STEADY-STATE AND TRANSIENT SIMULATIONS OF HYDRAULIC ROD SEALS

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A steady-state soft EHL (elastohydrodynamic lubrication) model of a reciprocating hydraulic seal has been used to simulate the performance of a U-cup seal and a step seal in a conventional actuator. The model consists of coupled steady state fluid mechanics, deformation mechanics, contact mechanics and thermal analyses, with an iterative computational procedure. Results indicate for a given seal roughness and stroke length there is a critical rod speed above which the seal will not leak. The critical speed is dependent on both seal roughness and sealed pressure.

The same type of steady-state model has been used to exam a potential seal improvement, the provision of a micro-scale pattern on the sealing surface. The behavior of a U-cup rod seal with a sawtooth pattern on the lip surface has been examined. The results indicate that the micro-scale surface pattern can substantially decrease the critical speed of a conventional rod seal and, hence, improve its effectiveness.

A transient soft EHL model of a reciprocating hydraulic rod seal has also been developed. The model has been used to analyze a U-cup lip seal in an injection molding application with a time-varying sealed pressure and rod velocity. Results include the histories of the hydraulic fluid flow rate, fluid transport, mean shear stress on rod, sealing zone length and friction force on rod, as well as distributions of the fluid pressure, film thickness and contact pressure.