



### **ASME Wind Energy Technical Committee**

Donaldson is a founding member of this new ASME Committee, chartered to improve wind turbine reliability in North America. Other members include: NREL, NASA, Timken, and SKF. Several wind turbine gearbox manufactures, large users, and gear oil suppliers are expected to join in the near future. A web site will soon be available listing members and providing presentations from the ASME Wind Turbine Symposium held in Miami in October 2008. This ASME Committee will be meeting and hosting a one day technical session at the next ASME/STLE International Joint Tribology Conference this coming October in Memphis TN.

### **AWEA Asset Management Workshop – San Diego, January ‘09**

Donaldson (Bill Needelman) presented a talk entitled: “Increasing Wind Turbine Gearbox Reliability” at the San Diego meeting held on January 12-13, 2009. About 350 people attended this year, up ~30% from last year in spite of the economy. The workshop was attended by people responsible for maintaining and increasing wind farm energy production. Bill’s presentation explained how to improve energy production through contamination control, how these improvements can be quantified, and how to implement these improvements with specific (Donaldson) products. The talk was very well received.

### **AWEA Windpower 2009 Conference and Exhibition – Chicago, 4-7 May 09**

Donaldson will have a booth at the Exhibition, held at McCormick Place Convention Center – Booth 4512. Donaldson (Bill Needelman & Mike Brown) will also make a ‘Podium Presentation’ at the Conference, 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 and aerospace) can significantly improve energy production and reduce repair costs. Copies of the paper will be available at the Conference and from Industrial Hydraulics Literature in Spring 09.

### **Timken**

Donaldson (Bill Needelman) is co-authoring a paper with Timken. It will discuss improvements in wind turbine gearbox bearing life achieved by reducing the harmful effects of oil contamination. The paper will be presented at the ASME Wind Energy Technical Session in Memphis in October 2009, and also published in an ASME journal. Reprints will be available this Fall.

### **NASA**

Donaldson (Bill Needelman) is co-authoring a paper with NASA, titled: “Recalibrated Equations for Determining Effects of Oil Filtration on Rolling Bearing Life”. The paper will provide equations and charts for extending bearing life based on new filter ratings. The paper will be presented at the STLE Annual Meeting in Orlando this May. Reprints of the Extended Abstract will be available this Spring.

### **Columbia University**

Donaldson (Bill Needelman) is co-authoring a paper with Columbia University on contamination control and tribology in wind turbines. The paper will be presented at the ASME Wind Energy Technical Session in October 2009, and also published in an ASME journal. Reprints will be available this Fall.

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### **Legend**

Bill Needelman: Chief Science Advisor  
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



### Case Study: Contamination Control Solution for Improved Wind Turbine Operation

One of the largest renewable energy power utility companies in the world owns and operates several wind farm sites in the northern region of the US. Covering a two-state region, the customer operates 287 Zond Z750 wind turbines with a maximum output of 750 kW each. Because of environmental temperature extremes, the Zond gearbox operates over temperature ranges normally of 40-66 °C (104-150 °F). The desired service interval for the gearbox filter is 6 months.

#### The Problem

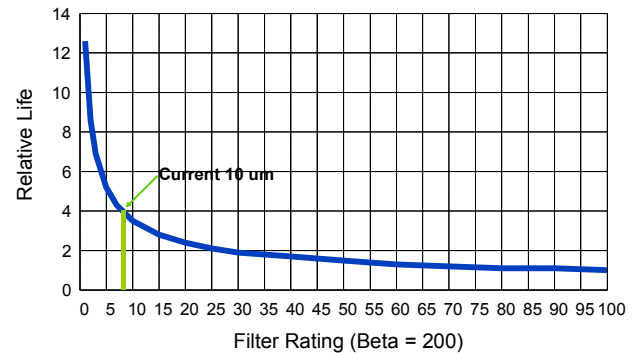
The customer was convinced they were not getting effective filtration, due to the high viscosity gear lube coupled with a small main filter. These two factors led to frequent filter by-passing. The filtration system goes into bypass whenever the differential pressure across the filter exceeds 25 psid. The system is designed to operate at a flow rate of 12 gpm. When the current system is filtering properly, the 10 um absolute glass fiber filter delivers extended bearing life, estimated as 4 times longer than without filtration, based on the STLE Bearing Life Factors Handbook (at right).

However, every time the system exceeds the 25 psid threshold, bypassing allows unfiltered oil into the gearbox, seriously reducing bearing life. The current filter consists of a single 5" diameter low pressure spin-on element.



Our measurements of the filter assembly (shown in the photo at left) found a rather high new filter clean pressure drop of 4.4 psid at 12 gpm when the gear oil was at 66 °C (150 °F) and had a viscosity of 90 cSt. Target clean pressure drop is normally around 2-3 psi, in order to affectively maintain 18/16/13 ISO cleanliness for the entire 6 months service interval. During low temperature operation excursions of 35 °C (95 °F) and a gear oil viscosity of 450 cSt, pressure drop across the filter was 27 psid and in the bypass mode. Unfortunately, bypass operation will be a common occurrence for this system as particulate contaminant loads the filter element, and at low operating temperatures.

NASA/STLE Bearing Life Factor  
Estimated Wind Turbine Bearing Life Increases



Reference: STLE Handbook on Life Factors for Rolling Bearings (1992)

#### The Solution



Upgrading the current filtration system to a dual filter head design with two Donaldson HBK05 P165876 spin-ons reduced these high viscosity pressure losses (shown in the photo at right). The P165876 is a 10 um absolute glass fiber filter, rated at  $\beta$ 1000. In this case, at 12 gpm, 66 °C (150 °F), and a gear oil viscosity of 90 cSt, differential pressure across the filters was only 2 psid, less than half of the single filter design. More importantly, during low temperature extremes of 35 °C (95 °F) and a gear oil viscosity of 450 cSt, the pressure drop was only 12 psid, well under bypass conditions.



#### Conclusion:

The customer requested a filter capable of retrofitting into the existing location that would alleviate the bypass problem and increase filtration effectiveness. Since the new system avoids bypass over a much broader range of temperature and viscosity, coupled with more media area and lower fluid velocities, the gearbox will achieve better oil cleanliness and longer life. The customer is pleased with these results and continues to upgrade their turbine gearboxes to this innovative design. To date the operator has converted 75 wind turbines to the Donaldson dual filter head design.