Wind Turbine Gearbox Lubrication: Performance, Selection and Cleanliness

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Functions of a Lubricant

- Lubrication
  - Reduces friction and wear by introducing a lubricating film between moving parts
- Cooling
  - Helps dissipate heat away from the critical parts of the equipment
- Cleaning and suspending
  - Facilitates smooth operation of equipment by removing and suspending products, such as carbon, sludge and varnish
- Protection
  - Prevents metal damage due to oxidation and corrosion

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What Lubricant Properties Are Wanted?

- Suitable viscosity
- High film strength
- Low pour point
- Lubricity
- Low corrosivity
- Good water tolerance
- Good cleansing and dispersing ability
- Non-toxicity
- Low flammability
- Protection against micropitting
- Good filterability

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What's in a Typical Gear Oil?

= Base oil + Additives

90-99%

Mineral oil

Polyalphaolefin (PAO)

Polyalkyleneglycol (PAG)

Vegetable oil

Synthetic Ester

1-10%

Extreme pressure

Antiwear

Rust inhibitor

Dispersant

Friction modifier

Demulsifier

Metal deactivator

Oxidation inhibitor

Antifoam

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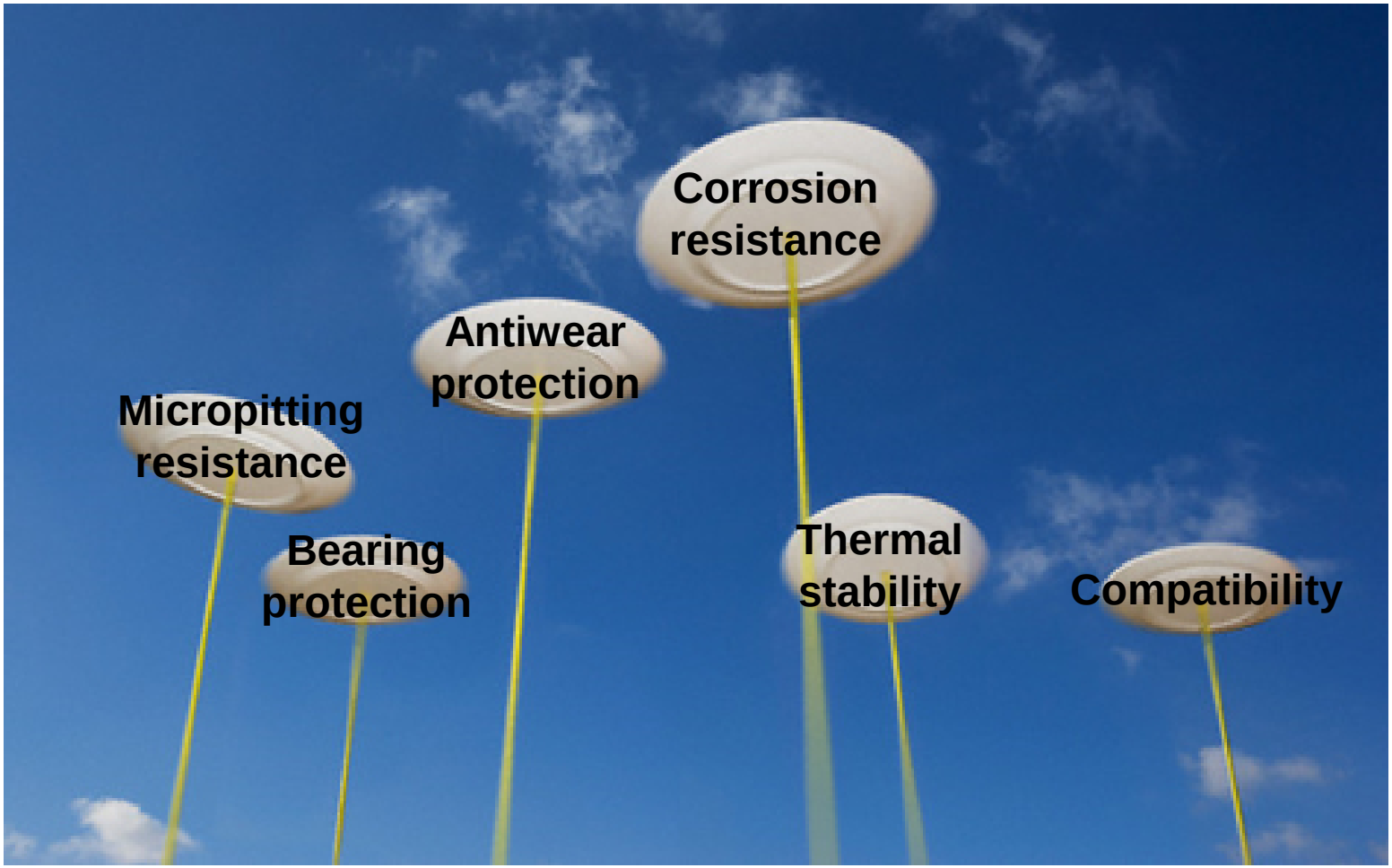
Formulating oils…the ultimate balancing act



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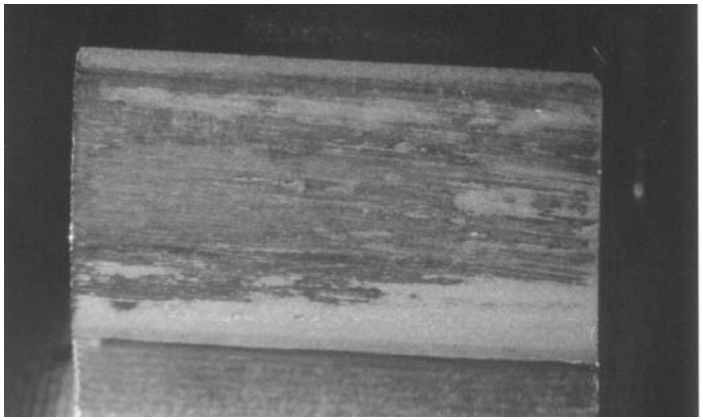
Key Tests

- General industrial gear bench tests: demulsibility, copper corrosion, rust, thermal stability, compatibility, etc.
- Mechanical tests:
  - FZG scuffing tests A/8.3/90 and A/16.6/90
  - FVA-54 micropitting test: FZG-based test using gears specifically designed to micropit; load stage and endurance portion of the test
  - FE-8 bearing test
- OEM specific tests
  - additional corrosion
  - volatility/thermal stability
  - additional foam test
  - filterability tests
  - many others



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Lubricant Performance – Key Gear Oil Specifications

Winergy (Hansen wind, Eickhoff, Moventas wind, Bosch Rexroth wind, etc.)

FVA-54 @ 60°C, FAG 4 step bearing test, Flender foam @ other temps, additional paints and sealant compatibility, SKF tests, filterability, Field Trial

Flender (Hansen IGO, Moventas IGO, RENK, JaKe, etc.)

FVA-54 @ 90°C, Flender foam, paint & sealant compatibility, Freudenberg seals, double speed FZG

DIN 51517-3 (similar to AGMA 9005-E02)

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Sources of Information

- Wind turbine supplier
- Gearbox manufacturer
- Lubricant supplier
- ANSI/AGMA/AWEA 6006-A03

- Choice of lubricant depends on:
  - turbine size (power, lubricant volume)
  - turbine transmission design (gearing type, stages, bearing type)
  - range of operating conditions (speed, loads, temperatures)
  - start up considerations (low temperature issues)
  - filtration systems (pumping requirements, filter media, pore size)
  - lubricant delivery system (splash vs. pressure fed)

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Mineral Based or Synthetic Based Oil

- Mineral – a mixture of hydrocarbons
  - have been used successfully for many years; typically have lower purchase cost
- Synthetic – manufactured to contain a very narrow range of hydrocarbons
  - Polyalphaolefin (PAO) may improve gearbox efficiency and increase oil change interval; increased lubricant film thickness
  - Polyalkyleneglycol (PAG) – excellent thermal stability; may have compatibility problems with other lubricants and materials
  - Synthetic Esters – some have poor stability in the presence of water; decreased film thickness in gear and bearing contacts
- Potential benefits of synthetic oils:
  - Expanded operating temperature range and viscosity characteristics
  - Improved thermal resistance
  - Longer oil drain interval

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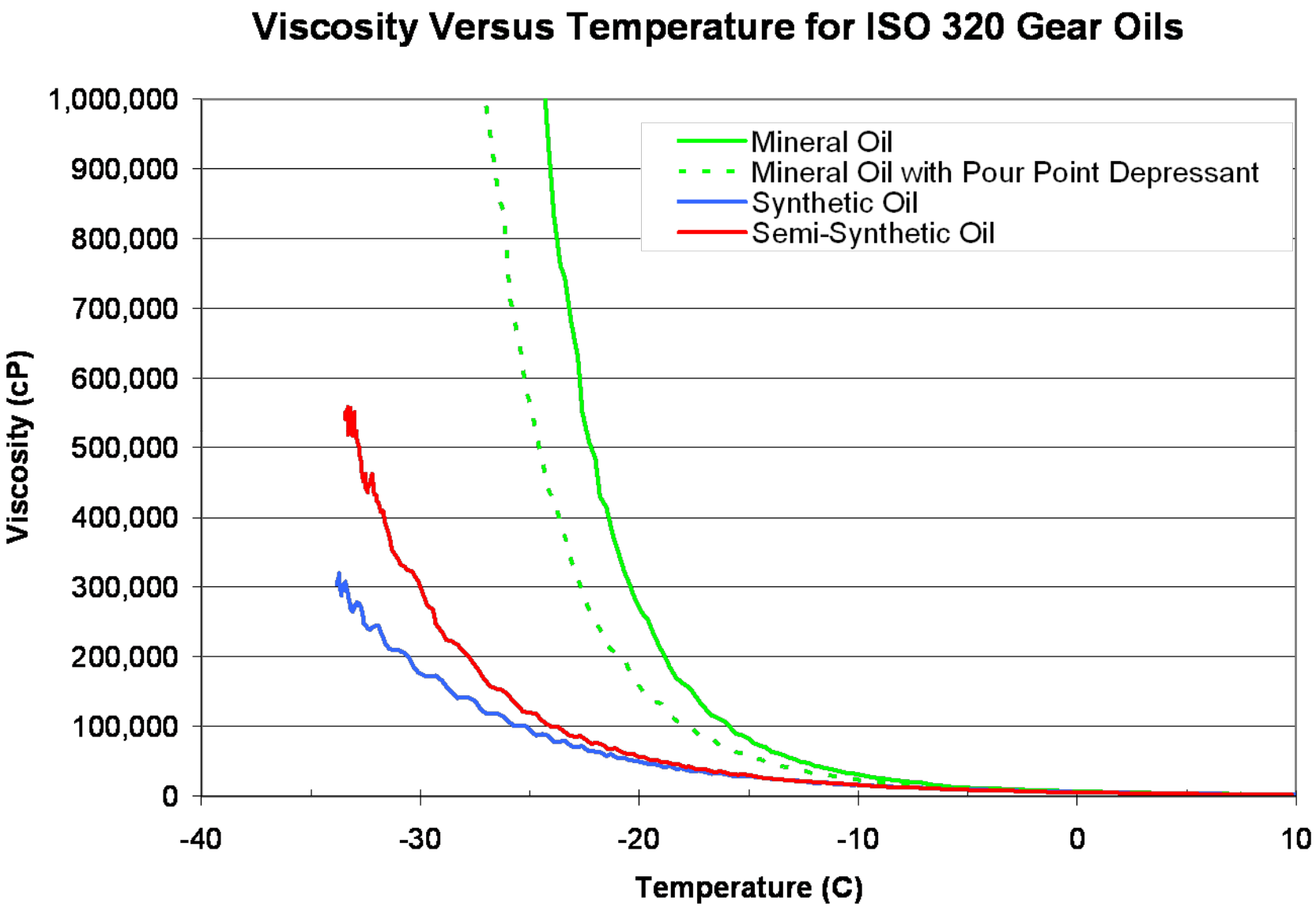
Lubricant Selection



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Points to Consider

- Anticipated oil life and what to base it on (calendar, oil analysis, etc.)
- Data/reports from field evaluations
- Compatibility with current lube
- Approvals/endorsements from equipment builders
- Special needs of your site and anticipated ambient conditions for each turbine
  - Discuss with your wind turbine supplier and/or oil supplier on your site-specific needs
- Cost
  - Consider the total cost versus just the cost of the oil

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Sources of Contamination

- Residual manufacturing debris
- Material ingested through breathers
- Material present in the new oil
- Material inadvertently added during maintenance
- Internally generated materials such as wear debris

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Impact of Contamination

- Wear debris
  - Collateral damage; debris dents cause stress concentrators around the dent
    - Depends on hardness, size and ductility of the material
  - Particles can clog fine clearances and ports resulting in oil starvation
- Water
  - Corrosion
  - Degradation of lubricant including accelerated additive breakdown and foaming
  - Damage to bearings
  - Potential to block filters
  - May promote micropitting and/or lower fatigue life

To realize the benefits of a quality lubricant, steps should be taken to keep it clean and dry.

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How to Minimize Contamination and its Impact

- Install desiccant filters on breathers
- Filter oil prior to filling utilizing quick-connect fitting on fill port
  - See AWEA/ANSI/AGMA 6006 for ISO 4406 cleanliness recommendations
- Clean and dry with a low lint rag around inspection and sample ports prior to opening
- Use kidney-loop filtration systems
- Avoid operation of turbine when filter is in bypass mode
- Monitor particle contamination of drain samples
  - Additional tools are available to help identify the source of particles
- Use a lubricant that minimizes varnish formation since particles can stick to the material creating an abrasive surface
- Use an oil with good micropitting resistance

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Summary

- Unfortunately with wind turbine gear oils, there is no universal answer for what is the best oil or type of oil
- Proper selection a lubricant for the wind turbine gearbox will help
  - Minimize downtime
  - Reduce maintenance and repair costs
  - Increase productivity

Proper selection and condition monitoring of a lubricant is essential to achieving maximum service life for wind turbine gearboxes.

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