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EXPERIMENTAL ANALYSIS OF FRICTION AND TEMPERATURE RISE OF GREASED OSCILLATING PIN AND BUSHING CONTACTS

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ABSTRACT

One particular interest to most researchers in contact mechanics is the phenomena of oscillating contacts. This paper presents the results of a series of experiments conducted to understand the nature of the friction and temperature behavior under heavily loaded, oscillatory conditions with greased contacts and the relationship to wear. Under oscillating loaded conditions, a machine component exhibits heat generation that remains over a relatively small area. This concentrated heat flux tends to cause failure more quickly than the same conditions in rotational mode.

The particular interest here is of a pin located on the bucket connection of a large wheel loader. This machine and similar machines are used to scoop and dump loads weighing up to 24 tons. Under normal operation, the bucket is constantly being cycled up and down in about 10 seconds. This creates an oscillating motion on the attachment pins which are under high stresses. The pin under investigation is large in size and undergoes a stress nearing 20,000 psi.

To test this pin and bushing combination in a controlled laboratory environment, Hertzian contact equations for elastic deformation were used to scale down the components while maintaining the original stress. The contact was simplified as a dry Hertzian line contact for parallel cylinders under static conditions. Hertz' analysis idealizes a pressure distribution shown in Figure 1 along the axis of contact.

The Lewis LRI-8H Bushing Tester shown in Figure 2 can apply up to a 3000 pound load. For simulation, the pins and 1.00 inch long bushings were designed with a 0.966 inch diameter and 1.00 inch inner diameter, respectively. Desired stress is obtained with a 1000 pound load and accelerated testing is done with higher loads.

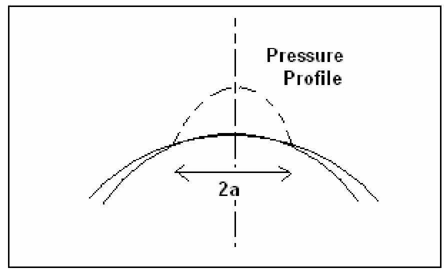

Figure 1: Hertzian Contact Pressure


Figure 2: Lewis LRI-8H Bushing Tester

The oscillations were run at frequency of 1.34 Hz, +/- 45 degrees. This angle is the same as the actual pin. The frequency, though greater than actual, was chosen based on Peclet number since temperature analysis at the contact for the actual pin is desired.

Majority of tests are conducted for four and eight hour time intervals. Prior to testing, each bushing is weighed to compare with weight after testing to quantify wear. The shafts are secured in a spindle housing driven by a crank arm off the motor. Grease is smeared on the inside of the bushing along the contact area. The bushing fits in a holder that is inserted in a bearing housing that is loaded in the downward direction. A torque arm on the holder is used to determine friction.

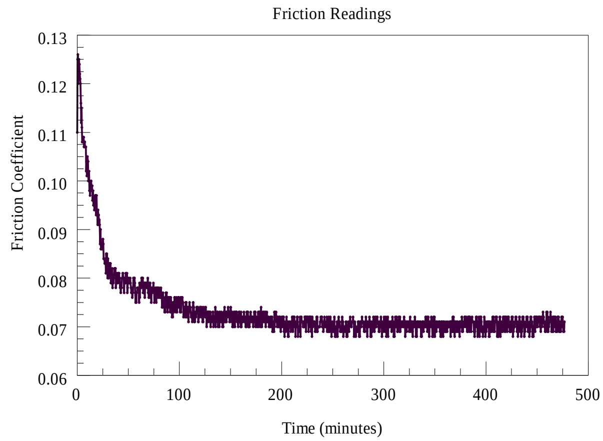

Figure 3: Friction Data

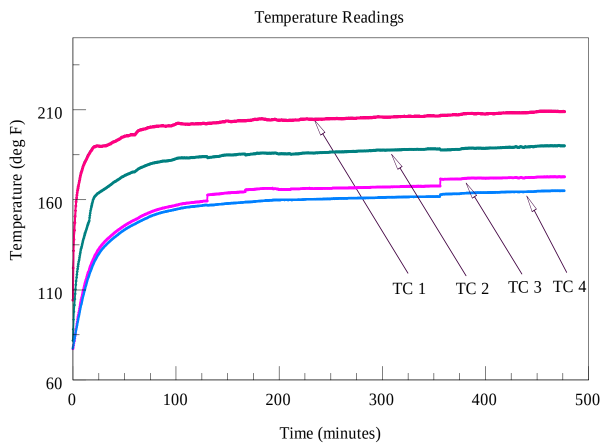

Figure 4: Temperature Data

Friction data at the contact and temperatures evenly spaced 45 degrees along four locations around the circumference of the outer diameter of the bushing were collected and analyzed. See Figures 3 and 4 for sample plot of eight hour test with a load of 3000 pounds.

From observations, temperature values were fairly consistent with frictional values. As was expected from previous testing, higher loads produced lower friction coefficients. Friction coefficients range from around 0.12 for 1000 pound loads to 0.07 for 3000 pound loads with the temperatures respectively ranging from around 150^{o}F to 200^{o}F. Some tests did exhibit unusually high temperatures that reached 450^{o}F.

The data has been and continues to be used for comparison to simulations run for oscillating contacts. More efforts are being made to change experimental setups to help bridge the gap between the simulated and recorded results. Further analysis of the curves is underway to understand the behavior.

ACKNOWLEDGMENTS

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