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PTFE and MoS2 as two competing solid lubricants for dry-running hydrogen compressors

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In modern societies, efficient and resilient production and processing of energy are key requirements for a circular economy, which safes resources and reduces pollution of our natural environment. Therefore, the international climate agreement (Paris 2015) has set the maximum allowed global warming from the beginning of the industrial age below 2°, which needs a drastic reduction of greenhouse gas emissions, including CO2 until 2030 and net neutrality until 2050. To achieve a CO2 neutral energy supply, fossil energy carriers like oil and natural gas have to be completely replaced by green hydrogen produced by renewable energy sources. The existing power grid and energy storage technology is subject to subsequent adaptation from CH4 operation to H2 by combined repurposing of existing and development of new technology. Therefore, advanced sealing materials have to be developed to handle the volatile H2 gas at higher pressures to preserve comparable energy densities, like CH4 and in dry operation to avoid unwanted contamination of the gas by oil lubricants.

The current work describes a comparative study of carbon fiber-reinforced PPS composites with different types of solid lubricants, developed as high-pressure sealing materials in dry-running piston compressors. Advanced characterization by electron microscopy and synchrotron tomography, supporting tribological testing, shows deformation behavior under simulated pressure forces and tribo-film formation and its mechanisms in predicted operation modes. PTFE and MoS2 could be directly compared on a micromechanical level, and main differences in their self-lubricating mechanisms could be derived. The results show the advantages of the well-known PTFE lubricated tribo-systems compared to new observations on the MoS2 lubricant. Advantages and limitations of both systems show applicability of sealing materials for dry-running hydrogen compression and give insights in MoS2 performance with respect to PTFE substitution, necessary to fit potential requirements of future PFAS regulations.

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