

High performance gear oil at lower costs – an economic solution for wind energy parks

CASE STUDY: WIND ENERGY PARKS

Wind turbines have increased in size to maximize power generation, placing a great load on the gearboxes. The operating conditions are challenging, and lifetime expectations are high, because of the difficulties associated with replacing gear box components. Therefore, the lubrication of wind turbine gearboxes is one of the most challenging tasks. A high-quality lubricant is an essential element of gearbox design, to ensure load handling, durability, and a long lifetime with uninterrupted operation. Synthetic fluids are therefore the preferred choice for wind turbine lubrication. However, this comes with a high price tag of the typically PAO based ISO VG 320 gear oils. In this case study, **NUFLUX®** technology, which has been proven in the field, shows equivalent performance versus PAO based gear oil at lower costs.

CRITICAL BENCH TESTS AND OEM APPROVALS

To prove the suitability of the **NUFLUX®** formulation for field performance test at wind energy parks, a variety of laboratory bench tests required by OEMs must be carried out. **NUFLUX® VG 320** has passed the following critical bench tests which are listed below.

- FVA 54 VI micropitting @ 60°C & 90°C with GFT > 10
- FE 8 wear test @ 100kN
- FZG scuffing load test at single and double speed, reaching LS > 14
- Flender foam test from 0°C to 60°C
- Hydac, Internormen and CC Jenssen filterability tests (covering filters with 2.5µm, 5µm and 10µm pore sizes)
- Extensive material compatibility tests covering elastomers (static & dynamic mode), liquid sealants, inner and outer coatings (all tested under PAO test conditions)

After all required bench tests were successfully completed, **NUFLUX® VG 320** fulfilled requirements of the

OEMs so that **NUFLUX® VG 320** received field trial approval letters from Winergy and Moventas. The formulation also fulfilled FAG Schaeffler's 4-step test passed with rating 1.2 and SKF's test program was passed for on-shore application as well.

FIELD TRIAL RESULTS AT WIND ENERGY PARKS

Numerous field trials were conducted with **NUFLUX® VG 320** in gearboxes produced by Winergy, Moventas, ZF wind, Rexroth, GE, Chongqing and NGC (1.5 and 2 MW). Positive outcomes of these field trials are reported with lower bearing temperatures, no deposit formation and even a cleaning effect on gears.



Figure 1.a. Starting point with **NUFLUX® VG 320**.

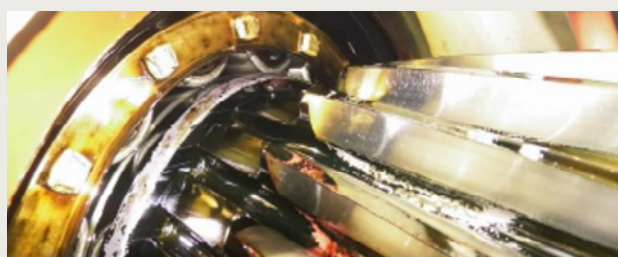


Figure 1.b. One year from starting point. **NUFLUX® VG 320** cleans and prevents gears from deposits and varnish.

Good wear performance of **NUFLUX®** technology is confirmed by low level of wear metals over the full length of wind turbine performance demonstrations. A detailed investigation was made over 16 months during an official wind turbine gear test. The following graphs show the comparison between reference gear oil and **NUFLUX® VG 320** (Figure 2).

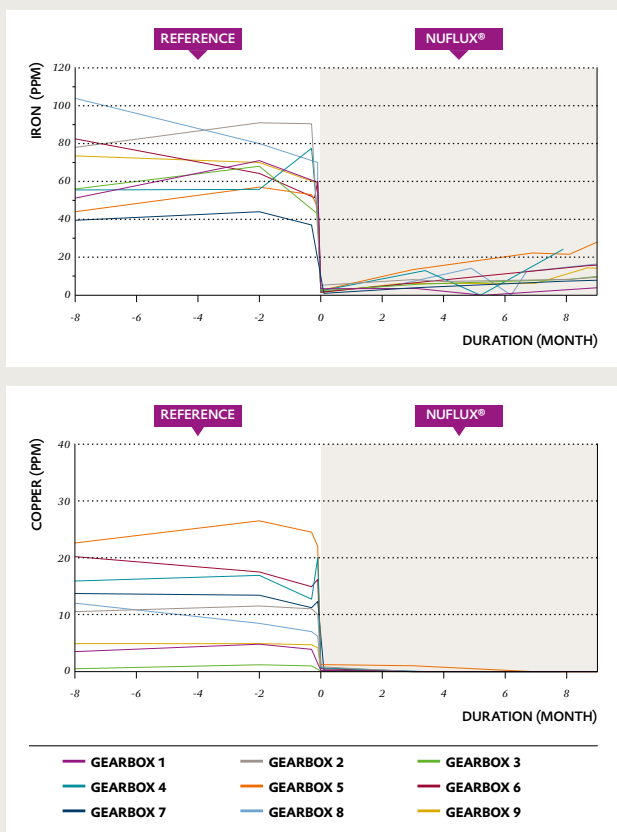


Figure 2. Measured concentrations of Fe and Cu wear by ICP over 16 months field trial with **NUFLUX® VG 320**.

CONCLUSION

Results from many field trials at running wind energy parks demonstrate that **NUFLUX®** technology potentially improves the overall gearbox efficiency and durabil-

ity of the system. The observations show superior oxidation stability, inhibited deposit formation and excellent equipment protection by good compatibility and high solvency of the oil. Up to 5°C lower bearing temperatures are observed with **NUFLUX®** technology compared to incumbent gear oils. Due to more efficient gear operations, lower operating temperatures contribute to extended oil drain intervals, less oil degradation and chemical attack with lower wear metal levels and cleaner bearings. **NUFLUX®** technology shows equivalent performance to widely adopted PAO-based wind turbine gear oils and receive acceptance as a proven, cost-effective alternative for this demanding application.

NUFLUX® VG 320 has demonstrated its performance on more than 40 wind turbine gears (Figure3). Most wind energy parks have conducted the field trials by themselves with the support of Evonik. In Europe, 20 wind turbines operated with **NUFLUX® VG 320** for more than 6 years without an oil change on gearboxes of Winergy, Moven-tas and ZF Wind.

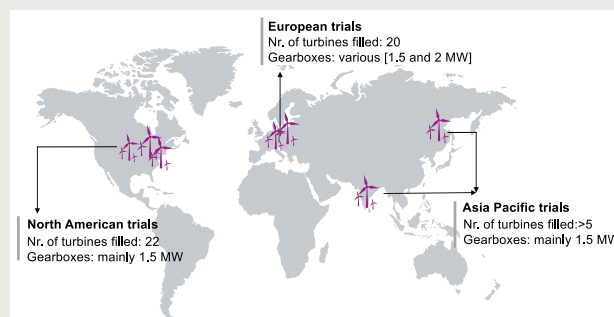


Figure 3. Global performance demonstrations map of **NUFLUX® VG 320**.

More trials were conducted on 1.5MW gearboxes of GE, Winergy and Rexroth, with many of them already switched to normal operation mode. More recently, performance demonstrations have started in India, China and the USA.

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