

Technical Paper on
Wind Turbine Gearbox Moisture Intrusion
Presented By:



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1. Scope

The purpose of this paper is to explore concerns that wind turbine manufacturers may have in relation to gearbox lubricant contamination from moisture. Drytech believes the problem to be a real issue which can be easily managed by the use of properly sized and designed desiccant breathers. The following paper outlines the main causes of contamination, current protection methods and proposed long term robust solutions.

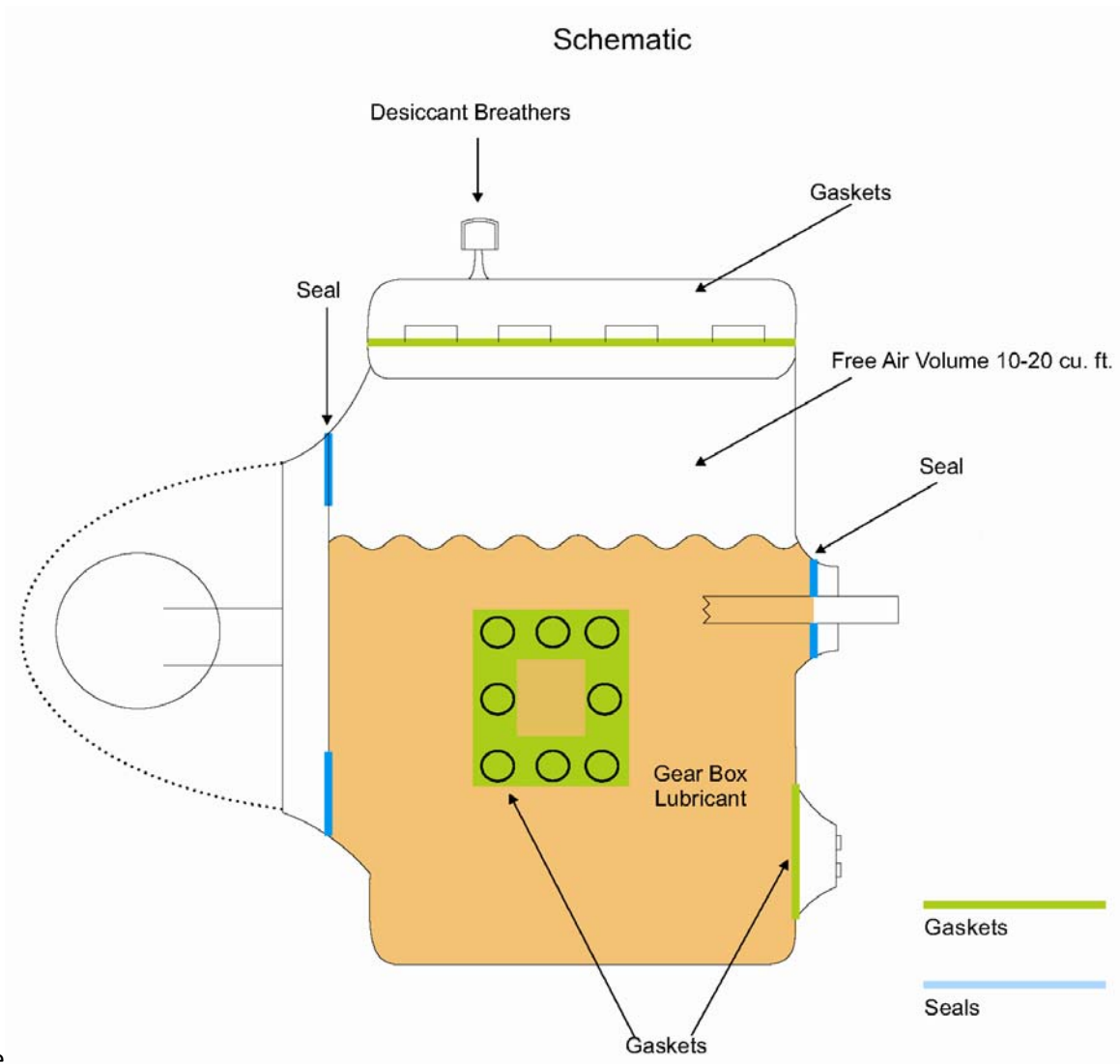
2. Gear Box Standards

The ANSI/AGMA/AWEA 6006-A 03 standard provides guidelines for design and manufacturing of wind turbine gear boxes. Specifically paragraph F.5.3.3.2 talks to the harmful effects of water contamination in gear box lubricant. It confirms that moisture levels should be kept below saturation point which for many oils is less than 500 PPM depending upon oil type and temperature; it further recommends that desiccant breathers be used.

Should this standard not be maintained, manufacturers and users may see:

- Lubricant degradation
- Degradation of internal gear box component
- Corrosion of metallic component

-Accelerated metal

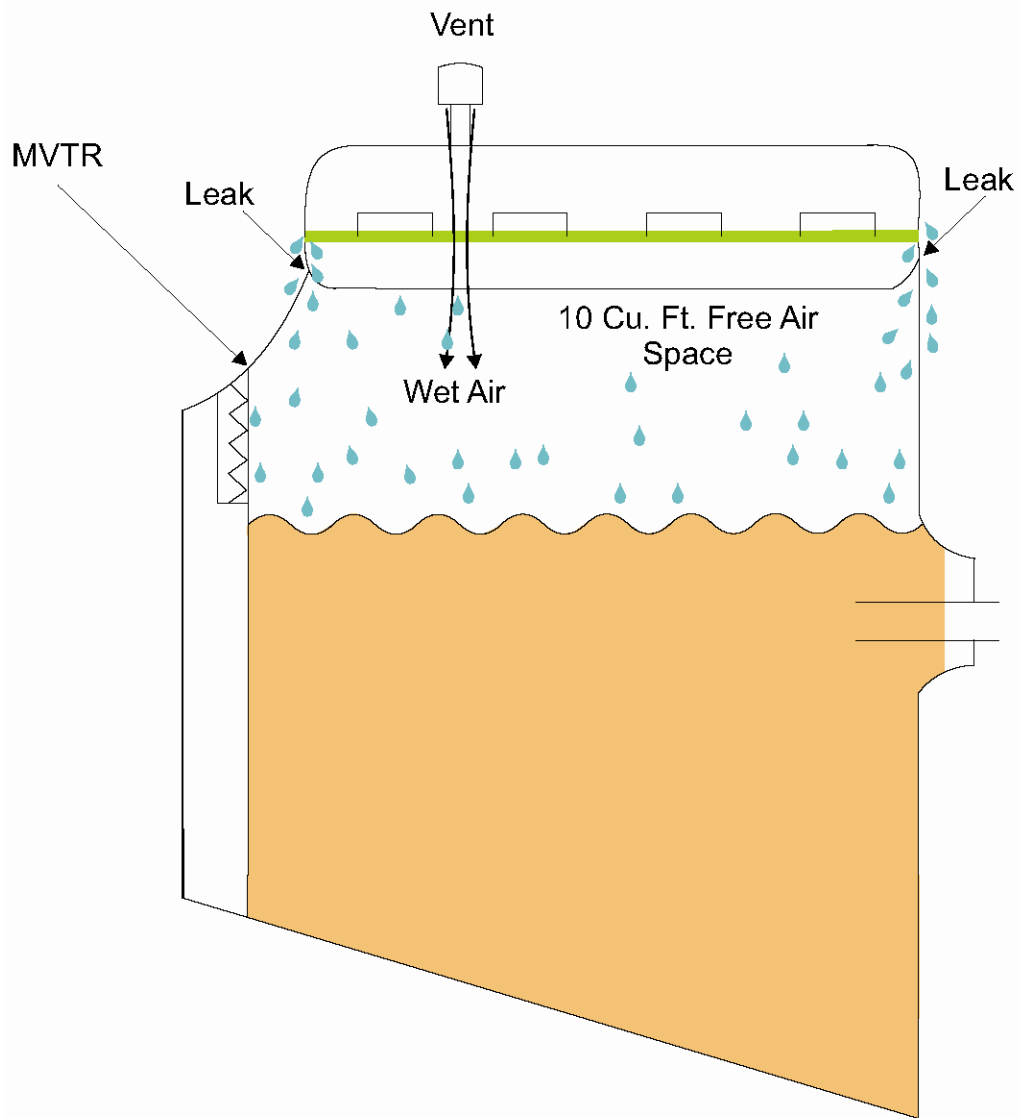


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3. Moisture Intrusion

Moisture intrusion occurs during diurnal exchanges of air caused by temperature variations during the day. Moisture is inhaled into the gear box through polyurethane and/or PTFE seals and gasket by leaks and moisture vapor transmission (MVTR). In cases where a desiccant breather is used, inhale will take place through the breather but these units are generally inadequate in both size and capacity to handle the significant levels of moisture over a maintenance period of 6 months.

Moisture / Water Intrusion Schematic



Example

-Typical inhale of air into a 10 cubic ft. gearbox free air space under a diurnal temperature swing of 115° F represents 5.7 grams of moisture/day.

-Typical MVTR of urethane seals represents approximately 2.0 grams of moisture/day.

-Typical change out of desiccant breather every 6 months. 183 days @ 7.7 grams/day = 1409.10 grams to be adsorbed (3.1 lbs).

-Typical adsorption capability of a 3 lb. desiccant breather is 476 grams (1.05 lbs).

Therefore under these conditions a 3 lbs. desiccant breather will last approximately 2 months and not 6 months.

4.

Current Solutions/Methodology

4.1 Desiccant Breather

Currently desiccant breathers are used in various configurations, but as it can be seen from the prior paragraphs, the volume of available desiccant is inadequate for a required desiccant life cycle of 6 months before change out and in extreme cases could only provide protection for a month before saturation and the gear box starting to see contamination from moisture at levels of a cup of moisture per week.

4.2 Accepting that, manufacturers are providing, as an option, stand alone oil purification systems estimated to be in the region of \$2,000.00 each using cellulose filter costing \$700.00 each requiring change out at service intervals.

5. Proposed Solutions

Drytech proposes that the following technical solutions be considered:

Option 1

The use of Drytech designed wind turbine gear box desiccant breathers per the below sizing charts.

Sizing Chart

Climatic/Conditions	Gearbox Free Air Space	Minimum Desiccant Required Lbs.	Change Out Interval	Drytech Model #
A) Marine/Harsh Environment Warm/Hot/Humid	10 Cu. Ft.	1.25 lbs. 3.75 lbs. 7.50 lbs. 15.0 lbs.	1 month 3 months 6 months 12 months	N/A N/A WTB708G WTB716G
	20 Cu. Ft.	2.5 lbs. 7.5 lbs. 15.0 lbs. 30.0 lbs.	1 month 3 months 6 months 12 months	N/A N/A WTB716G WTB730G
B) Tropical Hot/Humid Environment Moderate Diurnal and high MVTR	10 Cu. Ft.	.75 lbs. 2.0 lbs. 4.0 lbs. 8.0 lbs.	1 month 3 months 6 months 12 months	N/A N/A WTB705G WTB708G
	20 Cu. Ft.	1.5 lbs. 4.0 lbs. 8.0 lbs. 16.0 lbs.	1 month 3 months 6 months 12 months	N/A N/A WTB708G WTB716G
C) Moderate Higher Diurnal and lower MVTR	10 Cu. Ft.	.5 lbs. 1.25 lbs. 2.0 lbs. 5.0 lbs.	1 month 3 months 6 months 12 months	N/A N/A WTB702G WTB705G
	20 Cu. Ft.	1.0 lbs. 2.5 lbs. 5.0 lbs. 10.0 lbs.	1 month 3 months 6 months 12 months	N/A N/A WTB705G WTB710G

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*Climate conditions based upon MIL-STD-810E Method 507.3 Humidity

Option 2

The use of a Drytech designed self-reactivating desiccant breather for use in harsh inaccessible environments where service intervals could be extended out to 2-3 years.