME Wind Energy Tribology Committee

ASME hosted a Wind Energy Conference as part of the ASME/STLE Joint International Tribology Conference held in Memphis in October. This event is becoming the primary annual technical meeting for wind energy machinery in North America. Presentations were made by gearbox and bearing companies, several national government laboratories, and major owner/operators.

Donaldson (Bill Needelman) participation included:

1) Two ASME Subcommittees were created to study micropitting in wind turbine gearboxes, one for bearings and one for gears. Donaldson is the resource to both subcommittees for all issues regarding oil contamination.

2) A presentation on "Oil Contamination in Wind Turbine Machinery - Problems & Solutions" to the **ASME Graduate Student Workshop on Wind Power**. The audience was Ph.D. engineering students planning on going into wind energy and related areas. This was an excellent opportunity to educate future industry leaders on the importance of contamination control.

3) Co-authoring a technical paper with **Timken** (Michael Kotzalas, Chief Engineer of Product Design), on "Minimizing Oil Contamination and Using Debris Resistant Bearings to Enhance Wind Turbine Gearbox Performance". The paper discussed improvements in gearbox bearing performance and life achieved by reducing the harmful effects of oil contamination, and the advantages of using bearings resistant to oil contaminant debris.

4) Co-authoring a paper with **Columbia University** (Elon Terrell, Professor of Mechanical Engineering) on "Current and Future Tribological Challenges in Wind Turbine Power Systems". The paper surveyed problems that need to be solved to make wind turbine more reliable and efficient. Improving the control of oil contamination is one of the major issues.

The main message delivered by the Donaldson technical presentations at this ASME Wind Energy Conference was that oil contamination problems can be eliminated by keeping gear oil and hydraulic fluid scrupulously clean (14/12/10) and dry (< 125 ppm), resulting in greater wind turbine reliability and energy production, longer oil life, and lower maintenance costs.

NREL (National Renewable Energy Laboratory)

NREL hosted a Condition Monitoring Conference for Wind Turbines in October. Donaldson (Marshall Martin and Bill Needelman) attended and actively participated in the conference. A zip-file of the proceedings can be downloaded from: ftp://ftp2.nrel.gov/pub/Incoming/Wind_Turbine_CM_Workshop_2009_Presentations.zip

Noria Lubrication Excellence

Donaldson (Greg LaVallee and Bill Needelman) presented on "Dry Air Purging for Water Contamination Control". The presentation discussed reservoir head space management for controlling water and particle contamination. It explained how the ARV™ Dry Air Blanket System is a user-friendly method for maintaining very dry oil in operating systems, typically in the 50-150 ppm range. Field data from an operating lube system and an operating hydraulic system were presented showing excellent water contamination control, in spite of spikes of water ingression through leaky seals. In addition, the demonstration of the ARV™ system at the Donaldson booth received wide attention and much positive feedback from the conference attendees.

Legend

Bill Needelman: Chief Science Advisor
Greg LaVallee: Principal Engineer
Marty Barris: Engineering Director
Marshall Martin: Sales Manager

ASME: American Society of Mechanical Engineers
STLE: Society of Tribology and Lubrication Engineers

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Field Test Case Study: Tracking Gearbox Oil Water Content

Equipment:

- GE 1.5 MW wind turbines with Winergy gearboxes on a wind farm in the upper Midwest, which operates >200 turbines.

Gearbox Breather:

- Silica gel passive moisture absorptive breather (near right)
- Donaldson T.R.A.P. self-regenerating moisture absorptive breather (far right)

Silica Gel

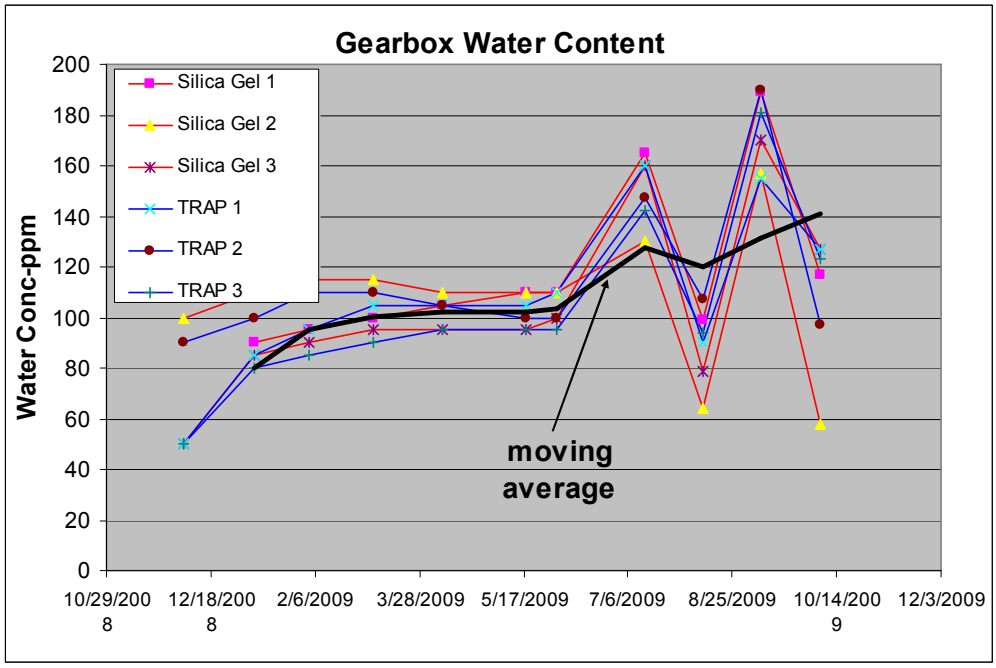
TRAP

Background:

These gearboxes normally operate over temperature range of 30-70 °C (86-158 °F). Gearbox lubrication is provided by an ISO VG320 gear oil, based on a PAO (polyalphaolefin) synthetic lubricant. Normally the gear lube is sampled and analyzed prior to each filter service interval. The wind farm operator was interested in assessing the performance of Donaldson TRAP regenerable breather-driers versus the current desiccant breather, using new gear oil. Their main objective was to monitor the gear oil's water content and to maintain that content as low as possible to extend gear oil life and gearbox performance. Prior to the installation of new moisture absorbing breathers, the gearboxes were drained and flushed thoroughly, and then refilled with new gear oil. Three TRAP breathers were then installed on three different turbines, as were three silica gel breathers on three turbines (total of six turbines overall). The turbines then were placed into service and monitored monthly as part of the field test. To minimize variability the same oil analysis laboratory tested all oil samples using the same preparation and Karl Fisher procedure.

Conclusions:

- Average starting water content was 68 ppm with a range of 50 to 100 ppm.
- Average water content after 6 months of operation rose slightly to 104 ppm (range 95 to 110 ppm).
- Most recent available data from the 10 month point averaged 110 ppm (range 58 to 127 ppm).
- Over the entire 12 month (to date) duration of the trial, the TRAP breathers averaged 109 ppm, with the Silica gel breathers averaging just slightly higher at 111 ppm.
- The difference in water content between TRAP and Silica gel equipped breathers is not considered statistically significant.



Recommendations:

- Always track the data trends, not relying on a single set of data points.
- Use TRAP for its superior combination of moisture removal, particle filtration, and gear oil mist coalescence.

Analysis:

There are several sources of water for wind turbine gearboxes. New oil has some water present, we measured 50-100 ppm. Atmospheric humidity can enter through breather ports. Moisture may also ingress through shaft seals, which the engineering staff at this wind farm believes to be the dominant factor in this location. Different gear oils have varying affinities for water; the synthetic PAO used in this test had a low water affinity.

The common silica gel breather absorbs water as moist air is drawn into the gearbox. Once water becomes adsorbed a silica gel breather cannot regenerate its capacity under normal operating temperatures. The Donaldson TRAP breather uses a patented adsorbent treatment that adsorbs water during inhalation into the gearbox, and then desorbs that water and releases it back to the atmosphere during exhalation out of the breather port. As long as the gearbox breathes on an approximately daily basis, TRAP regenerates. Self-regeneration coupled with a high surface area particle filter and an oil mist coalescing stage, enables the TRAP to provide better protection for gearbox applications.

Finally, it is important to note that different climates have varying levels of atmospheric moisture and seasonal trends. This field test was set in a relatively dry northern climate, excepting the summer season. Although useful for this region, the self-regenerating ability of TRAP becomes increasingly important in more humid climates.