Session 3D • Music Row 1

Wear I

Session Chair:
Mathieu Renouf, University of Montpellier, Montpellier, France

Session Vice Chair:
Arnab Ghosh, Sentient Science, Idaho Falls, ID

8 – 8:30 am | Effects of Shoe Design and Progressive Wear on Traction Performance

Sarah Hemler, Kurt Beschorner, University of Pittsburgh, Pittsburgh, PA

Previous research has shown variation in performance across shoes labeled as slip-resistant (SR) [1]. This research assessed how progressive shoe wear affects traction and fluid pressure measurements of SR shoes. Eight participants wore two types of SR shoes alternating every month walking a total of at least 75 km in each shoe. After each month, available coefficient of friction (ACOF) and fluid pressure measurements were recorded while each shoe was mechanically slid across a contaminated surface with embedded fluid pressure sensors. Fluid force measurements were then calculated. ACOF and fluid force were each affected by the number of months of wear ($p<.0001$, $p<.0001$), the heel type ($p=0.0443$, $p<.0001$), and the interaction between the two variables ($p<.0001$, $p<.0001$), respectively. This research shows that shoe design affects both performance at baseline and the progression of performance across the shoe's life. 1. Jones, T, et al. Applied Ergo, v70, pgs 134-135, 2018.

8:30 – 9 am | Methods to Study the Life of an Asperity Subjected to Tribological Contact

Arnab Bhattacharjee, Nikolay Garabedian, David Burris, University of Delaware, Newark, DE

Friction and wear are consequences of complex phenomena that occur within a buried tribological interface. Directly interrogating these phenomena often requires methods to penetrate the contact interface in real time or methods to separate the contact without disturbing the processes. Engines, and many other applications involve self-mated metals, which virtually precludes the former. We have challenged ourselves to develop interrupted methods to study the life of a sperity in self-mated metallic contacts. The goal here was to break and recreate tribological contact with repositioning errors of 150 nm or less. Validation testing demonstrated that, with methods that are relatively easy to duplicate, contact locations can be replaced with a repositioning error of ±100 nm. Additionally, validation experiments with self-mated steel and a neat PAO lubricant demonstrate that the tribological contacts can be broken and replaced without any statistically significant effect on the wear rate.

9 – 9:30 am | Gait Parameters of Shoe Wear: A Case Study of the Shoe Wear Rate by Individual Gait Parameters

Erika Pliner, Sarah Hemler, Kurt Beschorner, University of Pittsburgh, Pittsburgh, PA

Elastomeric wear is dependent on the cyclical loading conditions. Therefore, outsole shoe wear is likely to be dependent on an individual's gait pattern (i.e. frictional shoe forces and shoe sliding distance). This study presents a case study comparing the gait patterns of two individuals with different shoe wear rates. Participants were asked to wear two pairs of shoes (Shoes A and B) in their day-to-day life until the shoes were deemed unsafe to wear. One participant's wear style is referred to as 'Fast Wear', wearing shoes A and B after 86 and 238 km, respectively. The other participant is referred to as 'Slow Wear', wearing shoes A and B after 407 and 1255 km, respectively. During gait, the Fast Wear participant had higher frictional forces (27-31%) and sliding distances (27-65%) than the Slow Wear participant. The relationship between sliding distance and wear rate is consistent with Archard's wear equation. Gait patterns may influence tread wear consistent with tribology theory.

9:30 – 10 am | Ash-Induced Wear on Biomass Pre-Conversion Equipment

Kyungjun Lee, Jun Qu, James R. Keiser, Oak Ridge National Laboratory, Oak Ridge, TN, Erik Kuhn, Edward Wolfrum, National Renewable Energy Laboratory, Denver, CO

There is growing interest in using biomass as a renewable energy source, however some biomass pre-processing equipment has been reported to have wear issues. In a NREL low-temperature conversion reactor, the stainless steel plug screw feeder experiences severe wear, especially in processing high-ash biomass. In this study, the wear issue was investigated by identifying the wear modes and correlating them to the biomass ash species and contents. Characterization was performed on the worn screw feeder to reveal the wear mechanism, as well as on the extrinsic ash from biomass feedstock to analyze the ash particle size distribution, particle shape, and chemical composition. To understand the ash abrasiveness, bench-scale 3-body abrasion wear tests were carried out with selected ash samples and the screw feeder material. The worn surfaces generated during the bench test were examined and the morphology and composition were correlated to those of the actual worn screw feeder.

10 – 10:30 am | Break

10:30 – 11 am | Predicting Slip Risk Based on Footwear

Sarah Hemler, Kurt Beschorner, University of Pittsburgh, Pittsburgh, PA

This study assessed whether the under-shoe fluid load during a simulated slip could be predicted based on the size of the worn region. Four shoes underwent an abrasive wear procedure to generate localized wear in the heel. Periodically, fluid pressure sensors embedded in the flooring recorded under-shoe fluid pressures during a simulated slip. Fluid force was then calculated. The film thickness of the contaminant was predicted using a derivation of Reynold's equation for thrust bearings [1] based on the size of the shoe wear region. Linear regression analysis showed that the fluid force was affected by predicted film thickness ($p <.0001$). Therefore, the fluid film thickness predictions based on the size of the worn shoe region were able to predict the under-shoe hydrodynamics. This model may have potential in determining when worn shoes should be replaced.

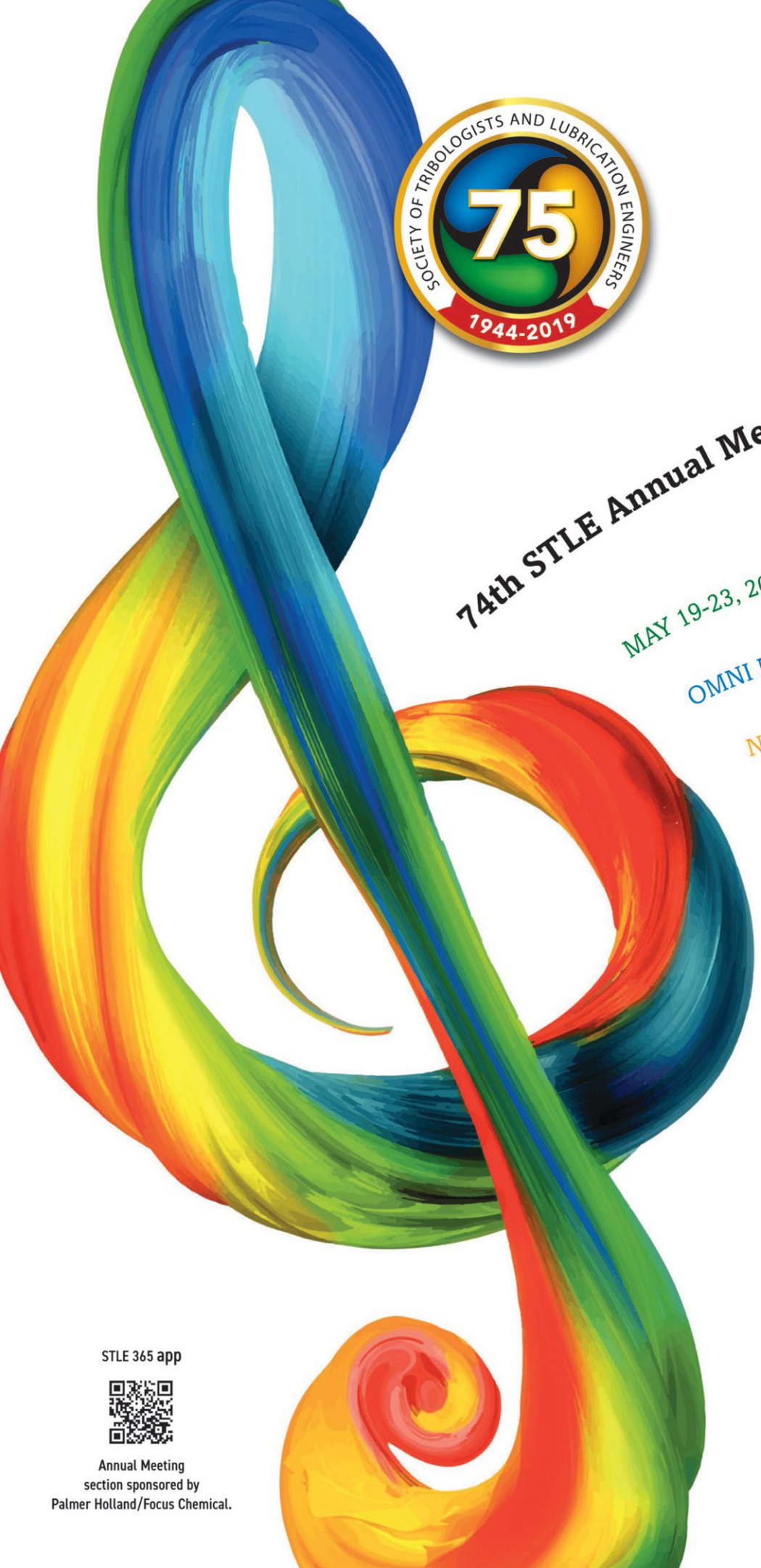
[1. Proctor & Coleman, J Occup Acc, Vol. 9, No. 4, pp. 269-285, 1988]

11 – 11:30 am | Influence of Film Structure on Vane Pump Protection

Xinggao Fang, Mark Devlin, Phillipe Ezanno, Afton Chemical Corp., Richmond, VA

Additives play a critical role in keeping vane pumps in power transmissions from damage. A systematic study on additives that form surface films has been carried out using modified ASTM D7403 a method for indicating wear characteristics of hydraulic fluids in a constant volume vane pump. A wear mechanism has been identified. Practical fluids with balanced needs for transmission hardware protection wil be discussed.

Program Guide and Schedule



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