Title:

Modeling of a Novel Elastohydrodynamic Seal for sCO_2 Power Cycles with Experimental Verification

Abstract:

Effective sealing remains one of the technological challenges at the subcomponent level for supercritical carbon dioxide (sCO_2) power generation to be practical. Leakages from sCO_2 power cycles can lower cycle efficiencies by up to 0.65%. Therefore, to fully harness the benefits of sCO2 power generation; this leakage must be addressed through engineering of efficient sealing technology. To this end, we propose an elastohydrodynamic (EHD) seal as a potentially effective solution that can operate at sCO_2 conditions with minimal leakage and wear. In this study, an FEA/CFD based fluid-solid coupling modeling approach was presented with experimental verification. For proof-of-concept purposes, the tests were performed on a 2" static shaft seal and with pressures up to 1.2 MPa using PTFE as the seal material. Both the test and simulation results exhibited a quadratic leakage trend. The leakage rate first increased with increasing pressures, then made its peak of about 6 g/s in mid-pressure range, then started to drop to lower values of about 1.5 g/s as the pressure reached the maximum operating pressure. The proposed model was demonstrated to be a quick and handy tool to determine the design space of the EHD seals with minimal computational time. The simulation converged in only 2 seconds. Yet, the proposed model could provide data regarding the leakage rate, seal deformation, pressure in the clearance, and stress on the seal, and thus, could serve as a design guide for the EHD seals.