The Role Of Tribology In The Advancement Of Sustainability

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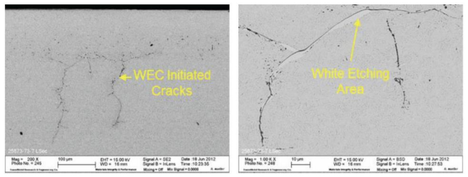
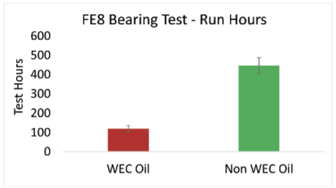
Introduction

Tribology has a major impact on sustainability in many different fields in varying ways. In order to reduce wear in machines and increase their lifetime, the friction between the moving parts of the machinery can be reduced, and as a result minimizes greenhouse gas emissions and increases machine efficiency. As machines get more efficient and last longer, they require less replacement and minimize the consumption of resources. Tribology has the potential to greatly improve different fields, such as wind power generation and electric vehicles, leading to increased sustainability. Wind power is one of the best options for minimizing greenhouse gas emissions and by utilizing tribology for longevity, wind turbines can be made more effective and economical. This allows for it to become a more reliable source of electrical energy. Due to this, electric vehicles become a more environmentally friendly option since they would be powered by renewable energy, such as wind or solar power. Friction reduction by tribological measures transduce directly into more range of electrical. On top of these benefits, using natural or biogenic, but biodegradable lubricants, which have the potential to be functional even better than synthetic lubricants, would make wind power generation and electric vehicles even more sustainable and environmentally friendly. This poster will go further into detail about how bio-lubricants, wind power, electric vehicles, and various other fields are benefited by tribology and lead to a more sustainable future.

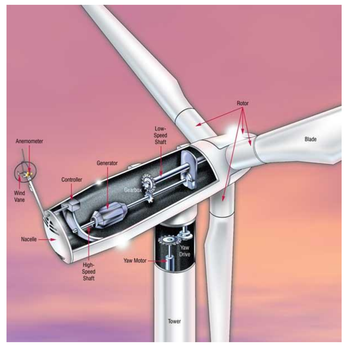
Wind Turbines

Wind turbines mostly fail because of their gearboxes malfunctioning and wearing down. A major factor in the premature failures of gearboxes is White Etching Cracking (WEC) which today occurs also in many other machineries. WEC have metallurgical origins and its formation can be enhanced by the quality and composition of lubricants used. Lubricants that prevent WEC increased the amount of time machinery could run 4-5 times longer than lubricants that favored WEC. As the effectiveness of the lubricants used for wind turbines increases, their lifespan will increase and resulting in require less replacements of gear boxes.





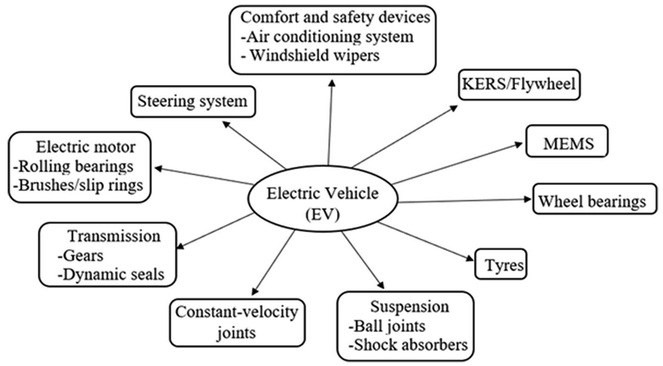
T. Haque, et al. "Lubricant Effects on White Etching Cracking Failures in Thrust Bearing Rig Tests." Tribology Transactions, 2018, 61:5, 979-990.



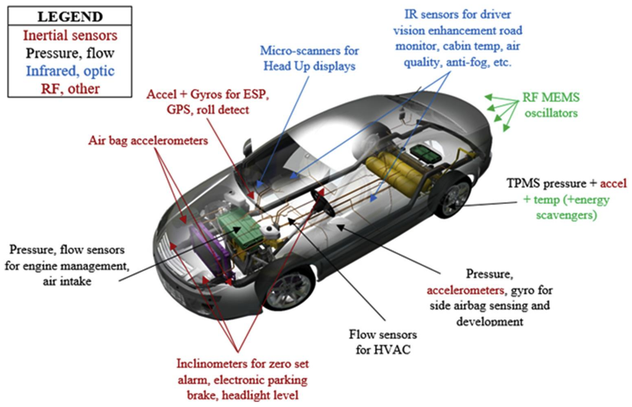
Deirdra Barr. "Modern Wind Turbines: A Lubrication Challenge."MachineryLubrication. https://www.machinerylubrication.com/Read/395/wind-turbine-lubrication

Electric Vehicles

As electric and plug-in hybrid vehicles become more popular and manufactured more often, the parts needed to make vehicles will change-due to the different functions of electric vehicles compared to internal combustion engine cars. Lubricants for electric vehicles must be much more specialized as there are many more requirements, e.g. electrical properties, friction reduction, and ability to cool batteries, motors and inverters. The lubricants and fluids will come into contact with more metallurgical different materials calling for extended corrosion protection. Obviously, these extended requirements will generate new classes of lubricants/fluids and one can not be chosen over the other so the lubricants must be formulated in such a way that all is optimized.



Leonardo Israel Farfan-Cabrera, Tribology of electric vehicles: A review of critical components, current state and future improvement trends, Tribology International, Volume 138, 2019, Pages 473-486, ISSN 0301-679X, https://doi.org/10.1016/j.triboint.2019.06.029.



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Above are 2 pictures highlighting different parts of an electric vehicle and the other showing parts of the electric vehicle on a model of the vehicle. Most of these different parts require lubricants. Electric vehicles have parts such as electric motors or battery packs which require different and more specialized lubricants or fluids.

Bio Lubricants

Biolubricants are non-toxic to humans and aquatic species as well as are ready/ultimate biodegradable which means they would not impact the environment in any negative way when unintentionally spilled or leaked. The base oils for biolubricants are factors more expensive than non-EAL ones, but have many functional advantages. Additives properly selected under toxicological criteria enable to meet all pre-existing specifications.

Application	Properties	Advantages
Engine oil	Low volatile organic compound emissions. Good lubricity	Reduces engine emissions Improves engine performance
Hydraulic oil	Low compressibility Fast air release rate	Better pressure transmission Less vibration and noise
Compressor oil	High thermal stability	Tolerates high temperature and pressure
Metalworking oil	Low volatility Good antirust capacity Good emulsifiability Good lubricity	Less harmful mist generation Longer tool life Stable emulsions at high temperature
Transmission oil	Good lubricity Higher weld load	Suitable additives can be added
Chainsaw oil	Low volatility	Less harmful mist generation
Insulating oil	Higher water solubility level High dielectric constant	Decreases the effect of moisture on insulation strength Better insulation properties

Cecilia, J.A.; Ballesteros Plata, D.; Alves Saboya, R.M.; Tavares de Luna, F.M.; Cavalcante, C.L., Jr.; Rodríguez-Castellón, E. An Overview of the Biolubricant Production Process: Challenges and Future Perspectives. Processes 2020, 8, 257.

Advantages
- Higher boiling point (less emissions)
- Higher biodegradability (free of aromatics)
- Higher lubricity
- Lower volatility
- Better skin compatibility
- Higher shear stability
- Higher tool life
- Higher viscosity index
- Higher safety on shop floor

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Conclusions

The application of biolubricants in wind turbines and electric vehicles will make them much more sustainable and reliable than current vehicles and systems in place. Even if biolubricants were not used, new and more reliable and effective lubricants/fluids used with electric vehicles and wind turbines would create more long lasting, sustainable and efficient sources of energy. Biolubricants themselves would also lead to much more sustainable machinery and enhance qualities of waters and soils, since they would be replacing lubricants with much higher adverse effects to the environments.

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