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Xuan Ma, Q. Jane Wang, Xiqun Lu, Viral S. Mehta

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1 **A Transient Hydrodynamic Lubrication Model for Piston/Cylinder Interface of**
2 **Variable Length**

3 Xuan Ma^{1,2}, Q. Jane Wang^{2*}, Xiqun Lu^{1**} and Viral S. Mehta³

4 ¹ College of Power and Energy Engineering, Harbin Engineering University,
5 145 Nantong Street, Harbin 150001, China

6 ²Department of Mechanical Engineering, Northwestern University,
7 2145 Sheridan Road, Evanston, IL, 60208, USA

8 ³Tech center, Caterpillar,
9 100 NE Adams St, Peoria, IL 61629

10 *email: qwang@northwestern.edu, Tel: +1 847 467 7510 Fax: +1 847 491 3915

11 **email: luxiqun@hrbeu.edu.cn, Tel: +86(0)451 82588822 Ext. 320, Fax: Ext. 311

12
13 Abstract

14
15 Hydraulic machinery transfers energy between a fluid and a mechanical system. The
16 swash plate pump is one of the most widely used pumps because of its simple and
17 compact structure. The piston/cylinder system is the core of the swash plate pump, and its
18 lubrication characteristics greatly affect the overall pumping performance. This study is
19 aimed at the development of a transient hydrodynamic lubrication model for the pumps
20 with varying length of the piston-cylinder interface and the investigation of the influences
21 of cylinder length, clearance, as well as other design parameters, on the pump piston
22 forces and friction. The changing domain and moving boundaries of the varying
23 piston-cylinder interface impose a challenge to the modeling, and a novel
24 equal-displacement-step method is developed to tackle this issue. The pressure, film
25 thickness, and friction performances of varying and constant interface-length systems are
26 studied, and the former is further analyzed in detail. The results indicate that increasing
27 the cylinder length reduces the misalignment angle and raises the minimum film
28 thickness, but it increases the maximum friction force at and slightly off the location for
29 the maximum velocity because friction is related to velocity and the interfacial area. A
30 longer piston is preferred, and the optimal length for stability should be $L_0/L_{min}=1.71$ for
31 the system analyzed in this study.

32
33 Keywords:

34
35 Transient Hydrodynamic Lubrication, Variable Piston/Cylinder Interface, Swash Plate
36 Pump.

37

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