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Effects of oxidation of biodegradable PAO for E-gearboxes on coefficient of friction

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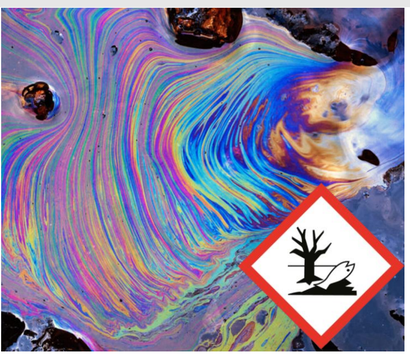
Motivation



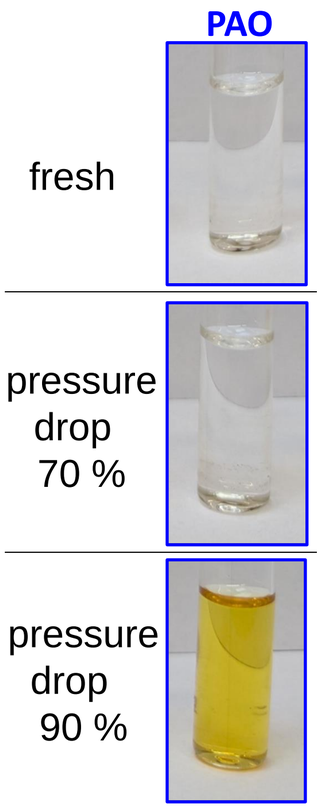
- Release of lubricants poses a great risk on the environment.
- Biodegradable and toxicologically safe lubricants are needed to reduce these risks.
- This research project aims to find a sustainable gear lubricant for electric motor gear units that provide a primary cooling function.
- Various base oils and their additives are tested for suitability.

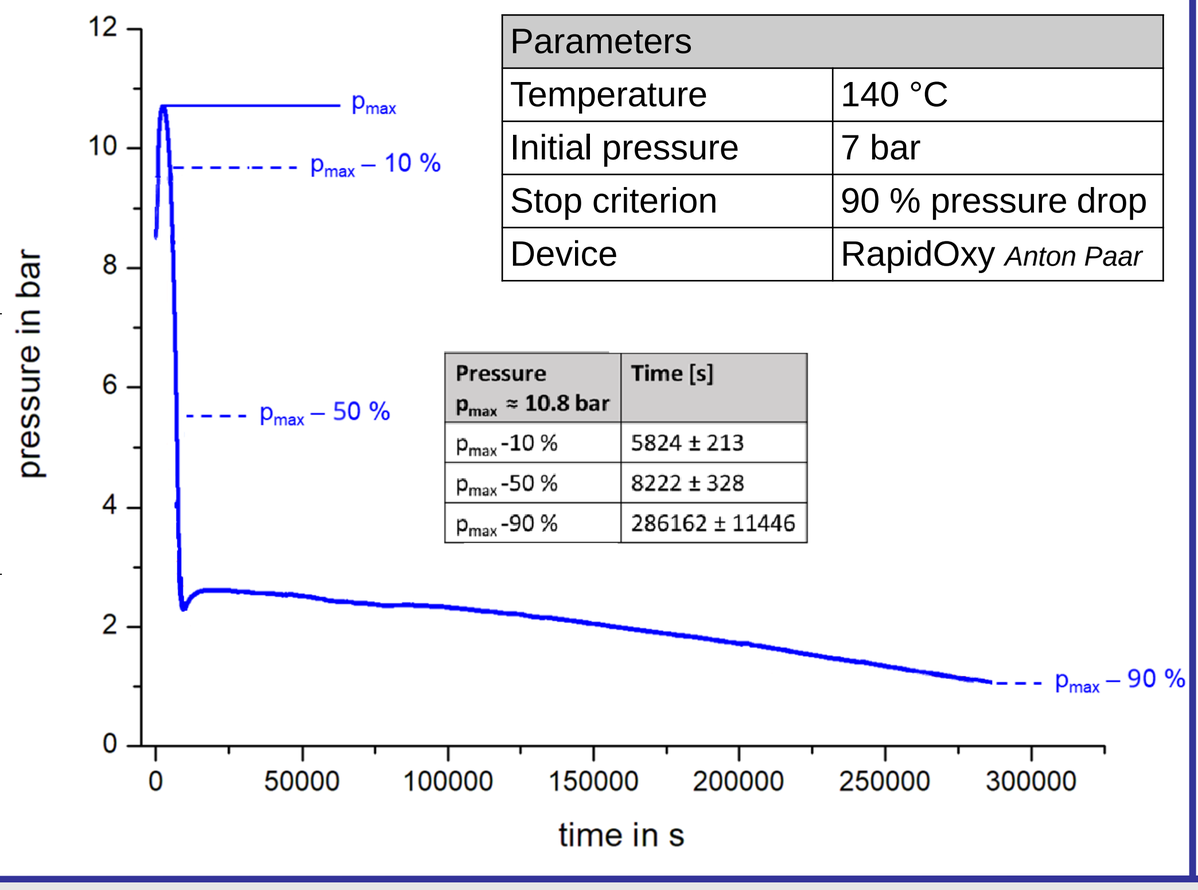
biodegradability *water hazard/toxicity* *foaming tendency* *FZG* *wear* *copper corrosion* *viscosity* *elastomer compatibility* *friction* *oxidation*

Conclusion

- Biodegradable PAO (>80% OECD 301 B) was tested
- FTIR spectra reveal a notable increase in peaks depending on oxidation rate.
- Formation of carbonyl, hydroxyl, and carboxyl groups through oxidation of PAO
- Likely formation of metal soaps that adsorb on the surface an form atribochemical film and thereby improve the coefficient of friction.
- At high oxidation, viscous deposits disrupt the lubricant film, increasing friction.

Oxidation Test following ASTM D8206 norm

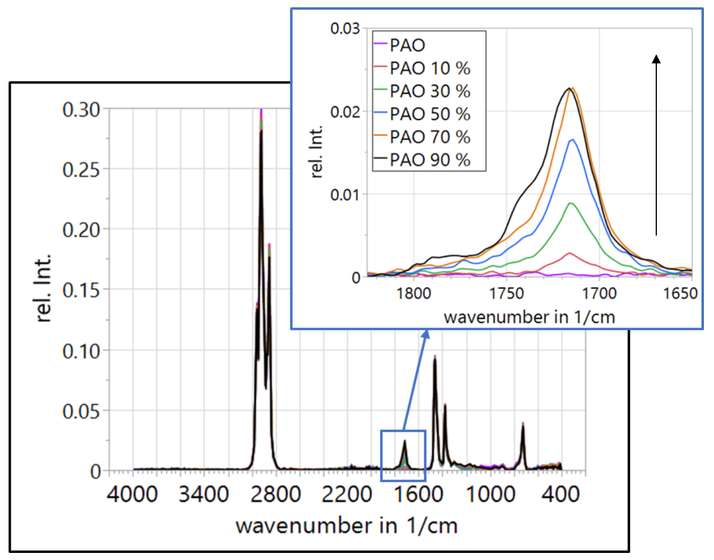




Parameters	
Temperature	140 °C
Initial pressure	7 bar
Stop criterion	90 % pressure drop
Device	RapidOxy *Anton Paar*

Pressure p_{max} ≈ 10.8 bar	Time [s]
p_{max} -10 %	5824 ± 213
p_{max} -50 %	8222 ± 328
p_{max} -90 %	286162 ± 11446

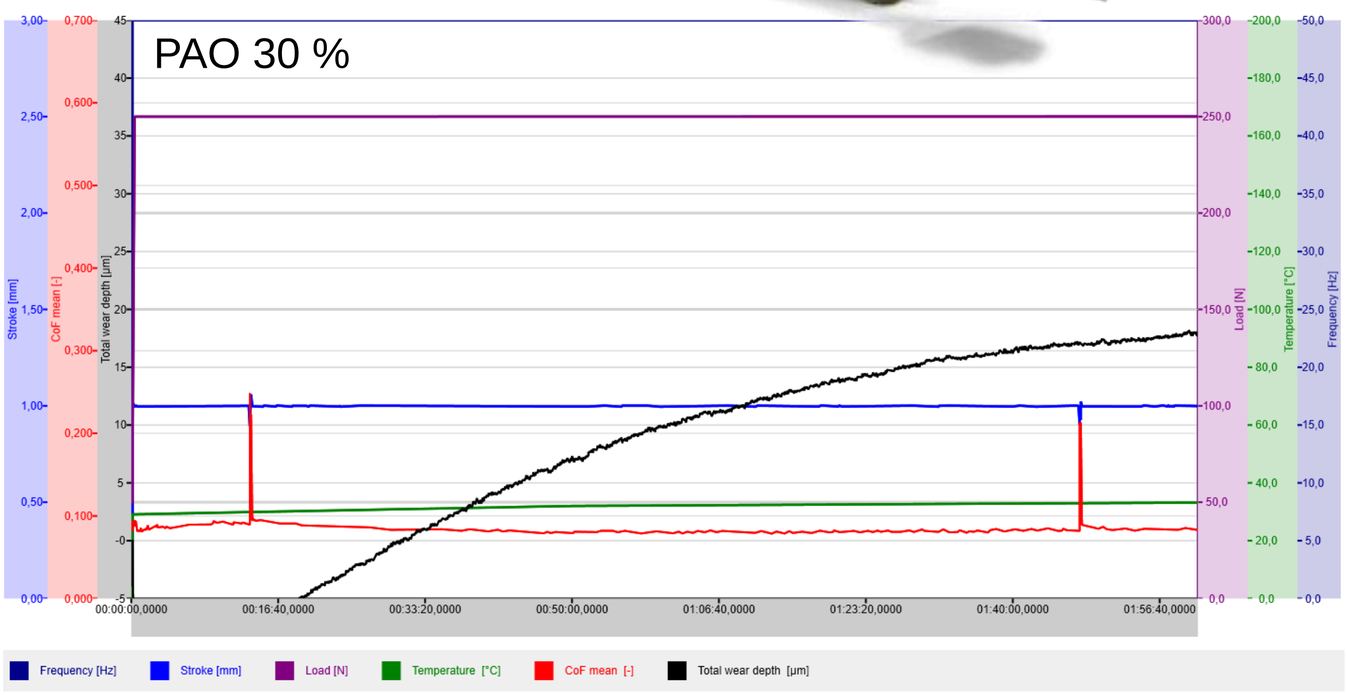
FTIR

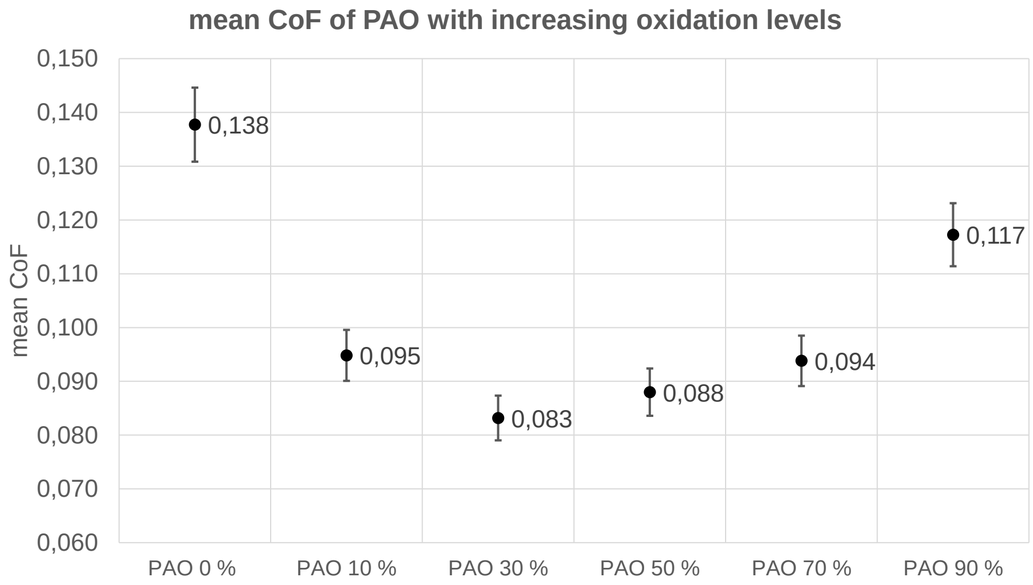


- In PAO, as the oxidation level increases (pressure drop from 10 % to 90 %), the 1730 cm^{-1} peak (C=O stretching) significantly rises.
- With advancing oxidation, a new peak manifests at 1740 cm^{-1}.

Tribology

Parameters acc. DIN 51834-2	
Load	250 N
Frequency	50 Hz
Stroke	1 mm
Temperature	30 °C
Device	ETS *Optimol*





- The friction coefficients of PAO decrease markedly with increasing oxidation up to 30 %, a behavior that has been observed in previous studies.
- With increased oxidation (>30 %), the friction coefficients deteriorate.

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