

FORM 2

THE PATENTS ACT, 1970
(39 of 1970)
AND
THE PATENTS RULES, 2003

**COMPLETE
SPECIFICATION**

(See section 10; rule 13)

TITLE OF THE INVENTION

“WIND TURBINE GEARBOX LUBRICATION SYSTEM”

APPLICANT

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The following specification particularly describes
the invention and the manner in which
it is to be performed

WHAT IS CLAIMED IS:

1. A wind-turbine gearbox system comprising:

an input gear stage having mating gear surfaces finished to a surface roughness Ra of less than 0.25 micron;

5 at least one bearing supporting the input gear stage;

a lubrication circuit arranged to deliver lubricant to the input gear stage and the bearing during operation of the wind-turbine and comprising an inline filter having a nominal pore size for removal of particles greater than 2 micron, preferably greater than 1 micron, from the lubricant prior to delivery; and

10 a quantity of lubricant in the lubrication circuit, the lubricant having an ISO VG of between 68 and 300, preferably between 100 and 220 and most preferably around 150.

2. The system of claim 1, further comprising a high-speed gear stage and a high-speed bearing, wherein the high speed gear stage comprises mating gear surfaces finished to a surface roughness Ra of less than 0.25 micron.

3. The system of claim 1 or claim 2, wherein one or more bearings are also finished to a surface roughness Ra of less than 0.25 micron.

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4. The system of any preceding claim, wherein the system is rated to a capacity of more than 1 MW and more preferably more than 1.5 MW.

5. The system of any preceding claim, wherein the lubrication circuit comprises a pump and the inline filter is located on a high-pressure side of the pump.

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6. The system of any preceding claim, wherein the inline filter is a surface filter comprising glass fiber, or modified glass fiber, or metal, or any proprietary polymer.
- 5 7. The system of any preceding claim, further comprising an offline filter connected in parallel to the inline filter.
8. The system of any preceding claim, further comprising a magnetic filter, preferably located in a sump region of the gearbox.
- 10 9. The system of any preceding claim, wherein the mating gear surfaces are planarized, preferably having an average peak to mean height roughness R_{pm} of 1.00 micron and more preferably 0.50 micron or less.
- 15 10. The system of any preceding claim, wherein the mating gear surfaces are chemically accelerated vibratory finished surfaces.
11. The system of any preceding claim, wherein the lubricant comprises more than 85 % mineral or synthetic base oil, preferably more than 95 % base oil and most preferably about
20 99% base oil.
12. The system of any preceding claim, wherein the lubricant is substantially free or completely free of a defoaming agent.
- 25 13. The system according to any preceding claim, wherein the lubricant has a concentration of phosphorous of less than 500 ppm, preferably less than 10 ppm.

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14. The system according to any preceding claim, wherein the lubricant has a concentration of zinc of less than 100 ppm, preferably less than 10 ppm.

15. The system according to any preceding claim, wherein the lubricant has a
5 concentration of nitrogen of less than 100 ppm, preferably less than 10 ppm.

16. The system according to any preceding claim, wherein the lubricant has a concentration of sulphur of less than 20 ppm, preferably less than 5 ppm.

10 17. The system according to preceding claim, wherein the lubricant has a concentration of molybdenum of less than 10 ppm, preferably less than 2 ppm.

18. The system according to any preceding claim, wherein the lubricant has a concentration of boron of less than 10 ppm and preferably less than 100 ppb.

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19. The system according to any preceding claim, wherein the lubricant has a concentration of silicon of less than 10 ppm and preferably less than 100 ppb.

20. Use of a lubricant in the operation of a wind turbine gearbox having superfinished
20 critical surfaces, comprising providing the lubricant at an ISO viscosity grade below 300, preferably below 200, and circulating the lubricant through an inline filter to the critical surfaces, wherein the inline filter has a nominal pore size for removal of particles greater than 2 microns, preferably greater than 1 micron, from the lubricant prior to delivery.

25 21. The use according to claim 20, wherein the lubricant is circulated through the filter at a rate of at least 60 litres per minute, preferably at least 100 litres per minute.

22. The use according to claim 20 or claim 21, wherein the lubricant comprises a concentration of phosphorous of less than 500 ppm, preferably less than 10 ppm.

23. The use according to any of claims 20 to 22, wherein the lubricant comprises a
5 concentration of zinc of less than 100 ppm, preferably less than 10 ppm.

24. The use according to any of claims 20 to 23, wherein the lubricant comprises a concentration of nitrogen of less than 100 ppm, preferably less than 10 ppm.

10 25. The use according to any of claims 20 to 24, wherein the lubricant comprises a concentration of sulphur of less than 20 ppm, preferably less than 5 ppm.

26. The use according to any of claims 20 to 25, wherein the lubricant comprises an additive having a concentration of molybdenum of less than 10 ppm, preferably less than 2
15 ppm.

27. The use according to any of claims 20 to 26, wherein the lubricant comprises an additive having a concentration of boron of less than 10 ppm and preferably less than 100
20 ppb.

28. The use according to any of claims 20 to 27, wherein the lubricant comprises an additive package having a concentration of silicon of less than 10 ppm and preferably less than 100 ppb.

25 29. A lubricant for use in a wind turbine gear box, comprising:
at least 85 % of a base oil; and
an additive package comprising:

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- a concentration of zinc of less than 100 ppm, preferably less than 10 ppm;
a concentration of nitrogen of less than 100 ppm, preferably less than 10 ppm;
a concentration of sulphur of less than 20 ppm, preferably less than 5 ppm;
a concentration of molybdenum of less than 10 ppm, preferably less than 2
5 ppm;
a concentration of boron of less than 10 ppm and preferably less than 100 ppb;
and
a concentration of silicon of less than 10 ppm and preferably less than 100
ppb,
- 10 the lubricant having an ISO viscosity grade of between 100 and 300, preferably between 150
and 250 and most preferably around 150.
30. The lubricant according to claim 29, wherein the lubricant comprises about 99.22
weight percent mineral base oil or poly-alpha-olefin (PAO) base oil or any mixture thereof
15 and having a viscosity of approximately ISO VG 150, about 0.1 weight percent antiwear
compound that may also function as an anti-micropitting, anti-scuffing and extreme pressure
compound, about 0.05 weight percent extreme pressure compound that may also function as
an antiwear, anti-micropitting and anti-scuffing compound, about 0.02 weight percent
antioxidant compound, about 0.01 weight percent anti-corrosion or anti-rust compound, about
20 0.5 weight percent dispersant compound and about 0.1 weight percent demulsifier.

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