Experimentally developed polymer composites for hydropower bearings

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To negate the environmental consequences of hydropower turbine downstream lubricant spillage, water based lubricated bearings have the potential to replace mineral oil lubricated systems. The use of water as lubricant however, makes the choice of bearing material critical, especially considering the high contact pressures and partial operation in starved conditions present under the frequent start-stop cycles. Previously obtained data on the tribological properties of PPS and PPS based composites indicated a poor dry sliding performance partly due to the brittle interface between short carbon fibers. A significant enhancement in tribological performance was obtained when introducing PTFE with a maximum reduction in friction of 81% at a PTFE content of 40 wt%. Based on these results and previous work, two experimentally developed composites based on UHMWPE and a PPS-PTFE matrix blend were selected and characterised with respect to commercially available composites. The mechanical properties of the composites were obtained using nano-indentation experiments. The friction and wear performance were analysed using reciprocating pin-on-plate tests under three different lubricating conditions; dry sliding, distilled water and using an environmentally adaptive lubricant (EAL). The contact pressure of 20 MPa and sliding speed were selected to simulate the conditions found in turbine guide vane bearings. Under dry conditions, the addition of solid lubricants enabled low friction and wear to be obtained for the polymer composites with respect to the reference bronze sample. The use of water lubrication however, prevented an adequate polymer and solid lubricant film formation, increasing friction and wear for the commercial materials. The developed PPS-PTFE composite, in contrast, indicated a reduced friction of up to 74%, outperforming the commercial materials. The use of the EAL provided a significant reduction in both friction and wear up to 98%. The developed PPS-PTFE composite proved to be a suitable alternative to enhance the service life of guide vane bearings especially considering the use of water and EAL lubrication. The UHMWPE composites indicated a good performance under lubricated conditions but underperformed in dry conditions as a result of the high contact pressure.

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