Society of Tribologists & Lubrication Engineers Annual Meeting & Exhibition 2011

Atlanta, Georgia, USA
15-19 May 2011

ISBN: 978-1-61839-105-6
# TABLE OF CONTENTS

Centrifiltergram and Filtersonicogram Maker: A New Tool for Solid Debris Separation From Used Lubricants and Used Lubricating Oil Filters ........................................................................................................................................... 1  
Surapol Raadmu

A “Low Cost” Solid Debris Separation for Used Grease Debris Analysis: Utilization of Particle Separating Tube (PST) and Centrifiltergram Maker ........................................................................................................................................... 6  
Surapol Raadmu

New Oil Soluble Polyalkylene Glycols For Grease Manufacture ........................................................................................................................................... 10  
G. Khemchandani

Tribological And Thermal Properties Of A New Flexible Ceramic Coating ........................................................................................................................................... 12  
Hooshang Heshmat, James F. Walton III, Said Jahanmir

Grease Lubrication – Pitting Load-Carrying Capacity of Gears ........................................................................................................................................... 15  
Johann-Paul Stemplinger, Bernd-Robert Hoehn, Karsten Stahl, Klaus Michaelis, Michael Hochmann

Thermal And Roughness Effects In A Long Porous Slider Bearing ........................................................................................................................................... 18  
Getachew Adamu, Prawal Sinha

Effect of Density Flow Factor on Thermal Elastohydrodynamic Lubrication of Infinite Line Contact Rough Surfaces ........................................................................................................................................... 21  
Hasim Khan, Prawal Sinha

Numerical Analysis of a Hydrodynamic Herringbone Grooved Journal Bearing ........................................................................................................................................... 24  
Dominique Souchet, Abdelhak Senouci, Hamid Zaidi, Mohamed Amirat

Sealing Suitability of Hard-Turned Shafts Operating With Rotary Lip Seals ........................................................................................................................................... 28  
Steffen Jung, Werner Haas

Residual Displacement and Strain Profiles In 3D Rolling Contact on An Elasto-Plastic Body With Isotropic or Kinematic Hardening ........................................................................................................................................... 31  
Thibaut Chaise, Daniel Nellas

Investigation of The Validity of The Carslaw and Jaeger Thermal Theory Under Different Working Conditions ........................................................................................................................................... 34  
Rong Zhang, Laila Guessous, Gary Barber

Numerical Modeling of The Mixed Lubrication of a Radial Lip Seal Running Against Surface Textured Shaft ........................................................................................................................................... 38  
Wei Li, L.S. Stephens

Solidly Deposit Formation on The Surface of Turbine Housing and Blades for Turbocharger at The Elevated Temperature ........................................................................................................................................... 44  
Fumihiko Yokoyama, Ryuuma Murano, Ken Nakano, Yutaka Hirata

Evaluation of Fiber Wear Resistance in an Atomic Force Microscope for Use in Cartilage Replacements ........................................................................................................................................... 46  
Michael Giordano, Steven Schmid

The Impact of Two Link Chain With a Flat Surface ........................................................................................................................................... 49  
Yang Xu, Dan B. Marghitu, Robert L. Jackson

Evaluation of Individual Fiber Wear Resistance Using Accelerated Life Testing ........................................................................................................................................... 52  
Michael Giordano, Steven Schmid

Broad Spectrum Wear Measurement for Plane Bearing Materials ........................................................................................................................................... 55  
Robert Adams, Qian Zou

The Effects of Profile on Journal Bearing's Performance ........................................................................................................................................... 58  
Amir Hasan Kakee, Ali Akbar Tabrizi

Effect of Aeroelastic Bearing on Rotor Dynamics: A Numerical Analysis ........................................................................................................................................... 64  
J. Rocchi, L. Barzema, B. Bou-Said, G. Grau

Gas Foil Bearings' Behavior in Refrigerating Gas ........................................................................................................................................... 68  
Mathieu Garcia, B. Bou-Said, J. Rocchi, G. Grau

In Turbine Oils, Minor Ingredients Can Have the Biggest Impact ........................................................................................................................................... 71  
Amy Fentress

Parallel Iterative Method for the Solution of Air Bearing Model ........................................................................................................................................... 76  
Nenzi Wang, Shih-Hung Chang, Kuo-Chiang Cha

Highly Stressable and Low Friction Slip-Rolling Contacts Through Thin Film Coatings and/or Uncoated, Alternative Steels ........................................................................................................................................... 79  
C. Scholz, D. Spaltmann, M. Woydt

The Relationship Between Molecular Structures and Tribological Properties of Pure Compounds for the Design of Synthetic Fuels ........................................................................................................................................... 86  
Arshia Fatemi, Kai Masuch, Peyman Yamin, Kai Leonhard, Hubertus Murrenhoff
Comparative Study of Formability of 304 L Steel Sheets with Green Lubricants—Theory and Experiments ................................................................. 178
Y.M. Shaashidhara, S.R. Jayaram
Thermo-Elastohydrodynamics of a Rough Piston Compression Ring-to-Cylinder Bore Conjunction ................................................................. 182
C.E. Baker, R. Rahmani, S. Theodossiades, H. Rahnejat, B. Fittsmons
Process Monitor and Control for Coolant Sump Longevity: Case Study of Green Chemistry & Sustainability in MWF ......................................................... 189
Yixing (Philip) Zhao, Robert Groundwater, Dave Enright, Peter Konogi, Ramy El-Helwi
Friction and Wear Behavior of Impact Extrusions of Al6061-SiC Composites .......................................................................................... 195
K.S. Sridhar, C.S. Ramesh, R. Keshavamurthy
Electrochemical Evaluation of Corrosion Kinetics in Heat Stressed Oil Films .................................................................................. 198
S. Joseph Asadunas, Asta Griguceviciene, Konstantinas Leinartas
Effects of Lubricant Viscosity Disruption Due to Water Contamination: Simulations of Hydrodynamic Thrust Bearing Behaviour ............................................... 201
Elias Hartka, Mathieu Helene, J. Bouyer, M. Fillon
Experiment and Development of a Laboratory Test Rig for Traction Force of Shaft-Sleeve Joint with Grease Lubrication under Radial Load and Low Speed .................................................. 204
Yang Boyuan, Y. Hua Diann, Zhou Jian
Advanced Large Diameter High Temperature Air Seals ........................................................................................................... 208
Hooshang Heshmat, James F. Walton II, Zhaohui Ren, Andrew Hunsberger, Said Jahannir
Friction of MoS2 Single Layers at Low and High Relative Humidities ............................................................................................... 211
Xueying Zhao, Scott S. Perry
Wear Characteristics of Advanced Honed and Cross-Hatched Coated Cylinder Liners .................................................................................... 214
M. Gore, M. Perera, G. Styles, P.D. King, H. Rahnejat
Multiphase Nano-Structured Coating for Cutting Tool Application .......................................................................................... 218
Jose Nainaparampil, A.K. Rai, Rabi Bhattacharya
Influence of High-intensity Pulsed Ion Beams Irradiation on Friction and Wear Properties of YWN8 Composite ............................................................................. 221
Qingfeng Wen, Ying Liu, Yuming Wang, Weifeng Huang, Shuangfu Suo, Xiangfeng Liu
Influence of Wear and Method of Compensation on the Performance of 2-Lobe Multirecess Hybrid Journal Bearing System ............................................................................ 224
Satish C. Sharma, Vikas M. Phalle, S.C. Jain
Tests of Solid Lubricants for Cryogenic and Vacuum Environment ........................................................................................................ 228
T. Schneider, T. Gradt, G. Theller
The Onset of Plastic Yielding in a Coated Sphere Compressed by a Rigid Flat .................................................................................. 231
I. Ettson, R. Gotsberg, G. Davidi
Performance of an Orifice Compensated Non-Recessed Hole-Entry Hybrid Journal Bearing Operating with Micropolar Lubricant ........................................................................................................................................................................................................................................ 234
Satish C. Sharma, Nathi Ram
Analysis of Rod Seals by Application of the Fluorescence Method ............................................................................................................. 237
K. Ottink, B. Wennehorst, G. Poll
Effect of Surface Oxide Layer of Steel Specimen on Tribological Characteristics of Additives for Multiply Alkylated Cyclopentane Oil Under High Vacuum ........................................................................................................ 240
Masabumi Masuko, Shigeru Iijima, Takahiro Terawaki, Akihiro Suzuki, Saiko Aoki, Takashi Nogi, Shingo Obara
A Study of a Constant Flow Valve Compensated Non-Recessed Hole-Entry Hybrid Journal Bearing Operating in Turbulent Regime .......................................................................................... 243
Nathi Ram, Devendra Sankla, Satish C. Sharma
Low-Viscosity Grease Lubricated Radial Lip Seals Influence of the Lubricant .................................................................................. 246
Michael Narten, Werner Haas
Investigation of the Tribological Behavior of Grease Lubricated Rubber Seals with a Ring-on-Disc Tribometer .................................................................................. 250
Max Sommer, Werner Haas
1 KW Less Friction Due to Textured Sliding Faces ............................................................................................................. 253
Lothar Hoerl, Claus Gerald Pflueger, Werner Haas, Andreas Laage, Matthias Heine
Lube Oil Management and Maintenance in Today's Gas Turbines ........................................................................................................ 260
Hans Oergsagga
Experimental Study on Dynamic Coefficients for Spindle System Supported by High-Speed Hybrid Bearing ........................................................................................................ 267
Shilei Ma, Qiushan Ma, Shiyuan Pei, Bei Zhang, Lin Wang, Hua Xu
Rotary Lip Seal Pumping by a Ground Shaft with and without a Laser Structure .......................................................................................... 270
Xiaohong Jia, Steffen Jung, Werner Haas, Richard F. Salant
A Simplified Mass-Conservating and Continuous Cavitation Model ................................................................. 273  
Noel Brunetiere, Q. Jane Wang

Extreme Pressure Performance of Greases: Testing and Additive Solutions .................................................. 276  
Gareth Fish, William C. Ward Jr.

Innovations in Polyalkylene Glycol Based Lubricants ...................................................................................... 279  
Richard Butler, G. Khemchandani

Metal Working Fluid Regulatory and Technology Discussion .............................................................................. 309

N/A

Study of Friction in Heavy Vehicles Braking Systems: Impact on the Coefficient of Friction Produced by Variable Normal Load ........................................................................................................ 328  
Edward Jun, Habib Benahdallah, Karim Khayami

Rheological Model of a Boundary Layer of Lubricant ....................................................................................... 333  
E. Zadorozhnaya, I. Mahortov, N. Usolcev, I. Levanev

High Temperature Impact-Fretting Experiments for Understanding of Repassivation Kinetics of Steels ........................................................................................................................................ 337

Michimasa Uchidate, Yoshiki Sato, Akira Iwabuchi, Hitoshi Yashiro, Robert J.K. Wood


Xuwen Zhu, Laila Guessous, Gary Barber

Lubrication Mechanisms of Aqueous Fatty Acids/Diamine Lamellar Systems .................................................. 343


TEHL Analysis of Rough Surface Spur Gears with Non-Newtonian Lubricants Under Load Loads .................. 346

Mongkol Wongrojn, Jeda Panichakorn

Investigation of Scuffing Behavior of Stainless Steels ....................................................................................... 349

Rebeca Lumbrañas, Xichen Sun, Gary Barber, Qian Zou

Mass Spectrometry As ‘High End’ Method for the Elucidation of Alteration Mechanisms of Antioxidants ......................................................................................................................................... 352

Alexander Kassler, Ernst Pittenauer, Nicole Doerr, Guenter Allmaier

Identification of Degradation Products of Ionic Liquids by Mass Spectrometry ............................................. 355

Nicole Dorr, Lucia Pisanova, Andjelka Ristic, Ernst Pittenauer, Guenter Allmaier

Elastohydrodynamic Lubrication of Oscillating Roller Contacts ...................................................................... 357

Xiao Yang Chen, Tong Shu Hua, Xue Jing Shen

A Field Investigation of the Behavior of Gas Turbine Oil Oxidation Products .................................................. 360

Carlo Galli

Piston Ring Cylinder Bore Friction Reduction ...................................................................................................... 384

Robert Zdrodowski, Steven J. Simko, Carol Regalbuto, Arup Gangopadhyay

EHL of Large Length/Diameter Ratio Profiled Needle Roller .......................................................................... 387

Xiao Yang Chen, Xuejin Shen, Martin Hardt, Ivan Krupka

Investigation of Friction and Wear Characteristics of Water Based ZnO and AL2O3 Nanofluids ...................... 391

Luan Gara, Qian Zou

Development and Tribological Characterization of Novel Alumina Based Composites for Reduced Friction and Wear Applications .................................................................................................. 394

Rajeshwari Paluri, Sudeep Ingole

Investigation of Water in Lubricating Oil ............................................................................................................. 397

Kenji Matsutomo, Akira Sasaki

A Study of Colors of Contamination in Used Oils .............................................................................................. 417

Akira Sasaki, Hideo Aoyama, Tomomi Honda, Yoshiro Iwai, C.K. Yong

Ionic Liquids As Lubricants ............................................................................................................................... 435

Paul Sutor

Oil Debris Monitoring Using Ultrasonic and Inductance Based Techniques ....................................................... 437

M. Appleby, Li Du, F.K. Choy, J. Zhe

Simulations and Experiments on the Influence of Surface Roughness on Hydraulic Rod Seals ....................... 440

Alexander Buck, Lothar Horl, Werner Haas

Getting Closer to One’s Machine. Magnetic Ferrous Particle Measurement Via Online and Onsite Devices Ushers in a New Paradigm for Site-Direct™ Oil Analysis ........................................... 443

Jack Poley

Automotive Gear Lubricant from Soybean Oil ..................................................................................................... 445

M. Arca, B.K. Sharma, K. Doll, J.M. Perez

Causes and Implications of Data Variability in Basic and Applied Tribotesting ............................................... 448

Peter J. Blau

Tribodynamics of Hypoid Gear Pairs .................................................................................................................. 451

I. Karagiannis, S. Theodossiades, H. Rahnejat
Investigation of Surface Damage on Wind Turbine Gearbox Bearings and Its Implications for Durability Testing

Peter J. Blau

Environmental Considerations Regarding the Benefits of “Green” Contamination Control

Minul Mahapatro, Christian Bauer

Understanding the Molecular Flow of PFPE Lubricant Films on Smooth and Patterned Surfaces

C. Mathew Mate

On the Performance of a Wave Bearing Supporting an Elastic Planet Gear in an Aerospace Transmission

F. Dimofte, Nicoleta M. Ene

Utilization of Filtration Technology with Stress Resistance in Modern Industrial Hydraulic Systems

Minul Mahapatro, Christian Bauer

Contamination Analysis – An Integral Part of Condition Monitoring

Christian Bauer

Observation of Metal Gasket Surfaces Using Laser Microscope with Wide Field of View

Isami Nitta, Yoshio Matsuzaki

Experimental Studies on the Tribological Behaviour of Engine Oil (SAE15w40) with the Addition of CuO Nanoparticles

P.K. Rajendrakumar, Manu V. Thottackkad, Nair K. Prabhakaran

Sliding Behaviour of UHMWPE and ASTM 316l Stainless Steel Used for Artificial Hip Replacement


Study of Friction on Multi-layer Graphene Using MD Simulation

Anirudh Udupa, Ashlie Martini

Significant Rough Surface Constituents for Consistent Contact and Lubrication Analyses

Sanxing Zhao, Noel Brunetiere, Q. Jane Wang

Particle Counting, Sizing and Characterization in Wind Turbine Gearbox Lubricants Utilizing Scanning Electron Microscopy (SEM) with Automated Electron Beam and Automated Feature Analysis (AFA) Software

William Hergher

Nanodiamond-Based Nanolubricants


Study of Wear Behavior of Nylon 66 Blended with Graphite and MoS2 Using Taguchi’s Technique

S.L Dinesh, S.R. Jayaram

Microscopic Damage Structure Just Under the Sliding Surface of Chrome-Molybdenum Steel

Kenji Matsumoto, Hideo Watanabe, Naoki Yoshida

Tribological Evaluation of Surface Texturing Used in Air Conditioning and Refrigeration

Compressor Surfaces

Surya P. Mishra, Andreas A. Polycarpou

Micro-Pitting on Gears: Main Influence Parameters Based on Gear Testing and a Calculation Method for Rating the Micro-Pitting Load Capacity of Gears

Thomas Tobie, Bernd-Robert Hohn, Karsten Stahl

A Dynamic Bearing Model for Four Point Contact Bearing Analysis

Aditya Dattawadkar, Farshid Sadeghi, Dave Van Langevelde

Localized Lubrication of Micro-Machines

Jonathan Y. Leong, Harikumar Vijayan, Nalam Satyanarayana, Sujeeet K. Sinha

Characteristics of Novel Renewable Base Fluid Derived from Castor Oil

G. Khemchandani, Daniele Vinci, Martin Greaves

Modern, Ester-Based Hydraulic Fluids for Power Generation

Nico Broekhof, Peter N. Skoog, Ronald Knecht

Effect of Coolant Characteristics on Tool Life When Machining Ti-6Al-4V Under High Pressure Coolant Flows

E.O. Ezugwu, A.B. Mohd Hadzley, J. Bonney

Improving Reliability by Evaluating In-Service Grease

Lisa A. Williams

Field Experiences Using Advanced Oil Contamination Control to Increase Gearbox Life and Reliability

William M. Needelman, Martin A. Barris

Shock Tolerant and Corrosion Proof Rolling Element Bearings Made from Superelastic Materials

Christopher Della Corte

Developments in Frictional Property by Micro-Scale Dimples

J.H. Kim, A. Amanov, K.S. Choi, Y.S. Pyoun, S.J. Lee, J.S. Im
The Effect of Various Heat Treatments on the Hardness of Ni-rich NITINOL Alloys for Tribological Applications
Fransua Thomas, Christopher DellaCorte, Malcolm K. Stanford .......................... 543

Role of Surface Texture on Friction and Transfer Layer Formation When Pure Aluminum Pins Slid
at Various Numbers of Cycles on Steel Plates .................................................... 546
Pradeep L. Menezes, K. Kishore, Satish V. Kailas, Michael R. Lovell

Studies on Friction in Steel-Aluminum Alloy Tribo-System: Role of Surface Texture of the Softer
Material ................................................................................................................. 549
Pradeep L. Menezes, K. Kishore, Satish V. Kailas, Michael R. Lovell

Influence of Rake Angle and Hardness Ratio on the Formation of Discontinuous Chip During
Orthogonal Metal Cutting .................................................................................. 552
Pradeep L. Menezes, Michael R. Lovell

Ionic Liquids – Versatile Materials for Lubrication ............................................. 555
Tom Beyersdorff, Thomas Schubert, Frank Stiemke

Wear Characterization of Bearing Surfaces – A Comparative Study .................... 557
Chih Lin

Liquid-Gas Two-Phase Flow Analysis of Lubricating Grease in Ball Bearing and Validation of Visual
Experiments Using X-Ray CT .............................................................................. 560
Takashi Noda, Shinji Miyata, Masato Taniguchi, Hirotoshi Aramaki

Optimization of Face Groove Parameters Based on a Integrated Performance Parameter for Dry Gas
Seals ...................................................................................................................... 562
Wei Feng Huang, Yuming Wang, Zhi Gao, Shuangfu Suo

Micro-Scratch Testing for Adhesion Study of Diamond-Coated Tools ............... 566
Ping Lu, Xingcheng Xiao, Michael Lukitsch, Kevin Chou

Diamond-Coated Tools with Different Etching Treatments - Delamination Characteristics and
Machining Performance ..................................................................................... 569
R.G. Thompson, D. Nolen, K. Chou, F. Qin

Effects of Surface Texturing on Friction and Wear Reduction Between Silicon Nitride and Stainless
Steel Materials .................................................................................................... 572
K.S. Choi, A. Amanov, J.H. Kim, Y.S. Pyoun

Different Effects of Micro-Grooves on the Lubricated Sliding Surfaces .............. 575
Xiaolei Wang, Shujuan Yuan, Wei Huang

Molecular Dynamics Simulations of Dry Sliding Copper Asperities to Study Friction and Frictional
Energy Dissipation ......................................................................................... 578
Bhavin N. Vadgama, Daniel K. Harris, Robert L. Jackson

Combined Influence of Viscous Dissipation and Starvation on Film Thickness in Grease Lubricated
Line Contacts: A Comparison with Oil Film Thickness ....................................... 582
R.K. Pandey, Y. Nath, S. Gupta

Hydrodynamically Stable Soy-Based Fluids Exhibiting a Wide Viscosity Range for Industrial Applications ................................. 585
D.B. Garbark, H.P. Benecke, S.I. Shaffer

The Debilitating Impact of Water Ingress on Wind Turbine Gear Oil Performance ......................... 588
K. Dinwiddie

Evolution of Surface Roughness Under High Pressure Lubrication Conditions .... 591
J. David Schall, Chakravarthi Mallikarjuna Nagulu

Condition Monitoring Methods and Analysis .................................................. 594
Eric J. Ryan, K. Dinwiddie

Numerical Study of the Influence of the Metalworking Fluid Properties on the Multiphase Fluid Flow
and Heat Transfer in Grinding ......................................................................... 597
Stefan Mihic, Sorin Cioc, Ioan D. Marinescu, Michael C. Weismiller

Squeeze Film Damping in Microsystems at Large Amplitude ............................. 600
Shujuan Huang, Diana Borca-Tasciuc, John Tichy

Experimental Analysis of Stable CuO Nanoparticle-Enhanced Lubricants ........ 603
Hamed Ghadri, Robert L. Jackson, Jay M. Khodadadi

An Evaluation of Antioxidants in Low Erucic Acid Rapeseed Oil (Canola Oil) at Elevated
Temperature ...................................................................................................... 606
Neil Higgins

Friction True Contact Area in Chemical Mechanical Polishing ......................... 608
Joseph A. Levert, Chad S. Korach, Benjamin Mooney, Franklin Lyman

Investigation of Image-Based Particle Shape and Size Analysis Techniques for Wind Turbine
Gearbox Lubricants ........................................................................................... 611
Shuangwen Sheng, William Herguth, Timothy J. Drake
An Integrated Computational Framework to Model Rotary Drilling
Jeremiah N. Mpagazehe, Alejandro F. Queiruga, C. Fred Higgs III

Carbon Nanotube Array-Based Contact Sensing
Chad S. Korach, Changhong Cao, Tommy McCune, Noah Machinay, Robert V. Kukta

Sub-Surface Deformation from CMP Scratch Defects
Chad S. Korach, Joo Hoon Choi

Interfacial Mechanics - Review and Prospect
Dong Zhu, Q. Jane Wang

Design Analysis of Recess-Type Hydrostatic Slide Systems for Machine Tool Applications
Hua-Chih Huang, Po-Chun Yaung

A Simplified Nonlinear Transient Analysis Method for Gas Bearings
A. Hassini, M. Arghir

A Comparison of Some Test Methods for the Evaluation of Biodiesel Quality and Blends
J.M. Perez, R.A. Johnson, W.A. Lloyd

Biomimetic Surface Texture for Elastomer Friction Control
Michael Varenberg, Boris Murarash, Yan Iovich

A Dynamic Analysis of a of a Dual Clearance Squeeze Film Damper Operating with Air Entrainment
L. Moraru, T.G. Keith Jr, F. Dimofte, Sorin Cioc, D.P. Fleming

Aluminum Sustainability — A World of Opportunity
Steve Larkin

Comparison of the Micro and Macro Regulations of Biocides and Biocontrol Additives
Cecile Giordana, David Bell

Amplitude Reduction in EHL Circular Contacts Under Rolling Sliding Conditions
J. Wang, C.H. Venner, A.A. Lubrecht

Hydraulic Fluids from an Environmental Point of View
M. Mueller-Zermini, Ben Martin, Gerhard Gaule

Rapid HLB-Based Method for Formulating and Improving Emulsion Stability
Bonnie Pyzowski, Mrunalini Dhamdhere

Steam Turbine Lubricant Development: A Case Study Approach
George Staniewski, William D. Hewson

Author Index