Donaldson
WIND ENERGY NEWS

The Leader in Wind Turbine Contamination Control Technology

Fall 2008

Wind Turbine Gearbox Symposium, ASME/STLE Joint International Tribology Conference, Miami, Oct '08

Donaldson (Bill Needelman) was an invited speaker. Other invited speakers at this prestigious Symposium were representatives from Timken, SKF, NREL (National Renewable Energy Laboratory), and ExxonMobil. Bill's presentation described strategies and products for improving WT gearbox reliability, leading to greater uptime, reduced maintenance costs, and greater ROI. Products included T.R.A.P.™ for moisture control, full-flow $\beta_{5(c)} = 1000$ particle filters, and side-loop $\beta_3 = 1000$ filters and water absorbing elements. Several photos (courtesy of COT-Puritech, an Ohio-based lubrication service provider) showing damage caused by additive drop-out from gear oils due to water contamination received considerable attention, and are reproduced on the right.

Water Damage: Additive Drop-Out

Clean Filter Bowl Sludged Filter Bowl

Water Damage: Additive Drop-Out

Fouled Oil-Level Sensor

Water Damage: Additive Drop-Out

Fouled Thermostat

ASME Committee on Wind Turbines

Donaldson is a founding member of this new Committee under the auspices of ASME. Other members include: NREL, NASA, Timken, and SKF. Several wind turbine gearbox manufactures, large users, and gear oil suppliers will likely join in the near future. This group is expected to become a national committee for improving wind turbine reliability in North America.

AWEA National Meeting – Houston, June '08

Donaldson (Bill Needelman & Greg LaVallee) co-authored a poster presentation with Timken. The title was: 'Improving Wind Turbine Gearbox Life by Minimizing Oil Contamination and Using Debris Resistant Bearings'. It recommended available new technologies for reducing maintenance and improving the life of wind turbine gearboxes. Copies of the poster are currently available from your Industrial Hydraulics District Manager.

AWEA National Meeting – Chicago, May '09

Donaldson (Bill Needelman & Mike Brown) will be presenting a paper titled, 'Best Practices for Controlling Oil Contamination in Wind Turbine Gearboxes and Hydraulic Systems'. Best Practices include lube circuit design, roll-off cleanliness, and better particle and water contamination control during operation. Adapting these best practices from other industries (such as mining equipment and aerospace) significantly improves uptime and reduces repair costs. Copies will be available from Industrial Hydraulics Literature in Spring 09.

Timken

Donaldson (Bill Needelman) is co-authoring a paper with Timken. It will quantify improvements in wind turbine gearbox bearing life produced by reducing the harmful effects of oil contamination. Anticipate this paper to be published in an ASME journal in Spring 09.

Wind Industry Network for Development, Minneapolis, Oct '08

Donaldson participated in the October 14th 2008 meeting Wind Industry Network for Development, held in Eden Prairie, MN. Under the direction of the Minnesota Department of Employment and Economic Development, a directory of manufacturers to the wind energy industry was launched. At this meeting, Moventas presented their plans to build a new wind turbine gearbox manufacturing plant in Faribault, MN, scheduled to open in 2010.

Legend

Bill Needelman: Chief Science Advisor
Greg LaVallee: Principal Engineer
Mike Brown: Senior Project Engineer

AWEA: American Wind Energy Association
ASME: American Society of Mechanical Engineers
NREL: National Renewable Energy Laboratory
STLE: Society of Tribology and Lubrication Engineers

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Filtration Solutions

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Wind Turbine Contamination Control Best Practices

Section 6 of thee ANSI/AGMA/AWEA 6006-A03, "Standard for Design and Specification of Gearboxes for Wind Turbines" is primarily concerned with gearbox lubrication and the end result oil cleanliness. Sub-section 6.3 addresses “Pressure fed lubrication” and begins with “Gearboxes 500 kW and above shall be lubricated by an oil circulation system capable of maintaining an oil cleanliness level as specified in table 17 by inline filters, offline filters or a combination of both.” It specifies ISO cleanliness levels as follows:

Table 17 – Lubricant Cleanliness

SOURCE OF OIL SAMPLE	REQUIRED CLEANLINESS PER ISO 4406
Oil added into gearbox at any location	- / 14 / 11
Bulk oil from gearbox after factory test at the gearbox manufacturer’s facility	- / 15 / 12
Bulk oil from gearbox after having been in service 24 to 72 hours after commissioning of the WTGS (pressure fed systems only)	- / 15 / 12
Bulk oil from gearbox sampled per the operating and maintenance manual (pressure fed systems only) (see 6.7)	- / 16 / 13

Sections 6.7 and 6.8 give information on lubricant condition monitoring. Section 6.9 covers lubricant filters. The filtration devices are required to be able to maintain bulk oil cleanliness at the levels in Table 17. Annex F is referenced for more information by sub-sections 6.7 to 6.9. The annexes are noted as informational only, and are not a part of the specification. Magnetic plugs are also recommended (section 6.12) as is breather filtration for both dirt and water (section 6.13).

Annex F of the standard provides specific filtration recommendations (not requirements) as listed below:

Summary of Annex F Recommendations:

- Efficiency of 10 um, β >200
- Automatic bypass for plugged filter and cold start conditions
- Filter element sized for minimum restricted flow of the required volume and pressure of oil
- Filter element to withstand restrictions on cold start (high collapse)
- Life of 7 months for semi-annual element change cycles

- Offline filters efficiency of 5 um, β >200
- Same system properties are noted above

- Pump suction strainer with bypass valve (optional)
- Inline 50 um pressure line strainer w/ bypass valve downstream of the inline filter (protection against collapse)
- Filter to be compatible with oil (oil additives or ESD)

Further Donaldson Recommendations

- Main inline filter element efficiency of 5 um, β >1000
- Offline filter efficiency of 3 um, β >1000
- ISO 14/12/10 in-use gear oil cleanliness
- Breathers equipped with automatic self-regenerative moisture adsorbency
- Water content to be maintained less than 50% of oil saturation level

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Legend:

ANSI: American National Standards Institute
AGMA: American Gear Manufacturers Association
AWEA: American Wind Energy Association
β: Beta value or filtration ratio (upstream counts / downstream counts), from ISO 16899 multi-pass filter testing
ESD: Electrostatic Discharge