Hydrodynamic lubrication model of the piston-cylinder interface from a piston pump

CATEGORY OR KEYWORDS
Surfaces and interfaces, Tribological Modeling, Pumps

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INTRODUCTION

In addition to providing the energy source for a motor, petroleum distillate motor fuel is used to lubricate interfaces within the fuel injection system. Non-optimal purity, viscosity, and chemical fuel properties can lead to increased friction and wear in fuel pumps and injectors, and sometimes failure of entire engine systems. The piston-cylinder interface within piston-style fuel pumps is a commonly crucial tribological component in many engines.

ABSTRACT

A hydrodynamic tribological model has been developed that analyzes the major phenomena involved in the piston-cylinder interface of a fuel pump. The model used the Successive-Over-Relaxation method (SOR) to solve the Reynolds Equation of the fluid. The contact area was adjusted and re-meshed throughout the simulation to account for the motion of the piston in and out of the cylinder [1]. Asperity contact was considered using the Greenwood Tripp boundary friction model. Elastic deformation of the piston and cylinder was estimated using Lamé Equations. The temperature within the interface was estimated, and fluid properties were updated based on the localized fluid temperature and pressure [2]. Based on an input of component geometry, mechanical properties, roughness, fluid properties, and pump operating conditions, the model outputted the following conditions throughout the pumping cycle: distribution of fluid pressure and film thickness, piston misalignment and eccentricity, and viscous and solid friction forces. Model results were compared to various tribological tests and real pump tests run with a range of fuel fluid properties.

ACKNOWLEDGMENTS

The authors would like to acknowledge valuable guidance and assistance Dr. Xuan Ma, Prof. Jane Q. Wang, as well as the Tribology Group at Argonne National Laboratory.

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