IndiaTrib - 2019

10th International Conference on Industrial Tribology

1st-4th December 2019

Indian Institute of Science, Bangalore

Indian Institute of Science

Tribology Society of India

MECHANICAL ENGINEERING 75 YEARS IISC

IndiaTrib - 2019

TRIBOLOGY SOCIETY OF INDIA

(Affiliated to International Tribology Council, U.K.)

Registered Office: R&D Centre – Indian Oil Corporation Limited, Sector – 13
Faridabad – 121 007 (Haryana), INDIA
Website: www.tribologyindia.org

Message

President, Tribology Society of India & Director(R&D), Indian Oil

Dear TSI members and IndiaTrib-2019 delegates,

Greetings to you all and Welcome to IndiaTrib-2019.

Indian Institute of Science, Bangalore is organizing this International Conference on Industrial Tribology - IndiaTrib-2019 under the aegis of Tribology Society of India focusing on the theme of "Tribology for Society".

As you are all aware, innovative tribological design and services can significantly improve the productivity and thus the profitability of all sectors of industries. In these times where the use of energy has not just to be considered only in terms of cost savings, but also in terms of its overall impact on the environmental ecosystem and in improving the quality life of people in different strata of the societies across the world. Therefore, the theme of the present Conference "Tribology for Society" is not only apt, but also very timely for addressing these issues.In Sanskrit, we describe as "ट्राइबोलॉजीसकलजनहिताय - *Tribology sakaljanhitaye* (means "Tribology is for everyone's benefit").

Tribology Society of India has been leading the way in organizing international conferences every two years with the sole objective of providing a platform to academicians, researchers and practicing engineers to showcase their work in form of technical papers and discuss the current trends and research in Tribology. IndiaTrib-2019 is the tenth in this series of international conferences which started with the inaugural edition in Kolkata in the year 1997.

I wish that the three days of the conference will provide a great opportunity to discuss Tribology practices with a special emphasis on understanding its societal impacts. Considering the overwhelming response in terms of papers received from India and around the world, I believe that this would be one of the largest gatherings in Tribology in India.

While conveying my greetings and best wishes for a successful organization of IndiaTrib-2019, I am sure that infusion of new ideas, discussions and deliberations during the conference will play a vital role in furthering the body of knowledge of this multi disciplinary science of Tribology.

With warm regards,

(Dr S S V Ramakumar)
President, TSI
& Director R&D, Indian Oil Corporation Ltd

Message

Satish V. Kailas, Vice President, Tribology Society of India

In the year 2006, we had a wonderful conference on Tribology at the Indian Institute of Science in this very venue. In this conference, several eminent tribologists from around the world gave Plenary, Keynote and Invited talks. Thirteen years later we are conducting this conference, IndiaTrib 2019. Several eminent Plenary, Keynote and Invited speakers have come from around the world and India to give talks here. I should thank them for having accepted the invitation to come here without even having to send a second request. This not only talks about their commitment toward Tribology, but also the faith that they have in the future of Tribology in India. Their support and the support of other speakers have made this conference a really packed one. To make a conference such as this a success, it is important that the interaction between the speakers and delegates are strong and healthy. Toward achieving this we have introduced an Oral (short) presentation, where the poster presenters will give a brief talk for about 4 minutes on their work. This will be followed by what we call an "Interactive Session" where the Oral (Short) presenters will put up their posters and interested delegates will discuss with them in more detail on the results. We are also having a special session where the delegates can discuss with the Editors of Journals on what is expected from the authors when sending papers for possible publication to these journals. After the four days of this conference, we do hope all the participants would have left this conference with a feeling of contentment, having learned several new things about tribology and made new friends. Your whole-hearted participation in several activities during this conference will make this happen.

I am sure that there will be one man who will be watching us and telling me, the organizers, all the Plenary, Keynote, Invited speakers, Speakers, Delegates, Exhibitors, and Sponsors that we did a wonderful job. The physical presence of Prof. Sanjay Kumar Biswas, who was the force behind the successful 2006 conference, will be missed.

Message

Dr Barun Chakrabarti, Vice President – TSI

I have great pleasure in welcoming all the authors, speakers, exhibitors and delegates from industry and academia to the IndiaTrib-2019 event. IndiaTrib-2019 is the first edition of the new series of international conferences by TSI, re-christened from the earlier ICIT events. While continuing the rich legacy of this flagship program, IndiaTrib-2019 aspires to rise to higher levels in terms of its contents, learning opportunities and industry-academia networking. We are also happy to have a very encouraging response from our colleagues from the global Tribology Community.

IndiaTrib-2019 will be a packed event, complete with plenary and keynote lectures, invited talks, oral technical presentations, business meet sessions and technical exhibition. My sincere compliments to the IndiaTrib-2019 organizing team at IISc – Bengaluru, which has been working tirelessly for nearly a year under the able leadership of Prof. Satish V Kailas, to uphold the rich tradition of TSI conferences and make this event a grand success.

This conference will offer a big opportunity for all of us to know one another, learn about the latest research and applications, exchange ideas and enlarge our circle of acquaintances within the Tribology fraternity. I invite you to get fully engaged with the technical proceedings, have a look at the latest products and services on display in the exhibition, get enthralled by the cultural program and, last but not the least, enjoy the traditional Indian hospitality.

I am sure all of us would return from this event enriched, enlightened and with a sense of fulfilment.

1st December 2019-Conference Day 1

Pre-Conference Education Course 09:00 to 13:00
Fundamentals of Tribology (Including two industrial applications - Separate registration is required)

Bruker Industrial Interaction 11:30 to 12:30
(Parallel Session)

Registration 11:00 to 13:00

Lunch Break 13:00 to 14:00

Oral Short Presentation Main Hall 14:00 - 16:20

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type Of Presentation	Institute/ Organisation	Abstract/Paper Title
1	TSI19236	ORAL-S-M01	14:00-14:05	Mohammad Autif Shahdhaar	Oral-Short	National Institute of Technology, Rourkela	Aerodynamic and Thermal Behaviour of Helium Lubricated Gas Foil Journal Bearing for High-Speed Cryogenic Turboexpander
2	TSI19106	ORAL-S-M02	14:05-14:10	Neha Sharma	Oral-Short	Indian Institute of Petroleum	Modelling insight for studying lubricity behaviour on different material surfaces
3	TSI19125	ORAL-S-M03	14:10-14:15	MEHAK NISAR	Oral-Short	NATIONAL INSTITUTE OF TECHNOLOGY	Influence of ultrasonic assisted stir casting on mechanical and tribological properties of MMCs: a review
4	TSI19114	ORAL-S-M04	14:15-14:20	Bharat Kumar	Oral-Short	INDIAN INSTITUTE OF TECHNOLOGY (BHU), VARANASI INDIA	Tribological behaviour of stearic acid stabilized calcium doped Ceria nanoparticles
5	TSI19169	ORAL-S-M05	14:20-14:25	Mohamed Haaris Memon	Oral-Short	Pandit Deendayal Petroleum University	Effect Of Multi Pass Friction Stir Processing On Elevated Temperature Wear Behaviour Of Aluminium 6061 Alloy
6	TSI19310	ORAL-S-M06	14:25-14:30	Parvathi Sunilkumar	Oral-Short	Indian Institue of Science, Bangalore	TRIBOLOGY OF HIGH ENTROPY ALLOYS (HEAs): A BRIEF REVIEW
7	TSI19308	ORAL-S-M07	14:30-14:35	Swati Gautam	Oral-Short	IIT Delhi	APPLICATION OF ACOUSTIC EMISSION MEASURING PARAMETERS: ENERGY AND RMS FOR CONDITION MONITORING OF GEARS
8	TSI19154	ORAL-S-M08	14:35-14:40	Sandesh Phalke	Oral-Short	SASTRA Deemed to be University	A STUDY OF TEXTURED AND UN-TEXTURED TOOLS WITH CHIP-BREAKERS UNDER DRY AND MQL CONDITION FOR THE MACHINING OF TITANIUM ALLOY
9	TSI19137	ORAL-S-M09	14:40-14:45	Suruj Protim Neog	Oral-Short	IIT ROORKEE	A PIN-ON-DISC STUDY OF NOVEL ULTRAFINE CONTINUOUSLY COOLED CARBIDE FREE BAINITIC STEEL
10	TSI19237	ORAL-S-M10	14:45-14:50	Sandeep Sangamesh Yadawad	Oral-Short	National Institute of Technology, Rourkela	Aerodynamic Analysis of Corrugated Bump-Type Gas Foil Thrust Bearing for High-speed Cryogenic Turboexpander used in Nitrogen Liquefaction Plant
11	TSI19120	ORAL-S-M11	14:50-14:55	Bisma Ali	Oral-Short	NIT SRINAGAR	Rheological properties of nanofluids containing Graphite nanoparticles
12	TSI19165	ORAL-S-M12	14:55-15:00	Sri Harsha Yerramsetti	Oral-Short	BML Munjal University	Abrasive Grit size effect on wear of Al-Cu-Zn ternary Alloy

Day-1

Day-1	13	TSI19126	ORAL-S-M13	15:00-15:05	MEHAK NISAR	Oral-Short	NATIONAL INSTITUTE OF TECHNOLOGY , SRINAGAR	effect of graphite particle reinforcement on dry sliding wear of Silicon nitride/ Gr/Al hybrid naocomposites
	14	TSI19181	ORAL-S-M14	15:05-15:10	Sandeep Singh	Oral-Short	North Eastern Regional Institute of Science and Technology	CORRELATION OF GALLING RESISTANCE AND HARDNESS OF PLAIN CARBON STEEL
	15	TSI19134	ORAL-S-M15	15:10-15:15	Alok Kumar Singh	Oral-Short	Indian Institute of Technology(BHU), Varanasi	Tribological behaviour of zinc oxide nanoparticles, g-C3N4 and the nanocomposite ZnO @g- C3N4
	16	TSI19221	ORAL-S-M16	15:15-15:20	Shankar Swarup Das	Oral-Short	National Institute of Technology, Agartala	Fabrication and Selection of Suitable Biomaterial from the Blends of HDHA for Acetabular Component of Hip Implants by using TOPSIS Method
	17	TSI19172	ORAL-S-M17	15:20-15:25	JAWAZ ALAM	Oral-Short	VSSUT, BURLA	OPTIMUM DESIGN OF SPUR GEAR- A MULTI-OBJECTIVE APPROACH
	18	TSI19162	ORAL-S-M18	15:25-15:30	Raja P	Oral-Short	Indian Institute of Technology Madras	Effect of Conventional Sintering on the Mechanical Properties of Copper based Brake Friction Material
	19	TSI19313	ORAL-S-M19	15:30-15:35	MANISH RAJ	Oral-Short	Indian Institute of Technology Delhi	Exploring the performance of rice straw-poly propylene composites for vibration isolation application
	20	TSI19166	ORAL-S-M20	15:35-15:40	Natesha C P	Oral-Short	Malnad College of Engineering, Hassan, Karnataka	Tribological Studies on Milling AISI D2 Using Modified Simarouba oil
	21	TSI19323	ORAL-S-M21	15:40-15:45	Umesh Marathe	Oral-Short	IIT Delhi	A novel method to strengthen the fiber-matrix interface leading to composites with superior tribological properties
	22	TSI19133	ORAL-S-M22	15:45-15:50	NIVEDITA SHUKLA	Oral-Short	IIT BHU Varanasi	Copper doped titania nanoparticles of varying size in boundary lubrication
	23	TSI19250	ORAL-S-M23	15:50-15:55	HIMANSHU RAI	Oral-Short	IIT Delhi	In Situ Nanoscale Tribology of Lubricants Containing Hexagonal Boron Nitride
	24	TSI19358	ORAL-S-M24	15:55-16:00	Mallikarjunachari G	Oral-Short	Madanapalle Institute of Technology & Science	Rolling Friction Characteristics of Hydrogel Membranes during Swelling ? An Application to Hip Implants
	25	TSI19390	ORAL-S-M25	16:00-16:05	Shubha H.N.	Oral-Short	IISc	Effect of Non-toxic surfactants on stability of coconut milk emulsion

Oral Short Presentation Hall A 14:00 - 16:20

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type Of Presentation	Institute/ Organisation	Abstract/Paper Title
1	TSI19219	ORAL-S-A01	14:00-14:05	Prem Kumar J	Oral-Short	College of Engineering, Thiruvananthapuram	Effect of load on wear characteristics of A356/10wt.% SiCp functionally graded composite dry sliding in unidirectional and reciprocating contacts
2	TSI19140	ORAL-S-A02	14:05-14:10	Deepak Kumar	Oral-Short	IIT Delhi	Nano scale tribology of precipitates containing AZ91 alloy under dry and lubricated conditions
3	TSI19241	ORAL-S-A03	14:10-14:15	Srikant Tiwari	Oral-Short	Motilal Nehru National Institute of Technology	Sliding Wear Behaviour of Medical Grade S31254 Steel for Orthopaedic Application
4	TSI19232	ORAL-S-A04	14:15-14:20	YOGITA MAITHANI	Oral-Short	IIT DELHI	Study of Nanomechanical Properties of Ag Nanorods Embedded Polydimethylsiloxane
5	TSI19174	ORAL-S-A05	14:20-14:25	SOURABH BHASKAR	Oral-Short	Malaviya National Institute of Technology	TRIBOLOGICAL PERFORMANCE OF AA2024 ALLOY COMPOSITE REINFORCED WITH AlN PARTICULATES
6	TSI19312	ORAL-S-A06	14:25-14:30	MANISH RAJ	Oral-Short	Indian Institute of Technology Delhi	Condition monitoring of a centrifugal pump by vibration and motor current signature analysis
7	TSI19196	ORAL-S-A07	14:30-14:35	Kanav Sharma	Oral-Short	NIT Srinagar	groundnut oil based cutting fluid
8	TSI19209	ORAL-S-A08	14:35-14:40	Sanketh Tonannavar	Oral-Short	Indian Institute of Science	Development of a Test Rig to Investigate the Wear of Two - Wheeler Chain
9	TSI19214	ORAL-S-A09	14:40-14:45	Prasad Dattatraya Kulkarni	Oral-Short	VJTI Mumbai	CFD Analysis Of Conical Hydrodynamic Journal Bearing To Study The Effect Of Eccentricity Ratio, Reynolds Number And Aspect Ratio On Pressure Distribution
10	TSI19247	ORAL-S-A10	14:45-14:50	Nilabh Vishwakarma	Oral-Short	Motilal Nehru National Institute of Technology Allahabad	Design and Optimization of Gas Foil Journal bearing
11	TSI19263	ORAL-S-A11	14:50-14:55	Gutta Bindu	Oral-Short	IISc	A Review on different particulate reinforced AA6082 Aluminium Alloy composites via Friction Stir Processing
12	TSI19281	ORAL-S-A12	14:55-15:00	Raghvendra M Murdande	Oral-Short	Indian Institute of Science	Design of Flexure for Capacitance based Cantilever Force Sensor

Day-1

Day-1	13	TSI19296	ORAL-S-A13	15:00-15:05	Nagare Prashant Narayan	Oral-Short	Amrutvahini College Engineering, Sangamner	DESIGN OPTIMIZATION OF HEAVILY LOADED JOURNAL BEARINGS USING MULTI OBJECTIVE GENETIC ALGORITHM
	14	TSI19256	ORAL-S-A14	15:05-15:10	Vyshakh V	Oral-Short	Motilal Nehru National Institute of Technology Allahabad	Investigation on Dynamic Characteristics of Meso Scale Air Journal Bearing with Texture
	15	TSI19116	ORAL-S-A15	15:10-15:15	Abhishek Kumar	Oral-Short	Indian Institute of Technology Roorkee	Influence of Geometric Errors in Conical Hybrid Journal Bearing Compensated with Capillary Restrictor
	16	TSI19117	ORAL-S-A16	15:15-15:20	VIVEK KUMAR	Oral-Short	INDIAN INSTITUTE OF TECHNOLOGY ROORKEE	Elastohydrostatic Lubrication of Control Flow Valve Compensated Thrust Bearing
	17	TSI19141	ORAL-S-A17	15:20-15:25	SOORAJ SINGH RAWAT	Oral-Short	IIT(BHU) VARANASI	Evaluation of the tribological behavior of paraffin oil-based lithium grease with ZnO nano-additive
	18	TSI19145	ORAL-S-A18	15:25-15:30	Vinod Kumar	Oral-Short	NIT Hamirpur (H.P)	Studies on Tribological properties of Few Triglycerides and Fatty acids
	19	TSI19176	ORAL-S-A19	15:30-15:35	Dr T Nagaraju	Oral-Short	P E S College of Engineering Mandya	PERFORMANCE OF POROUS JOURNAL BEARING WITH NON-NEWTONIAN LUBRICANT
	20	TSI19228	ORAL-S-A20	15:35-15:40	PAWAN KUMAR SONI	Oral-Short	visvesvaraya National Institute of Technology Nagpur	The Role of Residual Stress on Frictional Stability of Sliding Systems
	21	TSI19257	ORAL-S-A21	15:40-15:45	Shanmukhi Sripada	Oral-Short	IIT Delhi, INDIA	Gum acacia as filler for SU-8 composites for superior mechanical and tribological performance
	22	TSI19262	ORAL-S-A22	15:45-15:50	Ankitendran Mishra	Oral-Short	IIT (BHU)	Study of corrosion enhanced solid particle erosion behaviour on 904L at 650℃.
	23	TSI19222	ORAL-S-A23	15:50-15:55	Abhishek Parmar	Oral-Short	IIT MADRAS	EFFECT OF GEAR PARAMETERS ON SCUFFING AND WEAR RISK ON SINGLE STAGE SPUR GEAR SYSTEM
	24	TSI19365	ORAL-S-A24	15:55-16:00	Bhaskaranand Bhatt	Oral-Short	IIT Delhi	Influence of Hydrated Calcium Silicate in varying amount in Cu free brake-pads on theperformance properties
	25	TSI19389	ORAL-S-A25	16:00-16:05	Trupti Hinge	Oral-Short	JSPM's Rajarshi Shahu College Of Engineering Tathawade	Tribology in electrical contacts

Oral Short Presentation Hall B 14:00 - 16:20

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type Of Presentation	Institute/ Organisation	Abstract/Paper Title
1	TSI19284	ORAL-S-B01	14:00-14:05	Sandeep C. Fargade	Oral-Short	K. L. University, Vijayawada, A.P.	Friction and Sliding Wear Behaviour of PTFE Composites with Different Fillers
2	TSI19311	ORAL-S-B02	14:05-14:10	NIHARIKA GUPTA	Oral-Short	INDIAN INSTITUTE OF TECHNOLOGY DELHI	Performance Studies of Spur Gearsets with Textured Face and Flank using Fresh and MoS2 blended greases
3	TSI19233	ORAL-S-B03	14:10-14:15	Rubia Hassan	Oral-Short	Indian Institute of Technology Kanpur	Wear behavior of coarse and fine SiC reinforced ZrB2-HfB2 composite and the effect of carbon nanotubes addition
4	TSI19269	ORAL-S-B04	14:15-14:20	Ch. Sri Chaitanya	Oral-Short	National Institute of Technology, Warangal	Influence of Sliding Distance on the Dry Sliding Wear Behaviour of the Syntactic Foams
5	TSI19314	ORAL-S-B05	14:20-14:25	Nikhil Kumar	Oral-Short	NIT Srinagar , J&K , INDIA	Wear of Structures Manufactured by Fused Deposition Modelling
6	TSI19319	ORAL-S-B06	14:25-14:30	Patel Rohan Sanjay	Oral-Short	Indian Institute of Science	Wear of Intermetallic Composites:A review
7	TSI19151	ORAL-S-B07	14:30-14:35	Dr. Basil Kuriachen	Oral-Short	National Institute of Technology Mizoram	Wear Behavior of Laser Surface Textured Tungsten Carbide Tool with Engraved Dimple Patterns on Machining of Inconel 718
8	TSI19186	ORAL-S-B08	14:35-14:40	SUBIN S T	Oral-Short	COLLEGE OF ENGINEERING TRIVANDRUM	EVALUATION OF TRIBOLOGICAL PROPERTIES AND CORROSIVE STABILITY OF PTFE IMPREGNATION USING ELECTROPHORETIC DEPOSITION ON CHROME COATED ALUMINUM ALLOY A356
9	TSI19189	ORAL-S-B09	14:40-14:45	Jayanth Ivvala	Oral-Short	Shiv Nadar University	Wettability Controlled Tribological Behavior of the Metallic Surfaces
10	TSI19147	ORAL-S-B10	14:45-14:50	AFREEN NISSAR	Oral-Short	NIT SRINAGAR	An Investigation to the methods used for reclamation of Spent Oil
11	TSI19153	ORAL-S-B11	14:50-14:55	Navnath Ramchandra Kalel	Oral-Short	IIT, Delhi	Varying contents of resin in NAO Cu-free brake-pads and its impact on the performance (tribological and NV) properties
12	TSI19173	ORAL-S-B12	14:55-15:00	CHAUHAN VANVIRSINH JAGATSINH	Oral-Short	INDIAN INSTITUTE OF TECHNOLOGY, DELHI	Functionalization of particles of friction modifier to enhance the wear resistance of NAO brake-pads

Day-1

Day-1	13	TSI19259	ORAL-S-B13	15:00-15:05	GIRISH A R	Oral-Short	Malnad College of Engineering, Hassan	Tribological behavior of AISI 1055 under formulated Vegetable oils for Automotive applications
	14	TSI19155	ORAL-S-B14	15:05-15:10	D. SIVANANDA REDDY	Oral-Short	RGMCET	Static Performance Of Short Hydrodynamic Journal Bearing Operating With Lubricant Containing Tio2 Nanoparticles.
	15	TSI19179	ORAL-S-B15	15:10-15:15	Sandeep Singh	Oral-Short	North Eastern Regional Institute of Science and Technology	Experimental studies on effect of speed change mechanism on life of rolling element bearing
	16	TSI19185	ORAL-S-B16	15:15-15:20	ANANTHAN D THAMPI	Oral-Short	College of Engineering Trivandrum	Evaluation of the Tribological Properties and Oxidative Stability of Epoxidized and Ring opened products of pure Rice Bran Oil
	17	TSI19190	ORAL-S-B17	15:20-15:25	E. Sneha	Oral-Short	College of Engineering, Trivandrum	EVALUATION OF PHYSICO-CHEMICAL, TRIBOLOGICAL PROPERTIES AND OXIDATIVE STABILITY OF RICE BRAN OIL WITH TURMERIC OIL AND HALLOYSITE NANO CLAY AS ADDITIVES
	18	TSI19208	ORAL-S-B18	15:25-15:30	S. Arokya Agustin	Oral-Short	SRM Institute of Science and Technology	ANALYSIS OF LOAD CAPACITY OF TEXTURE FOIL JOURNAL BEARING
	19	TSI19226	ORAL-S-B19	15:30-15:35	Sachin P. Patel	Oral-Short	Indian Institute of Technology (IIT), Roorkee	Experimental exploration of cylindrical roller bearing for inner race defect under varying speed, load and defect size
	20	TSI19211	ORAL-S-B20	15:35-15:40	UPENDRA MAURYA	Oral-Short	NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL	Comparative Study of Tribological performance of boehmite AlO(OH) and Al2O3 nanoparticles as nanolubricants.
	21	TSI19235	ORAL-S-B21	15:40-15:45	Dr. Chippa Shriniwas P	Oral-Short	Vishwakarma Institute of Technology, Pune	Transient Elstohydrodynamic analysis of Finite Line Contact under Load Impulse
	22	TSI19301	ORAL-S-B22	15:45-15:50	HOMENDER KUMAR	Oral-Short	IIT (BHU), Varanasi	The role of COOH functionalized multi walled carbon nanotubes as lubricant additive in different grades of Polyalphaolefin oils.
	23	TSI19317	ORAL-S-B23	15:50-15:55	Ketan Mishra	Oral-Short	Indian Institute of Technology Bhilai	Exploration on the Improved machinability of hard ultrafine grained Aluminium alloy over the soft course grained alloy ? A tribological Perspective
	24	TSI19331	ORAL-S-B24	15:55-16:00	SANDAN KUMAR SHARMA	Oral-Short	University of Ljubljana	EFFECT OF TEMEPERATURE AND TUNGSTEN CARBIDE CONTENT ON RECIPROCATED SLIDING WERA OF SILICON CRABIDE CERAMICS
	25	TSI19362	ORAL-S-B25	16:05-16:10	Pranay Sheshak Anekal,	Oral-Short	IISc	Microtribological characteristics of AA5052 – MoS2 nanocomposite micropillars fabricated through friction stir processin
	26	TSI19391	ORAL-S-B26	16:10-16:15	Shivam Uppal	Oral-Short	Shri Mata Vaishno Devi University,Katra	Tribology of cobalt based super alloys: Short Review

Oral Short Presentation Hall C 14:00 - 16:20

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type Of Presentation	Institute/ Organisation	Abstract/Paper Title
1	TSI19191	ORAL-S-C01	14:00-14:05	Shubhajit Das	Oral-Short	NIT Arunachal Pradesh	A Review on Composite Coatings: Techniques, Materials, Properties, and Applications in Surface Engineering
2	TSI19193	ORAL-S-C02	14:05-14:10	Avinash Vitthal Borgaonkar	Oral-Short	National Institute of Technology Warangal	Development and Investigation of the Tribological Performance of pure MoS2 and composite MoS2-TiO2-ZrO2 Coating Materia
3	TSI19200	ORAL-S-C03	14:10-14:15	Abhishek babu	Oral-Short	Shiv Nadar university	COMPARATIVE STUDIES OF MICROWAVE SYNTHESIZED AND MICROWAVE POST PROCESSED WC-CO-CR CLADDINGS FOR SLURRY BEHAVIOR
4	TSI19231	ORAL-S-C04	14:15-14:20	Meenu Pandey	Oral-Short	IIT Delhi	Bio Inspired Textured Surfaces for Reduced Sliding Friction Fabricated by Glancing Angle Deposition Technique
5	TSI19238	ORAL-S-C05	14:20-14:25	Himanshu Markanday	Oral-Short	Indian Institute of Technology, Ropar, Punjab	EFFECT OF CAVITATION PEENING ON FATIGUE BEHAVIOR OF 304L STAINLESS STEEL
6	TSI19242	ORAL-S-C06	14:25-14:30	SUDHANSHU KUMAR	Oral-Short	Indian Institute of Technology Patna	Effect of Surface Topography on Failure of Tribological components
7	TSI19244	ORAL-S-C07	14:30-14:35	NILESH D. HINGAWE	Oral-Short	Motilal Nehru National Institute of Technology	Tribological performance of compound shaped surface texture in parallel slider
8	TSI19260	ORAL-S-C08	14:35-14:40	Gautam Revankar A	Oral-Short	Indian Institute of Science, Bengaluru	Synthesis of nano porous alumina hard coating by anodization of 6061 aluminium alloy for tribological applications
9	TSI19268	ORAL-S-C09	14:40-14:45	S. C. Atul	Oral-Short	Sri Venkateswara College of Engineering	TRIBOLOGICAL CHARECTERIZATION OF AISI 316L BORIDED BY DIFFERENT BORONIZING METHODS
10	TSI19278	ORAL-S-C10	14:45-14:50	Bikash Routh	Oral-Short	VIT vellore	EFFECTS OF SURFACE ROUGHNESS ON LUBRICATION MECHANISM IN THE FLEXSPLINE CUP-CAM INTERFACE OF HARMONIC DRIVE
11	TSI19282	ORAL-S-C11	14:50-14:55	Patil Vilas Karbhari	Oral-Short	AMRUTVAHINI COLLEGE OF ENGINEERING,SANGAMNER	Effect of Die Surface Roughness on the properties of metal Composite material
12	TSI19286	ORAL-S-C12	14:55-15:00	Parijat Sarkar	Oral-Short	SRM Institute Of Science And Technology	Investigating the wear properties of uncladded and cladded plates using pin on disc tribometer

Day-1

Day-1	13	TSI19289	ORAL-S-C13	15:00-15:05	Vimal Edachery	Oral-Short	Indian Institute of Science	Micro tribological and surface characteristics of shot blasted Ti-6Al-4V alloy in comparison with base Ti-6Al-4V alloy
	14	TSI19305	ORAL-S-C14	15:05-15:10	Dr. N. Ch. Kaushik	Oral-Short	BML Munjal University	Evaluation of amplitude surface roughness parameters of Fe-Cr-C-Si-Mn hardfaced alloy subjected to grinding abrasion process
	15	TSI19318	ORAL-S-C15	15:10-15:15	ABHISHEK KUMAR	Oral-Short	SRM INSTITUTE OF SCIENCE & TECHNOLOGY	Effect of Process Parameters on the Deposition Characteristics of Cold Metal Transfer Hard Facings
	16	TSI19194	ORAL-S-C16	15:15-15:20	Ajay Pratap Singh Lodhi	Oral-Short	Indian Institute of Technology Delhi	A step towards the development of environmentally friendly water-based nano-lubricant using naturally occurring lubricious materials
	17	TSI19206	ORAL-S-C17	15:20-15:25	Chethan S	Oral-Short	REVA University, Bangalore	Synthesis and Characterization of Environmental Friendly Vegetable Oil Based Grease with Potassium Hydroxide as Thickener
	18	TSI19287	ORAL-S-C18	15:25-15:30	CIMNA S ZAKIR	Oral-Short	Sree Chitra Thirunal College of Engineering	EXPERIMENTAL INVESTIGATION ON THE IMPROVEMENT OF LUBRICANT PROPERTIES OF BLENDED COCONUT OIL AND SESAME OIL WITH ADDITIVES
	19	TSI19240	ORAL-S-C19	15:30-15:35	Prasanth B Menon	Oral-Short	IIT Madras	FEASIBILITY STUDY OF TITANIUM NITRIDE AND DLC COATED BEARING STEEL FOR WIND TURBINE GEARBOX
	20	TSI19258	ORAL-S-C20	15:35-15:40	Anand Mathur	Oral-Short	Maharaja Agrasen Institute of Technology	An Insight to the Tribological Properties for Applicability of Alpha-Beta Titanium Alloy Ti 6 Al 4V and Near Alpha Titanium Alloy Ti 8Al-1Mo-1V in an Aircraft Landing Gear
	21	TSI19216	ORAL-S-C21	15:40-15:45	Parshant Kumar	Oral-Short	Indian Institute of Technology (BHU) Varanasi	Sliding tribology of freezing conditions treated carbon/carbon composites
	22	TSI19227	ORAL-S-C22	15:45-15:50	RAJAN KUMAR	Oral-Short	MAULANA AZAD NATIONAL INSTITUTE OF TECHNOLOGY	MECHANICAL PROPERTIES AND RETAINED AUSTENIT ROLE IN WEAR BEHAVIOR OF CARBIDE FREE BAINITE STEEL: A REVIEW
	23	TSI19363	ORAL-S-C23	15:50-15:55	Shivaram	Oral-Short	NITK, Surathkal,	Tribocorrosion behavior of biomedical porous Ti-based alloy in simulated body fluid
	24	TSI19368	ORAL-S-C24	15:55-16:00	Abhishek babu	Oral-Short	Shiv Nadar university	SURFACE DEGRADATION ON AS-CAST AND MICROWAVE CLADDING OF AI0.1CoCrFeNi HIGH ENTROPY ALLOY. A COMPARATIVE STUDY
	25	TSI19369	ORAL-S-C25	16:00-16:05	SIDDESH KUMAR N M	Oral-Short	Manipal University	EFFECT ON WEAR PROPERTY OF ALUMINIUM ALLOY WITH DIFFERENT REINFORCMENT BY FRICTION STIR PROCESSING? A REVIEW
	26	TSI19392	ORAL-S-C26	16:05-16:10	Aashish John	Oral-Short		Influence of counter surface roughness on two-body abrasive wear of AZ31 Mg alloy in dry sliding conditions
	Cultural Program Main Hall 16:30 to 17:00 - Geetanjali Hembrom, Classical Chau Dance							
	Registration + Coffee Break 17:00 to 17:30							

2nd December 2019 - Conference Day 2 - Forenoon Main Hall
Theme : Industrial Tribology and Friction and Wear I

Registration 08:00 to 09:00

Inauguration
Main Hall - 09:00 to 09:30

Plenary Talk 1 by Prof.Nicholas Spencer,ETH Zurich - Main Hall - 09:30 to 10:10

Keynote Talk 1 by Prof.Daniel Nelias,INSA Lyon France - Main Hall - 10:10 to 10:40

Group Photo 10:40 to 10:50

Coffee Break 10:50 to 11:10

Invited Talk 1 by Prof.Jayadas NH,Cochin University of Science and Technology
Main Hall 11:15 - 11:35

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19129	ORAL-M01	11:35 - 11:45	G D Thakre	Oral	CSIR-IIP Dehradun	EXPERIMENTAL STUDY ON ASPERITY LEVEL CONFORMITY IN POINT CONTACTS
2	TSI19294	ORAL-M02	11:45 - 11:55	Takuya Yashiki	Oral	Kyushu University	Subsonic to Intersonic Transition in Sliding Contact of Soft Solids
3	TSI19149	ORAL-M03	11:55 - 12:05	Senthilvel M	Oral	PSG Institute of Technology and Applied Research	Tribological investigation of SAE 20W50 engine oil with micro graphite lubricant additives
4	TSI19302	ORAL-M04	12:05 -12:15	Ajith Kurian Baby	Oral	National Institute of Technology Calicut	TRIBOLOGICAL BEHAVIOUR OF HYPEREUTECTIC Al-Si AUTOMOTIVE CYLINDER LINER MATERIAL UNDER DRY SLIDING WEAR CONDITION IN SEVERE WEAR REGIME
5	TSI19188	ORAL-M05	12:15 -12:25	D. V. SRIKANTH	Oral	SREENIDHI INSTITUTE OF TECHNOLOGY AND SCIENCE	THEORETICAL STUDY OF LOW TOXICITY LUBRICANT OILS IN LARGE HYDROELECTRIC THRUST BEARINGS
6	TSI19324	ORAL-M06	12:25 - 12:35	ARVIND P	Oral	MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY	INVESTIGATION OF TRIBOLOGICAL PROPERTIES OF PURE AND OXIDISED BLENDS OF RCO DERIVED BIODIESEL
7	TSI19128	ORAL-M07	12:35 - 12:45	Amar Kr. Jain	Oral	CSIR-IIP Dehradun	EXPERIMENTAL INVESTIGATION ON LUBRICATION PERFORMANCE OF ENGINE OILS IN PISTON RING-LINER CONTACT
8	TSI19143	ORAL-M08	12:45 - 12:55	Gaurab Kumar Ghosh	Oral	Indira Gandhi Institute of Technology, Sarang	Thermophysical and Rheological Properties evaluation of Graphene and Hybrid MWCNT/Graphene(90-10) gear oil-based nanolubricants
9	TSI19273	ORAL-M09	12:55-13:05	Dr. Arun Kumar Sikder	Oral	SABIC Research and Technology Pvt. Ltd.	EFFECT OF TIP SIZE AND EXPERIMENTAL CONDITIONS ON NANO-SCALE FRICTION TESTING

2nd December 2019 - Conference Day 2 - Forenoon Hall A
Theme : Industrial Tribology and Friction and Wear I

Invited Talk 2 by Dr.Shaju K Albert,Indira Gandhi Centre for Atomic Research
Hall A- 11:15 - 11:35

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Oraganization	Abstract/Paper Title
1	TSI19131	ORAL-A01	11:35 - 11:45	MANISH KUMAR THAKUR	Oral	INDIAN INSTITUTE OF TECHNOLOGY PATNA	WEAR ANALYSIS OF MAGNETORHEOLOGICAL FLUID USED IN MR CLUTCH
2	TSI19158	ORAL-A02	11:45 - 11:55	Binfa Bongfa	Oral	Federal Polytechnic, Idah	Tribology of Formulated Atili Oil as Bio-based Fluid for Automotive Shock Absorber Application
3	TSI19338	ORAL-A03	11:55 - 12:05	Dr S Murali	Oral	Balmer Lawrie & Co.Ltd. AVP(R & D)	Comparative Study of Method for Determination of Soot Content in Used Engine Lubricants
4	TSI19210	ORAL-A04	12:05 -12:15	Ankit Saxena	Oral	IIT Delhi	Development of eco-friendly lubricating grease
5	TSI19345	ORAL-A05	12:15-12:25	Ryohei Okada	Oral	Doshisha University	Understanding of Tribological Characteristics of Sodium Carboxylates Having Different Chain Structures in Water
6	TSI19187	ORAL-A06	12:25 - 12:35	DHANENDRA DEWANGAN	Oral	INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR	Stiffness and Damping Characteristics of Finite Line Contact Lubricated with Micropolar Fluid
7	TSI19298	ORAL-A07	12:35 - 12:45	A. Megalingam	Oral	Bannari Amman Institute of Technology	Effect of Isotropic strain hardening in contact analysis of a deformable asperity againt a flat plane.
8	TSI19152	ORAL-A08	12:45 - 12:55	Vinay Saini	Oral	IIT DELHI	Role of Base oil polarity on the performance of PTFE-Nano-oils
9	TSI19156	ORAL-A09	12:55-13:05	HEMANT M. BARI	Oral	Adani Electricity Mumbai Limited ,Adani Dahanu Thermal Power Station	Gear Wear Detection using Advanced Condition Monitoring Tool ? Wear Debris Analysis

Day-2

Day-2

2nd December 2019 - Conference Day 2 - Forenoon Hall B
Theme : Industrial Tribology and Friction and Wear I

Invited Talk 3 by Prof.M F Wani,NIT Srinagar
Hall B - 11:15am - 11:35am

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Oraganization	Abstract/Paper Title
1	TSI19225	ORAL-B01	11:35 - 11:45	Dr Sarita Seth	Oral	Indian Oil Corporation Ltd, R&D Centre	"Energy Efficiency Through Automotive Lubricants"
2	TSI19161	ORAL-B02	11:45 - 11:55	Raja P	Oral	Indian Institute of Technology Madras	TRIBOLOGICAL BEHAVIOUR OF TITANIUM CARBIDE ON SINTERED COPPER BASED BRAKE COMPOSITE FRICTION MATERIAL
3	TSI19352	ORAL-B03	11:55 - 12:05	Raghu Vamsi Patnala	Oral	Research and Development division, BEML Ltd, KGF, Karnataka, India.	Tribological approach to Enhance performance and durability of off-highway power train aggregates.
4	TSI19212	ORAL-B04	12:05 -12:15	Anoop Kumar S	Oral	Sree Chitra Thirunal College of Engineering	EVALUATION OF BIO-ADDITIVES AS EFFECTIVE ANTI-OXIDANTS FOR COCONUT OIL BASED LUBRICANTS
5	TSI19333	ORAL-B05	12:15 -12:25	R. Vaira Vignesh	Oral	Amrita Vishwa Vidyapeetham	Development of Fly Ash based Friction Material for Wind Turbines by Liquid Phase Sintering Technology
6	TSI19245	ORAL-B06	12:25- 12:35	Avinash	Oral	PGI-1, Forschungszentrum Juelich	Contact mechanics of suction cups
7	TSI19111	ORAL-B07	12:35 - 12:45	PRASHANT MITTAL	Oral	IIT DELHI	Nanoscale Tribology of ADC12 in Lubricated conditions using In Situ Scanning Probe Microscopy
7	TSI19361	ORAL-B08	17:25-17:35	Debdutt Patro	Oral	Ducom	High temperature erosion performance evaluation of advanced materials
9	TSI19180	ORAL-B09	12:55-13:05	Sandeep Singh	Oral	North Eastern Regional Institute of Science and Technology	A preliminary investigation on effect of tooth brush bristles and toothpaste on the erosion of human teeth

2nd December 2019 - Conference Day 2 - Forenoon Hall C
Theme : Industrial Tribology and Friction and Wear I

Invited Talk 4 by Prof.Gnanamoorthy R, IIT Madras
Hall C- 11:15 - 11:35

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19170	ORAL-C01	11:35-11:45	Fathimunnisa Begum	Oral	Baba engineering college	Experimental study on physicochemical and tribological properties of a nano bio-lubricant and its application in IC engine
2	TSI19295	ORAL-C02	11:45 - 11:55	JITENDRA KUMAR KATIYAR	Oral	SRM Institute of Science and Technology	Influence of Solid Fillers in Properties of Brake Materials
3	TSI19354	ORAL-C03	11:55 - 12:05	A Bharathwaj	Oral	BEML Ltd, KGF, Karnataka, India	Technology improvements in BEML oils for the Profitable utilization of Heavy Earth Moving Machinery
4	TSI19297	ORAL-C04	12:05 -12:15	Dr. Ponnekanti Nagendramma	Oral	CSIR-Indian Institute of petroleum	Development of sustainable green polyglycerol esters as biolubricants for industrial applications
5	TSI19316	ORAL-C05	12:15 -12:25	Sanjiv Wazir	Oral	LUKOIL Marine Lubricants	REGULATIONS AND MARINE LUBRICATION
6	TSI19254	ORAL-C06	12:25 - 12:35	Mohammed Shafeeque KK	Oral	IIT Palakkad	Contact stress analysis of brake drum under different contact conditions
7	TSI19130	ORAL-C07	12:35 - 12:45	Dinesh Kumar Verma	Oral	IIT(BHU), Varanasi	Enhancing tribo-activity by decorating Mn-doped ZnO nanoparticles on graphene nanosheets
8	TSI19253	ORAL-C08	12:45 - 12:55	Sangita Kumari	Oral	CSIR-INDIAN INSTITUTE OF PETROLEUM DEHRADUN	CTAB-Functionalized h-BN Nanosheets for Enhancement of Tribological Properties
9	TSI19290	ORAL-C09	12:55-13:05	Hironori Shinmori	Oral	Kyushu university	Effect of synovial constituents on the wear of UHMWPE

Lunch Break 13:05 to 13:50

2nd December 2019 - Conference Day 2 - Afternoon Main Hall
Theme : Industrial Tribology and Friction and Wear II

Interactive Session for Short Oral Presentation 13:50 to 14:30

Plenary Talk 2 by Prof.Luo Jianbin,Tsinghua University China
Main Hall - 14:30 to 15:10

Keynote Talk 2 by Prof.Juliette Cayer-Barrioz,École Centrale de Lyon France
Main Hall - 15:10 to 15:40

Keynote Talk 3 by Prof.Enrico Ciulli ,University of Pisa Italy
Main Hall - 15:40 to 16:10

Coffee Break 16:10 to 16:30

Invited Talk 5 by Prof.Jayashree Bijwe , IIT Delhi
Main Hall- 16:30 - 16:50

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19112	ORAL-M01	16:50-17:00	Lakshminarayana Reddy Tamatam	Oral	Politecnico di Torino, Italy	Modelling the effect of wear on the dynamics of turbomachinery components using harmonic balance method
2	TSI19132	ORAL-M02	17:00-17:10	Kavita	Oral	Indian Institute of Technology(BHU)	Synthesis, characterization and evaluation of tribological behaviour of chromenopyridine
3	TSI19207	ORAL-M03	17:10-17:20	CHINMAYEE NAYAK	Oral	IIT K	Radiation Induced Effects on Micro-Scratch of Compression Molded Ultra High Molecular Weight Polyethylene (UHMWPE) based nanocomposites
4	TSI19255	ORAL-M04	17:20-17:30	JASWANT KUMAR HIRWANI	Oral	IIT Delhi	Comparison of mechanical and tribological properties of epoxy and SU-8 composites with UHMWPE filler
5	TSI19107	ORAL-M05	17:30-17:40	Prof. Babu Rao Jinugu	Oral	Andhra University	Dry sliding Wear behavior of Al-Si alloy castings made in Silica sand, Iron and Ferro alloys Slag moulds
6	TSI19195	ORAL-M06	17:40-17:50	Deepak Kumar	Oral	Indian Institute of Technology Delhi	Imparting self-lubrication character to near eutectic Al-Si alloy
7	TSI19325	ORAL-M07	17:50-18:00	DEEPAK M SHINDE	Oral	JADAVPUR UNIVERSITY KOLKATA	DRY SLIDING WEAR BEHAVIOR OF ULTRASONIC CAST BORON CARBIDE REINFORCED ALUMINIUM NANOCOMPOSITES.

2nd December 2019 - Conference Day 2 - Afternoon Hall A
Theme : Industrial Tribology and Friction and Wear

Invited Talk 6 by Prof.J. Ramkumar,IIT Kanpur
Hall A- 16:30 - 16:50

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Oraganization	Abstract/Paper Title
1	TSI19283	ORAL-A01	16:50-17:00	Manas Ranjan Pattnayak	Oral	Indian Institute of Technology, Delhi	Minimum Film Thickness, Friction and Nonlinear Dynamic Behaviours of Pocketed/Textured Rigid Aerodynamic Bearings
2	TSI19157	ORAL-A02	17:00-17:10	Suresha B	Oral	The National Institute of Engineering	EXPERIMENTAL STUDY OF LUBRICATING PROPERTIES OF MAHUA OIL AND GRAPHENE NANOPLATELETS INCORPORATED MAHUA OIL USING FOUR BALL TESTER
3	TSI19224	ORAL-A03	17:10-17:20	PRAKASH CHANDRA MANI	Oral	IIT(BHU) VARANASI	EFFECT OF MICROSTRUCTURE ON EROSION RESISTANCE OF HYPO-EUTECTOID AND HYPER-EUTECTOID STEEL
4	TSI19272	ORAL-A04	17:20-17:30	Babu Rao Jinugu	Oral	Andhra University	Dry sliding Wear behavior of micro and nano High Entropy Alloy particulates reinforced AA 7075 composites
5	TSI19122	ORAL-A05	17:30-17:40	SANTOSH KUMAR	Oral	Indian Institute of Technology (ISM) Dhanbad	Experimental investigation of correlation between mechanical and two body abrasive wear behavior of GFRE composites filled with graphene
6	TSI19199	ORAL-A06	17:40-17:50	Krishnamurti Singh	Oral	Indian Institute of Technology Patna	Mechanism of Fretting Wear for Partially Compatible Material Combination
7	TSI19334	ORAL-A07	17:50 -18:00	Mhaske Milind Shivram	Oral	AVCOE,Research Center , Sangamner, Maharastra	Development and investigation of Mechanical properties of Non asbestos composite material

Day-2

Day-2

2nd December 2019 - Conference Day 2 - Afternoon Hall B
Theme : Industrial Tribology and Friction and Wear II

Invited Talk 7 by Prof.P K Rajendrakumar, NIT Calicut
Hall B- 16:30 - 16:50

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19264	ORAL-B01	16:50-17:00	Muhammed Muaz	Oral	IIT Kanpur	Vegetable oil based nano cutting fluids for MQL application during machining of steel
2	TSI19183	ORAL-B02	17:00-17:10	Manjesh Kumar Singh	Oral	Max Planck Institute for Polymer Research, Mainz	Tribological Behavior of Polymer Brushes: Effect of crosslinking
3	TSI19239	ORAL-B03	17:10-17:20	Pardeshi Mohansing Rameshsing	Oral	K.K.Wagh Institute of Engineering Education and Research	Study and Analysis of Wear Plate Material for sliding Mechanism of Drill Rig
4	TSI19335	ORAL-B04	17:20-17:30	Jai Singh	Oral	Indian Institute of Technology Roorkee	Dry sliding wear behavior of cyclically heat treated 13-4 martensitic stainless steel
5	TSI19146	ORAL-B05	17:30-17:40	Vinod Kumar	Oral	NIT Hamirpur (H.P)	Analysis of Assumptions of Various Erosion Wear Models
6	TSI19243	ORAL-B06	17:40-17:50	Dr S.K.Acharya	Oral	NIT Rourkela	Solid Particle Erosive Wear Behavior of . Eulaliopsis binata Reinforced Epoxy Composite.
7	TSI19342	ORAL-B07	17:50-18:00	Samiksha Moharana	Oral	Indian Institute of Technology, Madras	fretting Behavior on Femoral Head and stem Assembly made of suspension plasma sprayed Hydroxyapatite coating on Titanium Substrate

2nd December 2019 - Conference Day 2 - Afternoon Hall C
Theme : Industrial Tribology and Friction and Wear II

Invited Talk 8 by Dr.Barun Chakrabarti, Larsen & Toubro Limited
Hall C- 16:30 - 16:50

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Oraganization	Abstract/Paper Title
1	TSI19118	ORAL-C01	16:50-17:00	Suresh Jadhav	Oral	Indian Institute of Technology Roorkee	Tribological Behavior of AISI E 5200 steel tribo-pair under EHL regime
2	TSI19192	ORAL-C02	17:00-17:10	Shubhajit Das	Oral	NIT Arunachal Pradesh	Effect of tribological parameters on wear rate of AA7075/SiC Metal Matrix Composites using Fuzzy Logic: A Case study
3	TSI19246	ORAL-C03	17:10-17:20	Linto Davis	Oral	Indian Institute of Technology Madras,Chennai	EVALUATE THE PERFORMANCE OF AISI 440C BEARING STAINLESS STEEL AGAINST WHITE ETCHING AREAS (WEAs) FORMATION USING DYNAMIC LOAD PIN-ON-DISC TRIBOMETER
4	TSI19337	ORAL-C04	17:20-17:30	Geeteshwar Sharan Varshney	Oral	M.B.M. Engineering College	DRY SLIDING WEAR BEHAVIOUR OF ALUMINIUM BRONZE AGAINST 17-4 PH STAINLESS STEEL
5	TSI19168	ORAL-C05	17:30-17:40	Ronak Jagetiya	Oral	School Of Technology, Pandit Deendayal Petroleum University,	Elevated Temperature Wear Behavior of Aluminium 6061 Alloy
6	TSI19321	ORAL-C06	17:40-17:50	Meghashree Padhan	Oral	IIT DELHI	Functionalization of Titania nano and micro-particles to enhance wear resistance of UHMWPE composites
7	TSI19304	ORAL-C07	17:50-18:00	Dipak S. Bajaj	Oral	Amrutvahini College of Engineering, Sangamner	EFFECT OF MoS2 ON TRIBOLOGICAL PROPERTIES OF CHEMICALLY MODIFIED COTTON SEED OIL

TSI Annual General Body Meeting Main Hall 18:00 to 19:00

Cultural Program Main Hall 19:00 to 20:00 - Carnatic Vocal by Shri. Maruthi Prasad and Team

Dinner 20:00 to 21:00

3rd December 2019 - Conference Day 3 - Main Hall
Theme : Tribology in Design & Manufacturing and Surface Treatments

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19136	ORAL-M01	08:30-08:40	Dr. Cherian Paul	Oral	SAINTGITS College of engineering, Kottayam,	COMPARATIVE STUDY OF THE MICROSTRUCTURE, HARDNESS AND WEAR PROPERTIES OF FUNCTIONALLY GRADED Cu-10Sn-xNi ALLOY DEVELOPED BY FRICTION STIR PROCESSING AND GTA HEAT SOURCE
2	TSI19213	ORAL-M02	08:40-08:50	P NARESH	Oral	Madanapalle Institute of Technology & Science	WEAR AND MECHANICAL CHARACTERISTICS OF HYBRID-SURFACE COMPOSITE LAYER FABRICATED ON ALUMINUM MATRIX BY FRICTION STIR PROCESSING
3	TSI19299	ORAL-M03	08:50-09:00	NITHIN J THOMAS	Oral	HCL	Characteristic study of lubing Process on three piece hypodermic syringes
4	TSI19103	ORAL-M04	09:00-09:10	ABHILASH SKARIAH	Oral	ISRO	Application of Empirical Mode Decomposition and Support Vector
5	TSI19197	ORAL-M05	09:10-09:20	Dr. Imran Moulaalli Jamadar	Oral	ADCET, ASHTA	A New Approach for Detection of Rotor Unbalance for Minimizing Premature Rolling Contact Bearing Failures
6	TSI19135	ORAL-M06	09:20-09:30	NAIK HARDIK VIJAYKUMAR	Oral	S. V. NATIONAL INSTITUTE OF TECHNOLOGY,	Experimental investigations on tribological behavior of Co-Cr alloy deposited using PTA weld overlay technique
7	TSI19175	ORAL-M07	09:30-09:40	Patil Atulkumar Sahebrao	Oral	AVCOE Sangamner/ Savitribai Phule Pune University Pune and KKWIEER,	Effect of laser surface textured dimples on the frictional behaviour of piston ring and cylinder liner interface in a reciprocating bench test

Invited Talk 9 by Prof.T V V L N Rao, SRM University
Main Hall - 09:40-10:00

3rd December 2019 - Conference Day 3 - Hall A
Theme : Tribology in Design & Manufacturing and Surface Treatments

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19171	ORAL-A01	08:30-08:40	ANWESH VIRKUNWAR	Oral	NATIONAL INSTITUTE OF TECHNOLOGY SIKKIM	Wear performance optimization of Al6061-Fly Ash metal matrix composite using Taguchi Method.
2	TSI19218	ORAL-A02	08:40-08:50	G.C.S.G.Bharat	Oral	MVGR College of Engineering (A)	Friction stir processed AA6061 aluminium alloy ?Tribological behavior
3	TSI19303	ORAL-A03	08:50-09:00	PRASANTA KUMAR PADHI	Oral	ROURKELA STEEL PLANT	Improvement of Corrosion Resistance of Gas pipelines in Rourkela Steel Plant: A Study to reduce Life Cycle Cost
4	TSI19285	ORAL-A04	09:00-09:10	Sanjiv Krishna kamble	Oral	Rashtriya Chemicals and Fertilizers ltd Chembur mumbai	Condition Based Maintenance of Turbo Generator using vibration Analysis & Wear Debris Analysis
5	TSI19144	ORAL-A05	09:10-09:20	Hemant Nautiyal	Oral	IIT(BHU), Varanasi	Dry Sliding of Atmospheric Plasma Sprayed Cr3C2- NiCr Coating on AISI-304 Stainless Steel
6	TSI19203	ORAL-A06	09:20-09:30	AVI GUPTA	Oral	Indian Institute of Technology Delhi	Ceramic-based coatings on steel for improved erosion performance
7	TSI19274	ORAL-A07	09:30-09:40	Sanjay Pawar	Oral	VJTI,Mumbai	COMPARISON OF STATIC PERFORMANCE ANALYSIS OF HOLE ENTRY WORN HYBRID AND HYDROSTATIC CONICAL JOURNAL BEARING.

Invited Talk 10 by Mr.Nirav Pancholi,Schaeffler India Ltd
Hall A - 09:40 - 10:00

Day-3

Day-3

3rd December 2019 - Conference Day 3 - Hall B
Theme : Tribology in Design & Manufacturing and Surface Treatments

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19201	ORAL-B01	08:30-08:40	Shubham Balaso Lidhade	Oral	Veermata Jijabai Technological Institute , Mumbai	Automation of Tubesheet and Tube Layout Modeling in ANSYS Workbench Using Scripting Languages.
2	TSI19261	ORAL-B02	08:40-08:50	Vikas BC	Oral	Magnum Engineers	DESIGN, DEVELOPMENT AND CHARACTERIZATION OF HIGH FREQUENCY RECIPROCATING TRIBOMETER
3	TSI19315	ORAL-B03	08:50-09:00	Dr H. P. Khairnar	Oral	VJTI,Mumbai	Tribology : Past , Present and Future
4	TSI19159	ORAL-B04	09:00-09:10	Mahesh M Sonekar	Oral	Veermata Jijabai Technological Institute, Mumbai	A Comparative study of wear mechanism in SS 316L and Ti6Al4V bio-implant material using ball on disc wear testing machine for orthopedic application?
5	TSI19102	ORAL-B05	09:10-09:20	Guoxin Xie	Oral	Tsinghua University	Excellent Tribological Properties of Black Phosphorous as a New Lubricant
6	TSI19150	ORAL-B06	09:20-09:30	Dr. Basil Kuriachen	Oral	National Institute of Technology Mizoram	Microstructural Transformation and Layer Deposition through Electrical Discharge Alloying on Tribo-Behavior of Ti6Al4V at Elevated Temperatures
7	TSI19385	ORAL-B07	09:30-09:40	Pranay Likhar	Oral	IISc	Determination of static and dynamic friction in force controlled sliding conditions

Invited Talk 11 by Mr.Anjeeve George,Eaton Technologies Pvt Ltd
Hall B- 09:40-10:00

3rd December 2019 - Conference Day 3 - Hall C
Theme : Tribology in Design & Manufacturing and Surface Treatments

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19205	ORAL-C01	08:30-08:40	MANJUNATH G K	Oral	REVA UNIVERSITY	Tribological behaviour of Al-Zn-Mg alloys processed by equal channel angular pressing
2	TSI19288	ORAL-C02	08:40-08:50	Dr. Hiralal Bhowmick	Oral	Thapar Institute of Engineering and Technology	Tribology of Microwave Sintered CNT-reinforced h-AMMC
3	TSI19344	ORAL-C03	08:50-09:00	Prasad M Patare	Oral	SRES Sanjivani College of Engineering Kopargaon	Optimization of MoS2, Bronze filled PTFE Composites using GRA Method
4	TSI19167	ORAL-C04	09:00-09:10	Prashant Tiwari	Oral	National Institute of Technology Uttarakhand	Grayscale representation of vibration signal for condition evaluation of rolling element bearing
5	TSI19280	ORAL-C05	09:10-09:20	Kavit Shah	Oral	Dharmsinh Desai University	Tribo-testing using indigenously fabricated Tribometer for Tribometric Characteristics
6	TSI19160	ORAL-C06	09:20-09:30	E ANUSHA	Oral	International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI)	Comparative sliding wear behavior study of different laser-assisted surface treatments with untreated bearing steel
7	TSI19384	ORAL-C07	09:30-09:40	Vimal Edachery	Oral	IISc	Correlating surface roughness parameters with wear mechanisms: Lubricated sliding wear of EN31-SAE52100 steel

Invited Talk 12 by Prof.Anirudhan Pottirayil,Government Engineering College Kozhikode
Hall C - 09:40 to 10:00

Keynote talk 4 by Prof.Sujeet K Sinha,IIT Delhi
Main Hall - 10:10 to 10:40

Coffee Break 10:40 to 11:00

Plenary Talk 3 by Prof.Mark Owen Robbins,Johns Hopkins University USA
Main Hall- 11:00 to 11:40

Keynote Talk 5 by Prof.Denis Mazuyer ,École Centrale de Lyon France
Main Hall - 11:40 to 12:10

Keynote Talk 6 by Prof.Jeng-Haur Horng,National Formosa University Taiwan
Main Hall - 12:10 to 12:40

Keynote Talk 7 by Prof.Yoshinori Sawae,Kyushu University Japan
Main Hall - 12:40 to 13:10

Lunch Break 13:10 to 13:55

Interactive Session for Short Oral Presentation 13:55 to 14:35

3rd December 2019 - Conference Day 3 - Main Hall
Theme : Surface Treatments and Lubricants & Additives

Plenary Talk 4 by Prof.Noritsugu Umehara,Nagoya University Japan
Main Hall- 14:35 to 15:15

Keynote Talk 8 by Prof.Zahrul Fuadi,Syiah Kuala University Indonesia
Main Hall - 15:15 to 15:45

Coffee Break 15:45 to 16:05

Invited Talk 13 by Prof.Udaya Bhat,NIT Surathkal
Main Hall -16:05 - 16:25

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19230	ORAL-M01	16:25-16:35	Dr.Shubrajit Bhaumik	Oral	SRM Institute of Science and Technology,	Investigating the tribological properties of dimpled steel surface under lubricated condition
2	TSI19271	ORAL-M02	16:35-16:45	Bhavanishankar Sabat	Oral	Veermata Jijabai Technological Institute	Tribological Properties Evaluation of Plasma Nitrided 17-4 PH Stainless Steel in Dry Sliding conditions
3	TSI19309	ORAL-M03	16:45-16:55	Aashish John	Oral	Indian Institute of Science	Improving mechanical and micro-tribological properties of Inconel X-750 by sandblasting technique
4	TSI19148	ORAL-M04	16:55-17:05	AFREEN NISSAR	Oral	NIT SRINAGAR	Analysis of difference in physical and chemical properties of virgin and recycled oil- A review paper
5	TSI19182	ORAL-M05	17:05-17:15	Jyoti Prakash Singh	Oral	DMSRDE, DRDO, Kanpur	A Comprehensive experimental Study on ?Nanocarbon? based Lubricant Additive?
6	TSI19248	ORAL-M06	17:15-17:25	Prasad Eknath Lokhande	Oral	Sinhgad Institute of Technology Lonavala	SYNTHESIS AND CHARACTERIZATION OF CUO/RGO NANOCOMPOSITE FOR FRICTION REDUCTION AND ANTI-WEAR ADDITIVES IN LUBRICANTS
7	TSI19387	ORAL-M07	17:25-17:35	Swamy Babu	Oral	IISc	Influence of normal load on coefficient of friction in lubricated sliding of EN31-SAE52100 steel

3rd December 2019 - Conference Day 3 - Hall A
Theme : Surface Treatments and Lubricants & Additives

Invited Talk 14 by Prof.Vikas M Phalle, VJTI Mumbai
Hall A - 16:05 - 16:25

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19249	ORAL-A01	16:25-16:35	AJU ZACHARIAH MANI	Oral	NATIONAL INSTITUTE OF TECHNOLOGY CALICUT	Molecular dynamics simulation of indentation in nano-coated surfaces: A comparison between spherical and cylindrical indenters
2	TSI19300	ORAL-A02	16:35-16:45	PRIYARANJAN M	Oral	National Institute of Technology Calicut	INVESTIGATION INTO THE INFLUENCE OF SURFACE PREPARATION AND HYBRID SURFACE ROUGHNESS PARAMETERS ON ADHESIVE JOINT STRENGTH OF ENGINEERING MATERIALS
3	TSI19351	ORAL-A03	16:45-16:55	Jayakumar S	Oral	Design and Development, H&P division, BEML Ltd, KGF, Karnataka, India.	Tribological approach on selection of interference fit and surface finish parameters for improving reliability and performance of external gear pumps.
4	TSI19138	ORAL-A04	16:55-17:05	Yongliang Jin	Oral	Wuhan Research Institute of Materials Protection	Thermal oxidation behavior of trimethylolpropane trioleate base oil on iron surface
5	TSI19198	ORAL-A05	17:05-17:15	PRAVEEN KUMAR KHATRI	Oral	CSIR-INDIAN INSTITUTE OF PETROLEUM DEHRADUN	Tribo-evaluation of amino acid ionic liquids as lubricant additives for steel-steel contacts
6	TSI19265	ORAL-A06	17:15-17:25	Schneider Ameneh	Oral	Company Optimol Instruments	Methodologies for establishing the tribological profile of greases
7	TSI19386	ORAL-A07	17:25-17:35	Rajeev Gupta	Oral	IISc	Effect of surface topography on wear behaviour and debris morphology of polymer sliding against SS316L stainless steel

Day-3

Day-3

3rd December 2019 - Conference Day 3 - Hall B
Theme : Surface Treatments and Lubricants & Additives

Invited Talk 15 by Dr.Vijay Chaudhry,NPCIL
Hall B - 16:05 - 16:25

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19252	ORAL-B01	16:25-16:35	AJAY CHOUHAN	Oral	CSIR-INDIAN INSTITUTE OF PETROLEUM DEHRADUN	Spectroscopic Studies to Reveal the Deposition of Graphene on Tribo-Interfaces
2	TSI19306	ORAL-B02	16:35-16:45	R. Kumutha	Oral	Sri Venkateswara	Study of Tribological Behaviour of Surface Modified High Carbon Chromium Steel
3	TSI19108	ORAL-B03	16:45-16:55	Asima Shaukat	Oral	BITS Pilani, K K Birla Goa Campus	The effect of rheological dynamics of grease on its tribological performance
4	TSI19164	ORAL-B04	16:55-17:05	DR. AMIT PRATAP Prof. V. R. GAVAL	Oral	Institute of Chemical Technology	Tribological Properties of Guerbet Alcohol Esters as Potential Biobased Lube Oil Base Stock
5	TSI19202	ORAL-B05	17:05-17:15	Ekta faujdar	Oral	CSIR-Indian Institute of Petroleum	Novel amides of N-phenyl-p-phenylenediamine with acrylate copolymers of maleic anhydride: Synthesis, characterization and performance evaluation as multifunctional lubricant additives
6	TSI19360	ORAL-B06	17:15-17:25	Angela Maria Tortora	Oral	Ducom	Wear of antibacterial coatings on CoCrMo under butterfly motion and dynamic loads in a biotribometer.
7	TSI19359	ORAL-B07	17:25-17:35	Giulia Chiarioni	Oral	Ducom	Development of lubricity test methods to investigate aging of lubricants

3rd December 2019 - Conference Day 3 - Hall C
Theme : Surface Treatments and Lubricants & Additives

Invited Talk 16 by Prof.D. Devaprakasam, VIT Vellore
Hall C 16:05 - 16:25

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19270	ORAL-C01	16:25-16:35	Soumya Ranjan Guru	Oral	Indian Institute of Technology Kharagpur	Surface Characterization of the polymers by using micro-indentation methods
2	TSI19307	ORAL-C02	16:35-16:45	S. Arumugavel	Oral	Sri Venkateswara College of Engineering	Study of erosion behaviour of borided AISI 316 L Stainless steel
3	TSI19110	ORAL-C03	16:45-16:55	SHITENDU SOME	Oral	INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY	Effect of percolation of polar additives of coupled-stress lubricant on the non-linear stability analysis of double-layered porous journal bearings with slip effect
4	TSI19177	ORAL-C04	16:55-17:05	Dr T Nagaraju	Oral	P E S College of Engineering Mandya	Study of Epoxidized and Benzoic Acid Additive added Pongamia Bio-Lubricant
5	TSI19217	ORAL-C05	17:05-17:15	Daiki MATSUOKA	Oral	Doshisha University	DYNAMIC BEHAVIOR OF EHL OIL FILM FORMED BETWEEN BALL AND DISK SURFACE WITH MICRODIMPLES UNDER CYCLIC SQUEEZE MOTION
6	TSI19370	ORAL-C06	17:15-17:25	Chenhui Zhang	Oral	Tsinghua University	Contribution of hydratioin effect to water-based Superlubricity
7	TSI19388	ORAL-C07	17:25-17:35	Santosh kumar	Oral	IISc	Rolling direction effect on clinching joint strength performance in LAP-SHEAR configuration

Banquet Dinner 19:00 to 22:00 - Kalinga Hall, Hotel Lalit Ashok

4th December 2019 - Conference Day 4 - Forenoon Main Hall
Theme : Lubricants & Additives and Bearing & Gear Tribology

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19267	ORAL-M01	08:30-08:40	Dr Pranab Samanta	Oral	CSIR-Central Mechanical Engineering Research Institute	Experiments on Graphene oxide as a hot forging die lubricant
2	TSI19293	ORAL-M02	08:40-08:50	Pikesh Bansal	Oral	ABES EC, Ghaziabad	Effect of various parameters on steady state performance of Hydrodynamic Journal Bearing with Flexible Liner under Micropolar Lubrication
3	TSI19105	ORAL-M03	08:50-09:00	Abhishake chaudhary	Oral	NIT Kurushetra	Performance Evaluation of Geometrically Irregular Four Pocket Hybrid Journal Bearing operating with CSL
4	TSI19124	ORAL-M04	09:00-09:10	ANIL SINGH	Oral	Indian Institute of Technology, Roorkee	A study of a constant flow valve compensated three pocket hybrid journal bearing operating with micropolar lubricant
5	TSI19127	ORAL-M05	09:10-09:20	AKANT KUMAR SINGH	Oral	I.T.S ENGINEERING COLLEGE GREATER NOIDA	Thermal and wear peculiarity of glass fiber filled PBT based homogeneous and FGM spur gears
6	TSI19215	ORAL-M06	09:20-09:30	Dr. Prashant B. Kushare	Oral	K.K.Wagh Institute of Engineering Education and Research	Thermal Analysis of Two Lobe Non-Recessed Hybrid Journal Bearings
7	TSI19393	ORAL-M07	09:30-09:40	Ashokraj Jayachandran	Oral	IISc	EFFECT OF PLASTIC DEFORMATION MECHANISMS, TRIBO CHEMICAL REACTIONS AND MECHANICALLY MIXED LAYERS IN TRIBOLOGY OF TI-6AL-4V ALLOYS

Invited Talk 17 by Prof.Satish C.Sharma,IIT Roorkee
Main Hall- 09:40-10:00

4th December 2019 - Conference Day 4 - Forenoon Hall A
Theme : Lubricants & Additives and Bearing & Gear Tribology

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19275	ORAL-A01	08:30-08:40	AMZAD KHAN	Oral	CSIR- INDIAN INSTITUTE OF PETROLEUM MOKHMPUR DEHRADUN	Halogen-Free Organosulphate Anion-Based Ionic Liquids as Lubricant Additives for Steel-Steel Tribo-Interfaces
2	TSI19322	ORAL-A02	08:40-08:50	Neha Singh	Oral	IIT DELHI	In-situ Lubrication effect of base oil (SN-150) filled Epoxy Composite
3	TSI19328	ORAL-A03	08:50-09:00	NITIN AGRAWAL	Oral	Tribology Laboratory, Indian Institute of Technology, Roorkee	Performance analysis of hybrid circular thrust bearing operating with Electro-rheological lubricant
4	TSI19109	ORAL-A04	09:00-09:10	SUBRATA DAS	Oral	A.P.C. Ray Polytechnic, Jadavpur, Kolkata-700032	Analysis of linear stability characteristics of axial-grooved journal bearing lubricated with couple stress fluid
5	TSI19123	ORAL-A05	09:10-09:20	ADESH KUMAR TOMAR	Oral	Indian Institute of Technology, Roorkee	Performance analysis of five pocket capillary compensated hybrid journal bearing operating with Non-Newtonian lubricant
6	TSI19142	ORAL-A06	09:20-09:30	Ritesh Kumar Patel	Oral	Indira Gandhi Institute of Technology Sarang	Elasto-hydrodynamic simulation of one-dimensional Rayleigh step bearing with Industrial Engine oils
7	TSI19220	ORAL-A07	09:30-09:40	Abir Bhattacharyya	Oral	Indian Institute of Technology Jodhpur	On Improving the Existing Life Prediction Models for Rolling Element Bearings

Invited Talk 18 by Amitabh Kumar Jain
Hall A- 09:40-10:00

Day-4

Day-4

4th December 2019 - Conference Day 4 - Forenoon Hall B
Theme : Lubricants & Additives and Bearing & Gear Tribology

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19277	ORAL-B01	08:30-08:40	Jeewan Chandra Atwal	Oral	Indian Institute of Technology Delhi	Friction Coefficient and Minimum Film Thickness Studies of Textured Pad Thrust Bearing through Stribeck Curves
2	TSI19340	ORAL-B02	08:40-08:50	Dr. Chiranjit Sarkar	Oral	IIT Patna	Numerical simulations of magnetorheological grease in a rectangular channel with- and without restrictions in the presence of external magnetic field
3	TSI19229	ORAL-B03	08:50-09:00	Ramesh V Bhandare	Oral	K.K.Wagh Institute of Engineering Education and Research	Experimental Investigation of Multi-Lobe hydrodynamic journal bearing
4	TSI19115	ORAL-B04	09:00-09:10	SATISH C SHARMA	Oral	INDIAN INSTITUTE OF TECHNOLOGY ROORKEE	Performance of textured surface hybrid thrust pad bearing considering micro-roughness
5	TSI19139	ORAL-B05	09:10-09:20	Harpreet Singh	Oral	John Deere	Impact of Micro-geometry and Material Parameters on the Tribological performance of Gears
6	TSI19178	ORAL-B06	09:20-09:30	Dillip Kumar Panigrahi	Oral	Indian Institute of Technology Kharagpur	Influence of Texture Height and Film Thickness on Hydrodynamic Performance of Parallel Sliding Thrust Bearing
7	TSI19223	ORAL-B07	09:30-09:40	Dr.Prashant B.Kushare	Oral	K.K.Wagh Institute of Engineering Education and Research	Thermal Analysis of Two Lobe Non-Recessed Hybrid Journal Bearings

Invited Talk 19 by Prof.Mayank Tiwari, IIT Patna
Hall B- 09:40 - 10:00

4th December 2019 - Conference Day 4 - Forenoon Hall C
Theme : Lubricants & Additives and Bearing & Gear Tribology

Sr.	Abstract ID	Presentation ID	Time	Author/co-author Name	Type of Presentation	Institute/ Organization	Abstract/Paper Title
1	TSI19279	ORAL-C01	08:30-08:40	Bikash Routh	Oral	VIT-Vellore	LUBRICATION PERFORMANCE IMPROVEMENT OF HARMONIC DRIVE BY POROUS STRAIN WAVE GENERATING CAM
2	TSI19339	ORAL-C02	08:40-08:50	Manoj Parjane	Oral	Shri Guru Gobind Singh Inst of Engg and Technology, Nanded	Evaluation of SAE 15W40 Lubricating Oil By Adding Nano Particle Additives
3	TSI19234	ORAL-C03	08:50-09:00	Dr. Chippa Shriniwas P	Oral	Vishwakarma Institute of Technology, Pune	Thermo-hydrodynamic analysis of journal bearing including surface roughness and cavitation effects
4	TSI19119	ORAL-C04	09:00-09:10	Krishnkant Sahu	Oral	Mechanical and Industrial Engineering, Indian Institute of Technology, Roorkee	A study on Grooved Slot-entry hybrid journal bearing system
5	TSI19291	ORAL-C05	09:10-09:20	Dr. Nimeshchandra S. Patel	Oral	Dharmsinh Desai University	Experimental Tribometric Characteristics Analysis of a Ferrofluid Based Journal Bearing System
6	TSI19184	ORAL-C06	09:20-09:30	Bansidhar Gouda	Oral	Centre For Automotive Research & Tribology (CART), IIT Delhi	Lubrication in Ball Bearing: A Review

Invited Talk 20 by Gopakumar Parameswaran, 3M India Ltd
Hall C- 09:40 - 10:00

Keynote Talk 9 by Dr.Syed Asif,Bruker USA
Main Hall- 10:10 to 10:40

Coffee Break 10:40 to 11:00

Plenary Talk 5 by Prof.Michael Khonsari,Louisiana State University USA
Main Hall - 11:00 to 11:40

Plenary Talk 6 by Prof.Hong Liang ,Texas A&M University USA
Main Hall - 11:40 to 12:20

Keynote Talk 10 by Prof.Nitya Nand Gosvami,IIT Delhi
Main Hall- 12:20 to 12:50

Lunch Break 12:50 to 13:50

Keynote Talk 11 by Manish Roy,DMRL -DRDO Hyderabad
Main Hall- 13:50 to 14:20

Keynote Talk 12 by Dr.Om P Khatri,CSIR-IIP Dehradun India
Main Hall- 14:20 to 14:50

Interaction with Editors 14:50 to 15:50

Special Lecture by Dr. B V A Rao 15:50 to 16:10

Closing Session & Awarding Ceremony
National Anthem 16:10 to 16:30

Coffee Break & End of the Conference 16:30 to 17:00

IndiaTrib-2019
10th International Conference on Industrial Tribology
Dec 01-04, 2019, Indian Institute of Science Bangalore

Prof. Nicholas D. Spencer,
ETH Zurich

BRUSHES ON GELS: CARTILAGE, CONTACTS AND CATHETERS

Our everyday lives involve the articulation of many joints in our bodies, and for the most part, these vital components last for many decades without need of repair. Great progress has been made in the replacement of load-bearing joints by engineering materials, but ultimately better solutions would be either the growth of new, living sliding materials identical to the cartilage that has worn out, or replacement of diseased and worn sliding components with artificial materials with very similar properties to the natural cartilage. We are working on the early stages of the latter approach, using what is known about the behavior and properties of living cartilage and attempting to imitate it by constructing systems consisting of hydrogels covered by polymer brushes. The knowledge gained from these efforts will hopefully lead eventually to novel implant materials, but in the meantime, it will help us to test current theories of joint function, and to develop lubricious polymeric systems that could have applications in other biomedical applications such as contact lenses, intraocular insertion devices, and catheters.

KEY WORDS: Polymer Brushes; Gels; Cartilage; Contact Lenses; Catheters; Lubrication

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Prof. Jianbin Luo
Tshingua University, China

THE NEW ADVANCES OF SUPER LUBRICITY

Super lubricity has developed very fast in recent years as a new and an important area in tribology. Many new phenomena, new materials, and new mechanism both in liquid and solid super lubricity have been obtained. In the liquid area, a new system of super lubricity liquids with new mechanism has been found, which exhibits very good properties of super lubricity under the higher pressure. In solid area, more materials in super lubricity have been observed both by experiment and the molecular dynamics simulation (MDS), such as grapheme to grapheme surfaces, highly oriented pyrolytic graphite (HOPG) to grapheme etc. Mechanism for different tribo-systems has been discussed.

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Prof. Mark Robbins
Johns Hopkins University, USA

CONTACT AND FRICTION ACROSS SCALES: HOW ELASTICITY DETERMINES THE REAL CONTACT AREA AND DESTROYS STRUCTURAL LUBRICITY

Joseph M. Monti, Mark O. Robbins,
Johns Hopkins University, Baltimore, MD 21218, USA Lars Pastewka Freiburg University, Freiburg, Germany.

Friction is determined by the real area of contact where atoms on opposing surfaces are close enough to repel. Calculating this area is complicated because elastic interactions are long-range, and surfaces are rough on a wide range of scales. In many cases they can be described as self-affine fractals from nanometer to millimeter scales. The talk will first describe recent results on the variation of contact area and geometry with load, roughness, plasticity and adhesion. Then the scale dependence of friction forces in contacting regions will be described. The friction between rigid surfaces rises sub linearly with area in large contacts, leading to structural lubricity. Elasticity allows surfaces to lock together in sufficiently large contacts, leading to a constant shear stress or local friction coefficient. Commensurate, incommensurate and amorphous surfaces have very different behavior in the rigid limit, but all have similar friction forces in large contacts. However, the friction decreases exponentially with the ratio of substrate stiffness to interfacial interactions in 3D and as a power law in 2D. Saturation of the friction force occurs because elasticity allows different regions of the contact to advance independently, much like the mode 2 fracture observed in macroscopic contacts.

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Prof. Umehara Noritsugu
Nagoya University, Japan

CLARIFICATION OF LOW FRICTION MECHANISM BETWEEN A-C:H COATINGS AND OXIDIZED SIC AT HIGH TEMPERATURE

K. Konishi[1], N. Umehara[1*], M. Murashima[1] and T. Tokoroyama[1]
[1] Department of Mechanical Science and Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan

Tribological properties of a-C:H coatings has been investigated in various friction conditions. Temperature and mating materials give effects on tribological properties. In this study, we especially focus on the effect of mating material on its tribological properties of a-C:H coatings. Ball-on-disk friction test is conducted between a-C:H coating and 5 kinds of mating material, which is SiC, SiC(O)_800 (SiC oxidized at 800 °C), SiC(O)_1050 °C, SiC(O)_1300 °C, and Quartz glass. It is found that a-C:H coatings shows low friction coefficient and low specific wear rate when O/Si ratio of the element content of mating material is 2, in other words, mating material is SiO_2. In the wear scar of a-C:H coating after friction test with SiC, severe damage was confirmed. It is considered that a-C:H coating and SiO_2 show low adhesion even at high temperature, which leads low friction and wear. Compared SiC(O) with Quartz, the friction coefficients with a-C:H coatings are respectively 0.013 and 0.038. Even though SiC(O) and Quartz are both SiO_2, the tribological properties are different. On the wear track of SiC(O), transferred things from a-C:H coating are confirmed. It is considered that this graphitized transferred thingmakes the friction coefficient lower by working as solid lubricant

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Prof. Michael M. Khonsari
Louisiana State University, USA

APPLICATION OF IRREVERSIBLE THERMODYNAMICS FOR ASSESSING DEGRADATION

Wear and fatigue of materials involve a variety of complex and physically diverse phenomena that often occur in an inextricably intertwined fashion. Although often treated as separate phenomena, wear and fatigue are manifestation of the same physics. Indeed, they are examples of dissipative processes wherein the system's *free energy*, Ψ, responsible for doing useful work, decays with time. That is, if Ψ_i, denotes the initial free energy of a pristine tribosystem, then after completion of the dissipative process its free energy decreases to Ψ_f such that $\Psi_f < \Psi_i$. This decay in the free energy continues until the system attains a minimum at the equilibrium state in accordance with the principle of minimum free energy. Thus, the system's path to the minimum free-energy is always accompanied by increasing entropy until it reaches its peak value at the equilibrium state. The increase in entropy is a consequence of increasing disorder in the system with time. Therefore, notwithstanding the multiplicity of underlying dissipative processes involved, they all share one unique feature: they all produce entropy. Therefore, thermodynamic entropy production is believed to be a propitious measure for a systematic study of wear and friction. In this workshop, I present results of a series of recent experimental and analytical development associated with surface degradation such as wear as well as fatigue fracture within the framework of irreversible thermodynamics. This view offers a potentially transformative path forward for the development of predictive methodologies for variety of applications.

KEY WORDS: Wear; fatigue; degradation entropy theorem

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Prof. Hong Liang
Texas A&M University, USA

TRIBO-OXIDATION OF NON-EQUILIBRIUM OXIDES OF TANTALUM

Tribo-oxidation has been widely reported in metallic systems involving relative motion and mechanical contact in corrosive environments. However, the fundamental understanding in initiation of oxidation and the kinetics of growth of passivation layers is far from being complete. One of the key challenges is the inability to detect the interfacial phenomenon. To address this issue, in this presentation, we will discuss about our combinational approaches to pin point tribochemical interactions at the interface of a noble metal tantalum under contact stress. Due to its chemically stable nature, tantalum is a good candidate for such study with identifiable phases. Experimentally we developed combinational approaches to configure mechanical, electrochemical, and corrosion systems at various length scales. Using this approach, we were able to control the amount of mechanical and electrical energy in a designed chemical environment. Results enabled us to compare the equilibrium and non-equilibrium oxidation processes and the states of oxidation. The surface chemistry of the sliding surface was found modified by the electrolyte and mechanical force. The formation of non-equilibrium oxidation states of tantalum can be controlled by tailing the oxidation environment and the mechanical force. Subsequently, we conducted in situ characterization to identify and determine non-equilibrium phases existed under stress. Thermal energy analysis indicated that mechanical energy contributed to the instability of oxides and sub-oxides of tantalum and subsequently the phase transfer between the same. In other words, the mechanical energy induced the non-stable-state reactions leading to metastable oxidation states of the metal.

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Prof. Daniel Nélias
Univ Lyon, France

CONTACT ANALYSIS OF HOMOGENEOUS, LAYERED OR HETEROGENEOUS VISCOELASTIC MATERIALS

Steady-state or transient analysis of the contact between two materials when at least one of them behaves viscoelastically is a critical step for a deep understanding of the physics involved. That concerns a wide spectrum of applications. One may think first of the contact between tire and pavement [1], or shoes on floor. The viscoelastic behavior can be also revealed in electromechanical systems when plastic or other polymeric materials are used to translate or rotate axles or plates. Another example relates to composite materials when the matrix is viscoelastic (VE).

The simplest situation corresponds to the steady-state rolling or sliding of a homogeneous VE material against a rigid or elastic counter face [2]. One may also consider transient phases such as start and stop motion (or acceleration and deceleration). The fretting problem when stick and slip occurs simultaneously is a little more complex since it means transient analysis (oscillating movement) which is strongly dependent on the frequency or time response.

In many applications the VE material is not homogeneous anymore. Hard particles or voids and cavities may be distributed within the material [3,4], think about the complex structure of a tire, with cables or fibers at the macroscopic scale, and very tiny particles at the microscopic scale. Another application is the contact between a composite blade and a metallic disk in an aircraft engine. A viscoelastic layer may also be present on the top of a VE substrate. Both the thickness of the coating and the ratio between the characteristic time of the layer and the substrate will strongly affect the response (and dissipation) of the mechanical system.

After a brief summary of the mathematical background, the presentation will focus on some examples for academic configurations or more applied engineering situations.

KEY WORDS: Contact Mechanics; viscoelastic material; transient analysis; layered viscoelastic material; heterogeneous viscoelastic material.

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Prof. Juliette Helene Cayer
École Centrale de Lyon France

TRANSIENT EFFECTS in LUBRICATION

Transient effects in lubrication can occur in steady-state regimes and/or in time-varying conditions for all lubrication regimes. They can result in an evolution of the lubricating film, of the friction response or both. Analyzing these effects give access to crucial information about the buried interface and help one to understand the friction and lubrication mechanisms.

The strategy developed here to address this topic combined experimental, numerical and theoretical approaches and covers all the lubrication regimes. The experimental approach was mainly based on the measurement of contact forces and simultaneous film thickness distribution for controlled contact kinematics. The numerical approach consisted in solving Reynolds equation, taking into account the transient term and the surface topography effect. Theoretical predictions were made using statistical physics and additive friction laws and solving Reynolds equation with the transient term in the case of time-varying velocity conditions.

Examples of transient effects in lubrication will be presented and discussed in this presentation. For instance, we will show:

- how oil supply of the contact can be controlled using textured surfaces 1,
- how friction can be predicted even though aged lubricants were used 2-3,
- how friction can be governed in boundary regime by means of the molecular architecture of additives 4-5,
- how deceleration and squeeze modify the film thickness distribution and time-evolution 6-7.

In conclusion, the analysis of the local and transient modification of the film thickness and/or friction force allowed to demonstrate that coupled surface phenomena and interfacial rheology contribute to friction dissipation in all the lubrication regimes. The dynamics of contact spots that statistically undergo change state (pinned, depinned, dry, lubricated, …) is the key point in the lubrication regime transitions and in the friction level. In addition, considering the squeeze contribution and the transport effects in the lubricant flow is mandatory to predict the film thickness evolution.

KEY WORDS: Aged lubricant; Elastohydro dynamic lubrication; Lubrication regimes; Oil supply; Surface Force Apparatus; Squeeze.

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Prof. Ciulli Enrico
University of Pisa Italy

INVESTIGATION ON NONLINEAR BEHAVIOUR OF TILTING PAD JOURNAL BEARINGS

Enrico Ciulli[1*], Paola Forte[1] and Matteo Nuti[2]
[1]Dipartimento di Ingegneria Civile e Industriale, University of Pisa, Largo Lazzarino, 56122 Pisa, Italy
[2]AM Testing s.r.l., Pisa, Italy

Due to the today's increasing demand of higher efficiency for all machines, new lubricated bearings are facing extreme operating conditions and their behaviour must be investigated. Tilting pad journal bearings are widely used in turbomachinery. The bearing stiffness and damping coefficients must be known for rotor dynamic analyses particularly at the design stage. The coefficients are experimentally identified with linear models by applying dynamic loads to the bearing, measuring the rotor-stator relative displacement. The motion about the static equilibrium position must be small enough to be consistent with the linearity assumption but large enough to minimize the measurement error of the displacement sensors and to replicate the vibration amplitude in real operating conditions.

Several tests were performed at the University of Pisa on a test bench specifically designed for large size journal bearings operating at high peripheral speeds and static loads [1]. The test rig is shown in Fig. 1.

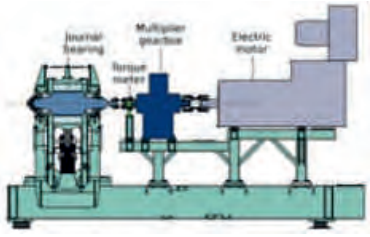

Fig. 1: Schematic drawing of the test rig.

Besides the classical procedures used for the identification of the dynamic coefficients [1], a quasi-static procedure was developed to check possible presence of nonlinearities. A slowly rotating force was applied to the floating bearing stator in addition to the static load and the relative displacement

between the stator and the rotating shaft was measured. Deformed orbits instead of the elliptical ones were observed increasing the ratio between dynamic and static load, suggesting the presence of nonlinearities. Quite similar results were obtained with simple analytical models including linear and quadratic stiffness coefficients and assuming suitably tuned non-linear stiffness terms [2].

In this work more systematic optimization methodologies are used to obtain a better fit between experimental and numerical results. The first order stiffness coefficients are also evaluated according to the nonlinear model.

A sample comparison between the results obtained in [2] and the present optimized ones is shown in Fig.2. Results refer to tests performed with a four-pad bearing with a rotating load 36% of the static one.

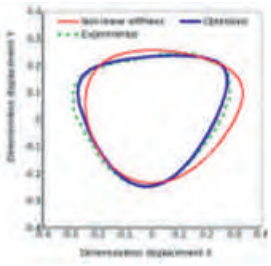

Fig. 2. Experimental orbit and calculated ones with the non-linear stiffness model [2] and the optimized one.

Results show that agreement improves with the new methodology and that the linear terms of the nonlinear model differ from the linear ones of the linear model as displacement increases.

In conclusion, the adopted quasi-static procedure could be a convenient way to define the displacement range for the validity of the linear assumption and of the linear dynamic coefficients at low frequency range.

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Prof. Sujeet K Sinha
IIT Delhi, India

SOFT POLYMERIC COATINGS – A NEW FRONTIER IN TRIBOLOGY

Whereas bulk polymeric composites have found many applications in tribology, polymeric coatings are still under developmental stage in this regard. There have been few successes in applying polymeric coatings to IC engine piston rings, journal bearings etc. Long-term wear durability is often the major challenge as the coatings are subjected to thermal and fatigue failures in addition to the abrasive and adhesive wear. The interfacial bonding properties between the coating and the substrate is important, at the same time, the surface properties of the coating must provide optimum friction and wear performances. Therefore, proper selection of the base polymer, the fillers, substrate preparation and the deposition procedure become very important in addition to some other factors. In this talk, the tribological performances of several polymeric composites will be presented. Examples are drawn from ultra-high molecular weight polyethylene (UHMWPE) and epoxy as the base polymers with fillers such as graphite, carbon nanotubes, graphene with liquid fillers of perfluoropolyether and base mineral oil. A preliminary effort will be made to present these data in the form of a performance map.

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Prof. Denis Mazuyer
École Centrale de Lyon France

MICROSCOPIC and MACROSCOPIC ASPECTS OF LUBRICATION REGIMES TRANSITIONS

By analogy with their wetting capabilities, the friction response of surfaces when involved in a lubricated contact, strongly depends on the complex coupling between their roughness and their chemistry. In this framework, the optimization of these properties for friction monitoring from full-film lubrication to boundary lubrication needs to have in mind three main challenging features:

- The rheology of lubricants is highly non-linear and are driven by the confinement effects occurring in the contact;
- A wide range of times and lengths scales are coupled and must be identified;
- The role of the molecular interfaces on the macroscopic tribological behaviour of the lubricated is usually unknown because of lack of in-situ measurements.

In this talk, we illustrate these points by analysing the multiscale frictional response of two types of lubricated contacts thanks to a common Stribeck curves approach:

- A high-pressure lubricated contact between smooth surfaces in which the role of boundary layers of polymers or organic friction modifiers is investigated in all the lubrication regimes;
- A base oil-lubricated contact between random rough surfaces that shows the effective wavelengths seen by the contact during sliding has a major effect on the ML/EHL transition.

A macroscopic friction model that weights the fluid-like and the solid-like contributions according to the importance of these local surface phenomena (topography and/or chemistry) is proposed in each of these lubricated contacts.

KEY WORDS: Friction; Stribeck curves; Lubrication Regimes

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Prof. Jeng HaurHorng
National Formosa University, Taiwan

Three-BODY MIXED LUBRICATION MODEL AND ITS APPLICATION

Jeng-Haur Horng[1*], Yang-Yuan Chen[1], Chia-Chun Yu[1] and Ging-Long Lin[1]
[1]Department of Power Mechanical Engineering, National Formosa University, Yunlin, Taiwan

This paper describes a method established for the analysis of load-sharing of lubricant, surface asperity and particles. Here, different the peak points per area of square inch (PPI) and the percentage of points (POP) and depth machined surfaces were used for the actual operation of the scarping surface. By measuring the surface topography of the scraping piece and substituting the surface topography parameters to a three-body contact friction model, the interface properties were observed. The obtained results showed that initial contact surface is under the initial mixed lubrication from the low solid load ratio (1.0~2.5%) and low real contact area ratio. After completing scraping process, the values of POP increases and surface roughness decreases from topography parameter software analysis. It means that the contact condition of the scraping piece change from the mixed lubrication to the elasto-hydrodynamic lubrication (EHD) regime. Because the EHD lubrication has the minimum value of friction coefficient in all lubrication regimes, that is the reason why scraping surface has a stable and reliable operation performance. Therefore, it is recommended to add a three-body wear model in the future to analyses the operating variations for different scraping surfaces, and then the quantitative mechanism for scraping effect can be confirmed.

KEY WORDS: friction, scraping, surface roughness, three-body micro-contact, POP, wear debris

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Prof. Sawae Yoshonori
Kyushu University, Japan

STUDY ON SYNOVIAL JOINT LUBRICATION WITH MACROSCALE EXPERIMENTAL MODELS OF CARTILAGE AND SYNOVIAL FLUID

Yoshinori Sawae[1,2,3*], Hironori Shinmori[4], Yuki Doi[4], Takehiro Morita[1,3] and Tetsuo Yamaguchi[1,2,3]
[1] Department of Mechanical Engineering, Faculty of Engineering, Kyushu University
[2] Advanced Research Center for Biomechanics, Kyushu University
[3] International Institute for Carbon Neutral Energy Research, Kyushu University
[4] Department of Mechanical Engineering, Graduate School of Engineering, Kyushu University

Natural synovial joints have fascinated many tribologists with their low friction and low wear nature during our daily activities. Sliding surfaces in natural synovial joints are covered with soft and highly hydrated articular cartilage and lubricated with synovial fluid which contains a lot of biological macromolecules, such as proteins, lipids and hyaluronic acid (HA). Many previous studies have been conducted to clarify the lubrication mechanism of synovial joint and a lot of different lubrication mechanisms have been proposed; some are emphasizing the boundary lubrication effects of synovial constituents and other studies are suggesting the important contribution of porous, permeable and hydrated nature of cartilage tissue. However, the clear conclusion about the joint lubrication mechanism which can depict the excellent tribological properties of our synovial joints has not been achieved.

In this study, the joint articulation was reproduced in friction testers using experimental models of both cartilage tissue and synovial fluid to explore the detailed mechanism of synovial joint lubrication. A synthetic polymer hydrogel with a high-water content, polyvinyl alcohol (PVA) hydrogel, was chosen as a simple physical model of articular cartilage to examine the role of soft, porous and hydrated nature of the cartilage tissue. In addition, hydrogel-chondrocytes constructs were prepared as quasi-cartilage models containing living cells. By using them, the contribution of extra cellular matrix (ECM) production of chondrocytes could be included in experiments. These cartilage tissue models were lubricated with saline-based model of the synovial fluid to examine the synergistical lubrication effects of combining cartilage and synovial fluid.

KEY WORDS: Synovial joint; Cartilage; Synovial fluid; Boundary lubrication; Biphasic lubrication; Chondrocyte

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Prof. Zahrul Fuadi
Syiah Kuala University, Indonesia

Tribological Properties of Stainless Steel under Methyl Esters

Zahrul Fuadi[1], Koshi Adachi[2], Koki Kanda[2], Kurniawan Rudi[1]
[1]Syiah Kuala University, [2]Tohoku University

Methyl esters are produced by transesterification of bio-oils and have been used as a mixture or substitute for petrol diesel fuel. Although methyl esters contain some oxidative elements as the residue of the chemical process such as soap and oxygen, it has been reported that their usage has several advantages such as friction and wear reduction, improvements in fuel efficiency, as well as emission reduction. In particular, the friction and wear reduction could be caused by the formation of a tribo-layer which protects the metal in contact by limiting the metal to metal direct contact during friction or by reducing the thermal energy at the contact interface. On the other hands, methyl esters also show some potential to be used as a lubricant's bio-additives. It has been reported that addition of a small amount of palm methyl ester in a lubricant had resulted in the wear reduction of the material up to 20%, particularly in boundary lubrication regimes. In this paper, the tribological properties of stainless steel under various lubrication condition involving methyl esters will be discussed. In particular, the methyl esters of interest are palm methyl ester, rubber seed methyl esters, and CerberaOdollam methyl ester. Results indicated that, in general, the methyl esters are potential to be used in mechanical systems for the tribological purposes.

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Dr. Syed Asif
Bruker Nano Surfaces, USA

Recent Developments in Nanomechanical and Nano-Tribological Testing

S.A. Syed Asif, Sanjit Bhowmick, Eric Hintsala, Praveena Manimunda
Bruker Nano Surface., Minneapolis, MN 55344, USA

The study of tribology includes contact mechanics, wear, friction, and lubrication of interacting surfaces in relative motions. Since the function of many engineering components depends on the appropriate friction and wear properties, the study of tribology has significant practical importance. However, traditional contact mechanics and tribology tests are limited by the inability to observe real-time progress of the sliding contacts and wear mechanism. In recent two decades, depth sensing nanoindentation emerged as a standalone technique that enabled mechanical response and property measurements such as hardness and elastic modulus at depths as shallow as a few nanometers. At shallow depths, the mechanical response often exhibited unusual features such as pop-in/pop-out load-displacement discontinuities which required additional characterization to uncover their source. Coupling mechanical testing to Transmission Electron Microscopy (TEM) or Scanning Electron Microscopy or Raman microscopy in an in-situ, quantitative manner represents an attractive way of time correlating an unusual mechanical response to the corresponding change in the microstructure of the sample being tested. Besides indentation, today's Nano and micromechanical methods include compression, tension bending, fracture, fatigue and creep tests, combined with different in situ testing techniques as diffraction methods like EBSD or X-rays or Raman. Recently we further extended the in-situ technique to understand the tribological behavior of materials under sliding contact. This talk will demonstrate this capability of structure property correlation from results on the in- situ and in-operando nanomechanical and tribological testing of various engineering materials. The results will be reported and the physical insight regarding the deformation mechanisms will be discussed.

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Dr. Manish Roy
DMRL - DRDO Hyderabad, India

Tribo-corrosion Measurements for Metallic Materials

Tribo-corrosion is a form of material degradation or transformation because of synergistic effect of sliding wear and corrosion. The consequences of coupling wear and corrosion are complex [1, 2]. The extensive understanding of the tribological behavior in the absence of corrosive medium and that of the corrosion in absence of wear is not enough to extrapolate mechanisms of degradation under condition of tribo-corrosion. Friction and wear indeed modify the sensitivity of material to corrosion and conversely corrosion modifies the conditions of friction. There is synergy between wear and corrosion. The combined action of corrosion and wear often results in a significant increase in material loss that is much higher than the sum of the individual contribution of wear and corrosion. Many engineering components are subjected to tribo-corrosion such as mining equipment, food processing devices, biomedical implants, chemo-mechanical polishing etc.

In this presentation, various test techniques for evaluating the tribo-corrosion response of metallic materials, advantages disadvantages of various techniques will be presented along with some recent results as shown in Fig. 1. Ways of separating contribution of pure corrosion, pure wear, corrosion enhanced wear and wear enhanced corrosion will be discussed with examples. Critical issues for tribo-corrosion experiments will be elaborated.

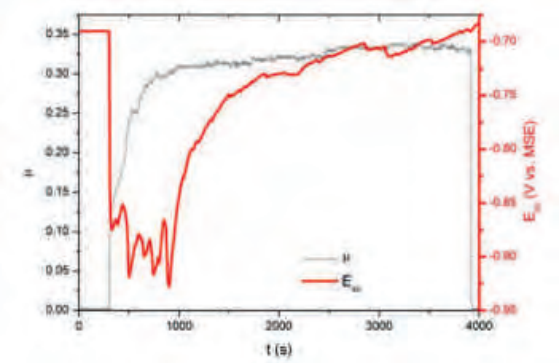

Fig. 1: Evolution of the coefficient of friction and the open circuit potential during sliding tribo corrosion experiments at E_{oc}.

KEY WORDS: Tribo-corrosion, wear, corrosion.

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Dr. Om Prakash Khatri
IIP Dehradun, India

Graphene Thin Film Lubrication

High friction and wear are accountable for energy wastage and material losses. The lubrication of engineering surfaces is the most effective way to reduce friction and wear. Over the last few years, nanostructured layered materials viz. graphene, *h*-BN, MoS_2, WS_2 have shown considerable interest as lubricant additives and lubricious thin films for enhancement of tribological properties. Herein, graphene-based materials would be addressed as dispersible additives to liquid lubricants for the reduction in friction and wear. The spectroscopic and microscopic results of contact interfaces will be discussed to reveal the nature of the tribo-thin film being deposited during the tribo-tests and emphasize the role of graphene for enhancement of tribological properties. The tribological results of the self-assembled thin films of graphene oxide on a silicon surface *via* covalent interaction will be presented. The self-assembled graphene thin film with ultralow thickness showed significantly low and steady friction compared to that of bare silicon surface and exhibited remarkable wear-resistivity.

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Prof. NityaNand Gosvami
IIT Delhi, India

In Situ study of antiwear tribofilm growth on Lightweight Alloys

Prashant Mittal[1], Deepak Kumar, Jayant Jain[1], and Nitya Nand Gosvami[1*]
[1]Department of Materials Science and Engineering, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016, India

Growth mechanisms of antiweartri bofilms derived from zincdialkyldithio phosphate (ZDDP) additives on lightweight metal surfaces are of great importance to find replacement of ferrous engine components, which can improve energy efficiency substantially [1]. However, due to the complex nature of the sliding interface in macroscale tests, questions remain regarding the nature of ZDDP interactions with such materials [2]. Iron and several other elements have been proposed to catalyze ZDDP tribofilm growth via the hard and soft acid base (HSAB) reaction model; in contrast, the model predicts no growth on aluminum (Al) [3]. Indeed, several macroscale studies have shown a lack of ZDDP tribofilm growth on Al- and magnesium (Mg)-based alloys, and the reasons for this are actively debated [4].

We use a novel *in situ* atomic force microscopy (AFM) technique [5] to study the growth of ZDDP tribofilms on Al-Si (ADC12) and Mg alloy (AZ91) against alumina countersurfaces. We show that tribofilm grows with sliding time at high temperature (110°C) and contact pressure over Al-matrix and Si-phase of the ADC12 substrate but more densely on harder phase (Si) due to higher contact stresses. Similarly, for as cast Mg alloy (AZ91), the tribofilm preferentially grows on harder $Mg_{17}Al_{12}$ precipitates and the softer matrix undergoes wear. However, aged AZ91, with finer precipitates, does not show tribofilm growth, revealing critical role of microstructure on tribochemical reactions.

Our study unambiguously highlights the critical role of stress, thermal activation and local microstructure on ZDDP tribofilm growth, and demonstrates that the presence of iron is not necessary.

KEY WORDS: Max of six key words separated by a ';'Zinc dialkyldithio phosphates (ZDDP), lightweight alloys, boundary lubrication, antiweartribo films, atomic force microscopy

Prof. Jayadas N H
University of Science and Technology, Kerala, India

SCREENING AND EVALUATION OF NATURAL OILS FOR INDUSTRIAL APPLICATION BY QUANTITIVE STRUCTURE-PROPERTY RELATIONS (QSPR) TECHNIQUES.

Bio-based materials like natural oils are increasingly being used for industrial applications because of their better environmental characteristics [1]. India has rich biodiversity and is home to many unique plant varieties. Oils from the seeds of many such plants are traditionally being used for applications like lighting, pest repellants, antiseptic and other medicinal purposes. To evaluate such oils for industrial applications such as lubricants require a lot of time-consuming and costly tests [2]. QSPR techniques offer an alternative inexpensive and fast method to screen and evaluate such oils for specific applications [3-6]. In this paper, the efficacy of chaulmoogra oil, a non-edible vegetable oil, as an environment-friendly base stock for lubricants is evaluated by QSPR techniques, and the results are compared with experimental values. Chaulmoogra oil is a non-edible oil extracted from the seeds of the chaulmoogra tree (Hydnocarpus Wightianus). It has a unique long-chain cyclic fatty acid composition with chaulmoogric acid, hydnocarpic acid, and gorlic acid. Fatty acid composition determines the bulk properties of vegetable oils. QSPR methods are used to predict the properties of chaulmugra oil, like viscosity, viscosity index, flash and fire points, thermal/oxidative properties, cold flow properties, and tribological properties. For QSPR predictions, free software like GROMAC, LAMMPS, GAMESS, etc. are used. The predicted values showed good agreement with experimentally determined values. The results strongly suggest that environmental advantage, coupled with non-edible nature makes chaulmoogra oil excellent base stock for lubricants

KEY WORDS: Base stocks; natural oil; QSPR; chaulmoogra oil

Dr. Shaju K. Albert
Indira Gandhi Centre for Atomic Research, INDIA

TRIBOLOGY FOR FAST BREEDER REACTOR SYSTEMS

S.K. Albert[1*], Hemant Kumar[1], Gopa Chakraborty[1], Utpal Borah[1], S. Nignshen[1] and B.K. Sreedhar[2]

[1]Metallurgy & Materials Group,[2]Reactor Design and Technology Group
Indira Gandhi Centre for Atomic Research Kalpakkam 603102, INDIA

Use of liquid sodium for heat transport in Fast Breeder Reactors (FBRs) introduces some unique tribological issues in reactor operation. Reactive sodium removes oxide films present on the surfaces of components immersed in liquid sodium making the mating surfaces of these components prone to self-welding and galling. Hence, for many reactor components which are in contact with each other, either one or both the mating surfaces are hard-faced using Ni base hard facing alloy, Colmonoy. Hence, a systematic study of wear and friction properties of this class of alloys has been carried out in flowing sodium using an indigenously developed in-sodium Tribometer. It is found that friction coefficient of Colmonoyhard-faced deposit in flowing sodium is significantly lower than that of the austenitic stainless the major structure material used in FBRs.

Another aspect studies in flowing sodium is the cavitation erosion of structural materials and hard acing alloys in flowing sodium. In an indigenously developed vibration cavitation test facility, vibration was generated using ultrasonic transducers. Results revealed the benefits of hard facing in improving the resistance to cavitation for the exposed surfaces.

Dilution from the substrate materials significantly affects the hardness of the hard-facing alloys. Hence a systematic study was also conducted on effect of dilution from austenitic stainless-steel base metal on wear and friction properties of this alloy. It is shown that deterioration in tribological properties with dilution is not as significant as reduction in hardness with increasing dilution.

Wear tests were also conducted for other applications for FBRs. For India's Prototype Fast Breeder Reactors, selection of coatings for rubber seals used in the rotating plugs was made

based on the wear tests conducted on seal materials with different type of coatings; PTFE and MoS_2 and PTFE was chosen based on better wear and frictional properties than that of the other. Another interesting study carried out is for the selection reinforcement for the rubber wheels used in the in-service-inspection vehicle for the reactor. Various bearing materials such as AISI 52100 and 440C have been characterized at room temperature, and at elevated temperatures for their tribological properties. Various bearing materials such as AISI 52100 and 440C have been characterized at room temperature, and at elevated temperatures for their tribological properties.

In nuclear reprocessing plants, which use nitric acid for dissolution of the fuel for further processing, tribocorrosion is an important aspect. Growth of a passive film on surface provides protection against corrosion, while wear destroy the protective passive film. Passive materials like type 304L stainless steel (SS), Zirconium-702, Zircaloy-4 and Titanium-grade2, potential materials being considered for reprocessing applications, exhibit an active-passive behavior in an aqueous environment. Tribocorrosion experiments were performed on these materials using a pin on disc system with tribocorrosion setup. The results revealed that the wear rate is lower for 304L SS than for Zircaloy-4, Zr-702 and Ti-grade2. The synergistic effect of wear and corrosion is more pronounced in Ti and Zr based materials than 304L SS.

This paper will cover major activities currently in progress at IGCAR in the area of tribology with their relevance to Fast Breeder Reactor and Re processing systems.

KEY WORDS: FBRs, Colmonoys, In-sodium Tribology, Tribocorrosion

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Prof. M F Wani
NIT Srinagar, India

TRIBOLOGICAL BEHAVIOUR OF MATERIALS AT HIGH TEMPERATURE

Materials used for design and fabrication of parts of internal combustion engines, bearings in aerospace propulsion systems, cutting tools and metal-working processes are subjected to high temperature environments at operational stage. Various research studies have been carried out to understand the friction, wear and lubrication behaviour of materials at high temperature. Tribological behaviour of super-alloys (Nimonic 80A and Nimonic 90 sliding against Nimonic 75) was studied up to 750 ^{o}C. A decreasing trend in friction (0.94-0.27 for N80A and 0.90-0.58 for N90) was observed with increase in temperature, which is attributed to the formation of glossy tribo-layers, further absence of oxide debris at room temperature resulted in severe delamination wear. For Ti-6Al-4V/Si_3N_4 and Ti-6Al-4V/Al_2O_3, it was observed that minimum coefficient of friction (0.4) and wear rate (22.37 X 10^{-6} mm^3/Nm) was attained for Ti-6Al-4V/Al_2O_3 tribo-pair at 400^{o}C. In case of N 80A and 21-4N valve materials sliding against ductile cast iron GGG-40 seat material up to 500 ^{o}C, it was observed that 21-4N exhibits better wear resistance (K_w = 2.2006 X 10^{-5}) and lower coefficient of friction (0.10) at all temperatures under dry sliding conditions. Formation of glaze layers at higher temperatures leads to lowering of friction coefficient and a reduced wear rate. At temperature of 250 ^{o}C, GNP lubricated Al-25Si/Steel tribo-pair, revealed that the addition of GNP to the base oil resulted in lower coefficient of friction (0.415-0.326) and wear rate (0.07 X 10^{-12} m^3/m), as compared to non-lubricated contact and lubrication by PAO.

KEY WORDS: Tribo-layers, Lubrication, Oxidation, High Temperature

Prof. Gnanamoorthy
IIT Madras, India

THERMO TRIBO CHARACTERISTICS OF SELECTIVE REINFORCED LATTICE STRUCTURE POLYESTER MATRIX COMPOSITES

R Gnanamoorthy[1] and C Gurunathan[2]
[1]Department of Mechanical Engineering, Indian Institute of Technology Madras, Chennai, India
[2]Department of Mechanical Engineering, Indian Institute of Information Technology Design and Manuacturing, IIITDM Kamcheepuram, Chennai, India

Advanced polymer matrix composites find increasing application due to their light weight, self-lubricating properties and ease of fabrication into a complex shaped part compared to metals. However, their application is restricted to light-duty power transmission due to the deterioration of mechanical properties because of heat accumulated during service. The heat generated during service in machine elements such as bushes, gears etc., is not dissipated in polymer matrix composites due to the poor thermal conductivity. A novel approach that will be useful to design machine elements using lattice or network structure reinforced polymer matrix composites is attempted in the current research work. The finite element analysis was performed to understand the transient heat conduction behaviour of proposed selective-reinforcement concept. Various geometries of reinforcement such as particle, short fibre and network, are analysed and the heat accumulation at the contact surface are reported for different material combination. The finite element analysis carried out reveals that the presence of three-dimensional continuity in the nature-inspired reinforcement form significantly reduces the surface temperature and uniformly dissipates the heat. The detailed study made on the network-reinforcement reveals that the cell size has significant influence in reducing the surface temperature compared to the relative density of the porous/cellular material. Experimental studies to understand the tribo characteristics using pin-on-disc tribometer were conducted with the selectively reinforced network composites and tests conducted revealed the reduction in the heat accumulated in the network-reinforced polymer composites. The friction and wear behaviour of neat, particle and network reinforced polymer matrix composites are also discussed.

KEY WORDS: Lattice Structure Composites; Polymer Matrix; Frictional Heating; Tribo behavior;

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Prof. Jayashree Bijwe
IIT Delhi, India

Synergism in functioning of Nano-particles as additives in Nano-oils

Research on new additives as extreme pressure additives (EPA) anti-wear additives (AWA) and anti-friction additives (AFA) in last decade was dominated by exploration of number of new Nano-particles (NPs), their amounts, sizes and shapes etc. The major focus was always ontrying new NPs and then their amount along with optimization of type and amount for the best possible improvement in the selected properties of Nano-oils/Nano- lubricants rather than their shape and size. Few efforts are also put on functionalization of NPs to enhance their potential in oils. This led to a significant increase in several publications in this area. Unfortunately, few important aspects such as systematic process of developing Nano-suspensions in true sense, their stability for a longer time and extent of losses in efficiency with time are not addressed adequately. Another important aspect of exploration of combination of NPs in right amount for synergism in action is hardly explored by the researchers and hence calls for attention.

The current research highlights this aspect by considering group III oil as a base oil and using combinations of NPs such as PTFE (polytetrafluoroethylene) and hBN (hexa-boron nitride); PTFE and graphite by varying wt. % (keeping total amount of NPs constant- 4 wt. %) along with dispersant. The synergism in EP and AW properties was observed in case of typical ratio of two types of particles by gaining highest value of improvement as compared to the parent NPs in isolation. The excellent quality of co-transfer of film by two types of NPs when came together in typical amounts was found to be the reason behind it.

Prof. Janakarajan Ramkumar
IIT Kanpur, India

PROTECTIVE TRIVALENT CHROMIUM BASED ELECTROCHEMICAL COMPOSITE COATINGS FOR GUN BARRELS

Pragya Tripathi[1], Janakarajan Ramkumar[1,2] and Kantesh Balani[3*]
[1]Materials Science Program Indian Institute of Technology, Kanpur, 208016, India
[2]Department of Mechanical Engineering Indian Institute of Technology, Kanpur, 208016, India
[3]Department of Materials Science and Engineering Indian Institute of Technology, Kanpur, 208016, India

Firearms operated by military are exposed to high temperatures (~ 3700 K) and pressures (~700 MPa) due to repeated firing rounds leading to wear of gun barrels. With an unremitting demand for increased lethality (muzzle velocities as high as 1700 m/s are required) of weapons, mandated over the period of time, development of ultra-high wear resistant and thermal resistant protective coatings with good mechanical properties. Coatings consisting of Cr, Cr-YSZ, Cr-CNT and Cr-YSZ-CNT were electro-co-deposited from environment friendly Cr (III) solution on steel substrate, so as to replace traditionally used toxic Cr (VI) bath. However, Cr (III) based coatings possess lower wear and corrosion resistance as compared to Cr (VI) based coatings, moreover, as deposited coatings contain micro-cracks. The focus of this work is to understand influence of yttria stabilized zirconia (YSZ) and carbon nanotubes (CNT) reinforcements on microstructural-, mechanical-, and tribological-performance of Cr (III) based composite electrochemical coatings.

Composite Cr coatings have shown an improvement in wear performance with respect to Cr coating, with reduced wear rate of ~ 4.2×10^{-11} for Cr-YSZ, 3.810^{-11} m^3/Nm for Cr-CNT and minimum of ~310^{-11} m^3/Nm exhibited by Cr-YSZ-CNT. Increase in hardness value ranging between ~10-26 GPa was also observed (~8 GPa for Cr) which may be ascribed to increased compressive residual stresses (~500-900 MPa) as a result of reinforcement. Further, electrochemical behavior and effect of laser peening on coatings revealed an improvement in wear resistance after laser peening with maximum for Cr-YSZ-CNT which might be ascribed to large residual stresses (~ -1757 MPa) introduced as a result of peening as well as high elastic recovery of ~62%. Highest corrosion resistance of ~3.9 $k\Omega cm^2$ was obtained by synergistic incorporation of YSZ and CNT in Cr-YSZ-CNT coating which might be assigned

to chemical stability imparted by inert YSZ. CNT incorporation also tends to fill up the defects and micro-holes on the surface of metal which might otherwise act as active sites for Cr dissolution.

Synergistic role of YSZ and CNT in Cr matrix leads to hardening as well as formation of lubrication reservoirs under the indenter due to presence of CNTs. Moreover, presence of chemically stable reinforcements, YSZ and CNT, act as physical barriers inhibiting localization of corrosion. Thus, with enhanced micro-hardness (~25 GPa), low coefficient of friction (~0.13), high wear and corrosion resistance, Cr-YSZ-CNT coating can be successfully applied to automotive, aerospace, defense, marine and various other industries in order to protect the vital components exposed to wear conditions and corrosive media.

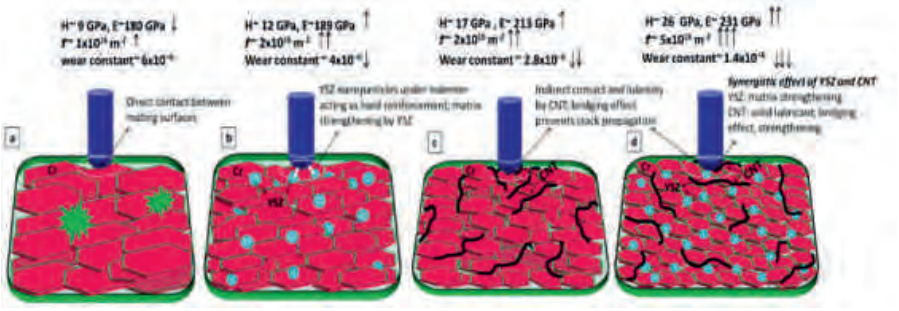

Fig: Schematic representing tribological behavior of (a) Cr, (B) Cr-YSZ, (c) Cr-CNT and (d) Cr-YSZ-CNT.

Prof. P.K. Rajendrakumar
NIT Calicut, India

MICRO AND NANOPARTICLES BLENDED SESAME OIL BIO-LUBRICANT: STUDY OF ITS TRIBOLOGICAL AND RHEOLOGICAL PROPERTIES

Rajendrakumar, P.K.*, Sabarinath, S. and Prabhakaran Nair, K.
Department of Mechanical Engineering, National Institute of Technology, Calicut-673601, Kerala, India

Non-renewability, depleting resources and damage caused to the environment by mineral oil-based lubricants are the greatest concerns of this century [1]. Recently, these issues have triggered a global trend to use vegetable oil-based lubricants in industries. Sesame oil (SESO) extracted from sesame (Sesamum indicum) possesses distinctive characteristics such as low pour point and reasonable oxidation stability [2]. However, the poor tribological properties of SESO limit its application as an industrial grade bio-lubricant. The present work encompasses blending of micro and nanoparticles in SESO so as to enhance its tribological properties to suit many industrial applications. Nanoparticles having difference in morphology such as spherical-shaped titanium dioxide (TiO_2) and rod-shaped zinc oxide (ZnO) have been used [3]. The significance of adding microparticles is also dealt with, by using molybdenum disulphide (MoS_2). To reduce the agglomeration of microparticles as well as nanoparticles, sorbitan monooleate (span 80) is used as the surfactant. Tribological properties of the above-formulated lubricants with and without surfactant addition are studied using a four-ball tester. The rheological properties of the oil blends are examined using a rheometer. Worn out portions of the ball specimens and the morphology of nanoparticles are imaged using a field emission scanning electron microscope (FESEM). With the addition of nanoparticles to SESO, improvement of wear resistance has been observed. This might be due to the rolling and/or mending effect produced by these nanoparticles between the contact surfaces [4]. Rod-shaped ZnO blended SESO reduced the coefficient of friction and wear scar diameter by 24.04% and 13.74%, respectively. It has also been revealed that rod-shaped nanoparticles are more effective in enhancing tribological properties than the spherical-shaped ones.

KEY WORDS: Sesame oil, bio-lubricant, nanoparticles, tribological properties

Dr. Barun Chakrabarti
General Manager & SME –Asset Integrity Management
L&T Hydrocarbon Engineering Limited, Mumbai (India)

MACHINERY DIAGNOSTICS IN THE DIGITAL AGE : ENRICHING DOMAIN EXPERTISE WITH "SMART" SOLUTIONS

Machinery troubleshooting and fault diagnostic practices have evolved over the years, moving from traditional time-scheduled maintenance to condition-based maintenance to predictive/prescriptive solutions. Determining the integrity of plant assets over their life cycle has become very critical today. To fulfill this objective, the role of domain experts has also become very challenging in terms of data and information to be processed, promptness required in taking key decisions and avoiding errors in judgement or subjective bias. Since such decisions by experts can have far-reaching implications for the industry, the move towards adopting Digital technologies, by way of IIoT enablement, became almost a foregone conclusion. This talk outlines the on-going Digital transformation in the field of machinery diagnostics. Use of Digital tools and artificial agents vis-à-vis depending on human experts throws up its own interesting debate, which is briefly addressed. The paper includes a few real-life cases on diagnostics. The traditional approach to solve such cases is compared with how "Intelligent" or "Smart" tools can be applied. Application of Artificial Intelligence / Machine Learning (AI / ML) technologies will have far-reaching implications in the way process plants are designed, constructed and operated today. But acceptance of such new technologies by the process industry remains a point to reckon with. The paper concludes that the migration from the Traditional to the Digital era is inevitable. The need of the hour is to put in place a robust and sustainable Management of Change (MoC) process that can make this transformation seamless and beneficial.

KEY WORDS: Diagnostics; Digital; Asset Integrity; IIoT; AI / ML

Prof. T. V. V. L. N. Rao
SRM Institute of Science and Technology, India

DAMPING CONSTANT ANALYSIS OF PISTON-CYLINDER DASHPOT WITH HYDROMAGNETIC NEWTONIAN FLUID

T V V L N Rao[1]*, AinulAkmar Mokhtar[2], Masdi Muhammad[2] and Hamdan Haji Ya[2]
[1]Department of Mechanical Engineering, SRM Institute of Science and Technology, Kattankulathur - 603203, India
[2]Department of Mechanical Engineering, UniversitiTeknologi PETRONAS, 32610, Bandar Seri Iskandar, Perak DarulRidzuan, Malaysia

An analytical model for damping constant calculation of piston-cylinder dashpot filled with Newtonian fluid considering slip on piston and cylinder surfaces is presented. The damping constant of dashpot is determined using shear stress equation for Newtonian fluids. Governing equations of fluid flow are derived from force on piston and viscous friction force. The influence of (i) Hartmann number, (ii) nondimensional piston-cylinder clearance and (iii) reference piston-cylinder clearance to piston radius ratio on damping constant ratio of piston-cylinder dashpot are investigated. Damping constant of piston-cylinder dashpot enhances under hydromagnetic effects. The increase in damping constant ratio with Hartmann number is investigated.

KEY WORDS: Piston-cylinder dashpot; Magnetic effects; Newtonian fluid

Mr. Nirav Pancholi
SCHAEFFLER Competence Centre for Surface technology, Germany

SURFACE TECHNOLOGY AND COATING: AN EFFECTIVE TOOL TO ENHANCE PRODUCT & SYSTEM PERFORMANCE THROUGH VALUE ADDITION

Tribology is the Science and Engineering of Interacting surfaces in relative motion and where, the surface interaction involves, there, presence the phenomena of friction, wear and lubrication. The challenge is to make the surface interaction more efficient and effective by reducing the friction, preventing or minimizing the wear and modify the regime of lubrication by innovative ways which are better, faster, cheaper and have the beneficial effect as far as the entire ecological systems are concern.

KEY WORDS: “Specialized coatings”, “multifunctional coated surfaces”

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Mr. Anjeeve George
Eaton Technologies Pvt. Ltd (India)

EFFECT OF EP ADDITIVE ON WEAR RESISTANCE IN VANE PUMPS

Lots of lab scale studies are being done on tribo modified lubricants and their impact on wear protection capabilities in different lubrication conditions. Anti-wear and extreme pressure lubricants are used for applications having mixed and boundary lubrication conditions for surface protection. It is always being asked that "what will happen if a different tribo modified lubricant is used with hydraulic components?" This is a study in actual operating conditions with commercial hydraulic components to find how an extreme pressure lubricant behave in hydraulic applications. Vane pump is selected for the studies, as the contact stress is the maximum and the anti-wear requirement is the highest among other types of hydraulic pumps.The heat generated by friction is considered as the major cause of tribo-chemical reactions. The heat generated is enough for anti-wear additives, but it is not the case with EP additives. Lower concentrations of EP additive are not fully capable of protecting the component, but the increase in concentration enables the lubricant to provide full protection.

KEY WORDS: Additives, Wear Resistance

Invited Talk

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Prof. Anirudhan P.
Government Engineering College, Kozhikode, Kerala, India

AN INVESTIGATION ON THE LUBRICIOUS LAYER AT THE CUTTING TOOL-CHIP INTERFACE

Anirudhan P.1*, Biswas S K[2] and Satish V. Kailas[2]
[1]Government Engineering College, Kozhikode, Kerala, India
[2]Indian Institute of Science, Bangalore, India

During metal cutting, the lubricant fluid supplied continuously into the cutting zone is known as cutting fluid, which is meant to remove the heat generated during cutting, as well as to reduce friction at the tool-chip interface. The influence of the cutting fluid in affecting the tribology of the process is complicated. This is because there is a coupled influence between (i) the change in mechanical properties of the work-piece induced by the fluid (as it removes heat), (ii) the severity of the chip-curl affected by the fluid and (iii) the change in friction conditions between tool and chip. Friction at the tool-chip interface is conventionally assessed using the Merchant circle diagram, but the method has limitations. Usual tribological methods cannot assess the lubricity of cutting fluids because that would require the lubricant film to be developed on a freshly cut (nascent) surface. This talk would focus on an experimental facility which would realize this, by measuring friction continuously on a freshly cut surface. Chemical investigation of the tribo-film formed on the nascent surface, analyzed using XPS/ESCA, confirms the formation of a metal-carboxylate, explaining the lubricity while using an oil-in-water type cutting fluid.

KEY WORDS: Metal cutting; Tribology; Cutting Fluid; Friction; XPS

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Prof. Udaya Bhat K.
Dept. of Metallurgical and Materials Engineering, NITK Surathkal, (India)

EFFECT OF NITRIDING TEMPERATURE ON PLASMA NITRIDING OF AISI 316L STAINLESS STEELS SUBJECTED TO SEVERE SHOT PEENING

Jayalakshmi M.[a], Badekai Ramachandra Bhat[b], Suma Bhat [c], Udaya Bhat K.[d*]
[a]Doctoral student dept. of Metallurgical and Materials Engineering, [b]Professor, Dept. of Chemistry, [c]Professor (Dept of Mechanical Engg), SSE, Mukka, Srinvasanagara, [d]*Professor, Dept. of Metallurgical and Materials Engineering, NITK Surathkal, (India)

Success of peening- nitriding duplex treatment lies in the right selection of nitriding temperature. In the present study, effect of plasma nitriding temperature over the range of 300 - 500 °C is assessed on severe peened 316L stainless steel samples. Nitriding temperature of 300°C is found insufficient to produce continuous nitride layer in spite of pre-treatment; while nitriding at 500 °C resulted in the precipitation of the chromium nitride phase. Nitriding of severe peened samples at 400 °C resulted in significant improvement in case depth, without chromium nitride precipitation, compared to nitriding of unpeened samples. Hence, the study infers that, plasma nitriding temperature of 400°C is ideal for utilizing the beneficial effects of severe peening pre-treatment to enhance the nitriding kinetics.

KEY WORDS: MPlasma nitriding; surface nanocrystallization; severe shot-peening; austenitic stainless steel; martensite; shear band; diffusion; chromium nitride

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Prof. Vikas M. Phalle
Veermata Jijabai Technological Institute (VJTI) Mumbai
Maharashtra, (India)

DESIGN AND DEVELOPMENT OF HYDRODYNAMIC CONICAL JOURNAL BEARING TEST-RIG

Hydrodynamic journal bearing is most widely used bearing to support the rotating machines. Generally radial and axial loads are generated in many turbo-machines such as turbines, compressors, pumps etc. and for sustaining these types of loads normally journal and thrust bearings are employed, which happens to be expensive and space occupying. Thus, need arises to explore the feasibility of single compact size conical hydrodynamic journal bearing for replacing of two independent bearings i.e. journal and thrust in application. Conical bearings have added advantages such as; can be preloaded conveniently by adjusting the gaps and improve its performance for thrust carrying load on rotating members.

In present research work, analytical method, Design and development of experimental setup and CFD analysis have been used to investigate the performance of conical hydrodynamic journal bearing. A customized experimental set up of conical hydrodynamic journal bearing is developed to validate the numerically simulated results by experimental work on developed test-rig. Finite element method is used to solve the modified Reynolds equation in the spherical co-ordinate system for conical hydrodynamic journal bearing. The analysis is focuses on the stability of the rigid rotor-bearing system to determine the performance of bearing. Based on the investigation, it has been found that, axial and radial load carrying capability of conical journal bearing is improved with increase of semi-cone angle and aspect ratio. All numerically computed results and experimental work on test-rig in this parametric study are useful for academician, research scholar and bearing designer.

KEY WORDS: Hydrodynamic, Conical Bearing, Experimental work

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Dr. V. Chaudhry
NPCL, Mumbai (India)

WEAR, FATIGUE AND FRACTURE UNDER CONTROLLED ENVIRONMENT CONDITIONS

V. Chaudhry*, Satish V. Kailas
*Nuclear Power Corporation of India Ltd., Mumbai (India)

Evaluation or quantification of mechanics and mechanisms involved in the surface degradation under fretting condition remains a challenge. Small amplitude oscillations induce surface degradation in the form of material wear and/or nucleation of surface crack, and propagation of surface cracks. In order to study the synergies of wear, fatigue and fracture phenomena, experimental and analytical studies have been carried out under controlled environment conditions. Different fretting regimes have been simulated under ambient and vacuum (10-9MPa), and temperature up to 400oC. Studies have been carried out with stainless steel spheres on a stainless-steel flat, and stainless-steel sphere against chromium carbide (25% nickel chrome binder) coatings. Mechanical responses are correlated with the damage observed. It has been observed that adhesion plays a vital role in material degradation process, and its effectiveness depends on mechanical variables such as normal load, interfacial tangential displacement, characteristics of the contacting bodies and most importantly on the environment conditions. Numerical techniques have been used to evaluate the stress field simulating the test conditions. For ductile materials, studies reveal that material degradation involves severe plastic deformation, which results in the initiation or nucleation of surface cracks. Ratcheting has been observed as the governing damage mode for crack nucleation under cyclic tangential loading condition. Further, propagation of the cracks has been observed under fatigue and their orientation has been observed to be governed by the contact conditions prevailing at the contact interface. It is observed that the propagation of the crack is controlled by normalized strain energy release rate. Change in the damage mechanism from fatigue to metal flow has been observed as the temperature increases. Coated surfaces show damage in the form of brittle fracture and spalling of the coatings. Chromium carbide with 25% nickel chrome binder coatings using high-velocity oxy-fuel process on stainless steel shows less fretting damage and can be considered as an effective palliative against fretting damage, even under high vacuum and high temperature conditions.

KEY WORDS: Wear, Fatigue, Fracture

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Prof. D. Devaprakasam
VIT Chennai India

SCIENCE OF ADAPTIVE CONTACT: A NEW TOOL TO CONTROL FRICTION AND ADHESION

In nature, pervasive presence of electromagnetic fields and the fluctuations of these fields at the quantum and the continuum levels become the genesis of forces between atoms, molecules and solid surfaces. These natural forces induce attraction and repulsion between quantum objects and continuum objects and which in turn causes elastic strain, plastic strain, and deformation in them. The contacting processes between them are energy-intensive; thermodynamically they are either rexothermic or endothermic. In living systems, the contacting process is optimized; Animals andplants achieve adaptive contact by optimizing the contact area and contact pressure that minimizes the energy involved in the process, which in turn control friction and adhesion at theirwill. However, to achieve such a robust adaptive contact poses a greater challenge to engineers and scientists. It is a quest to have adaptive contacts to achieve adaptive friction and adhesion in engineering applications. Since both friction and adhesion are interdependent and their interdependency changes quantitatively from nanoscale to macro scale. Therefore, achieving adaptive contact and well-tuned adaptive friction and adhesion is challenging. When two surfaces close to each other in the order of nm to 100 nm, the van der Waals (vdW) forces are dominant and exert vdW the pressure between the surfaces. The vdW force and pressure between the interacting surfaces can be manipulated by switching Hamaker constant (A) from positive to negative. Since Hamaker constant is a function of dielectric constants of the interacting surfaces(ε_1, ε_2, ε_3) and frequency of pervasive electromagnetic field between them. In order tounderstand and achieve adaptive contacts, we analyzed manifold of theoretical models and experimental investigations of quantum to the continuum scale. Based on the new theoretical and empirical models, achieving adaptive friction and adhesion will be demonstrated which includes cases of gecko adhesion and stability of nanocracks. In this talk, we further discuss theoptimized energy scales and length scales of adaptive contacts and methods to achieve adaptive friction and adhesion.

KEY WORDS: Adaptive Contact, Friction, Adhesion, van der Waals interactions, Hamaker constant

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Prof. Satish C Sharma
IIT Roorkee, India

TEXTURED SURFACE HYDROSTATIC / HYBRID FLUID FILM BEARINGS

For past few decades, it has been widely recognized that the textured bearing surfaces have a strong influence on the tribological performance of lubricated contacts. The use of textured surface has been found to be more demanding due to its advantageous features such as low friction coefficient and supporting heavy load simultaneously. The performance of tribo-contacts depends on the geometric features of textured surface such as orientation, size, shapes and density of texture pattern. Since, majority of studies in the field of surface texturing are limited to hydrodynamic fluid film bearings; therefore, this presentation is aimed to outline the research efforts undertaken so far in the area of hydrostatic / hybrid bearings and to present some salient findings of textured surface in these class of bearings. To get the solution of textured bearing surfaces, the numerical solution of modified Reynolds equation is obtained using Finite Element Method by taking the flow of lubricant through restrictor as constraint along with JFO/Reynolds boundary condition for cavitation in textured bearing. Newton-Raphson method is used to solve the non-linear system of equation generated due to restrictor equation and different non-Newtonian lubricants. Use of textured surfaces have been reported to enhance the efficiency of fluid film bearings by improving the load carrying capacity and reducing the friction between the sliding surfaces. Partial texturing is effective in enhancing the performance of fluid film bearings from view point of friction and load carrying capacity. The optimum bearing performance can be determined by selecting optimum texture dimensions.

KEY WORDS: Surface Texture; Hydrostatic/ Hybrid bearings; FEM; Journal bearing

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Dr. Amitabh K Jain
Hindustan Petroleum Corporation Limited, R&D center, Navi Mumbai

ENGINE OIL ADDITIVE PACKAGES – TRIBOMETERS AS SLECTION AND DIFFERENTIATION TOOL

Aradhana Tripathi, Vijaya B Baskar, Atul S Jaywant, Tarun Sharma, M Panda and Amitabh K Jain*
*Hindustan Petroleum Corporation Limited, R&D center, Navi Mumbai

Engine oils available in world market are mostly accepted basis the American Petroleum Institute (API) and/or European Automobile Manufacturer Association (ACEA) formulated specifications. Four chemical technology companies supply additives to oil companies duly supported with expensive fired engine test data as per requirements. Hence, all oils may look same, so it is essential for oil marketers to differentiate their products and select the best for getting new customer and retention of existing ones. In order to select the best additive systems and components, oil companies run field trials with OEM's and customers, which is a time consuming, laborious and expensive process. Utilizing laboratory bench tests, Pin-on-Disk, High Frequency Reciprocating Rig (HFRR), Block-on-Ring, Mini-Traction Machine (MTM), oils/additives of same viscometrics and same performance levels were evaluated to differentiate and select the best for our products without getting into field trials and expensive engine tests. Past field data was used to validate the findings of tribology tests. The four additives meeting API SN SAE 0W 20 oils evaluated had similar chemistries for EP/anti-wear performance. The coefficient of friction, wear scar depths, film forming abilities were found to be different in the tests performed. The trends clearly established superiority of one additive over others in parameters tested. Probably the chemistry of other ingredients had influenced the synergism on performance in frictional behavior. The additive system thus chosen, and an oil blended with it has shown 2.7% higher fuel efficiency than the recommended oil in real engine test.The use of tribology tests as a pre-screener for oil companies can help choosing the right additive for their market claims and save upon costs for validation.

KEY WORDS: Engine oil, Additives, Tribo testing, Friction, Lubrication

Prof. Mayank Tiwari
IIT Patna, India

WEAR EVOLUTION WITH OPERATIONAL CYCLES

Deepak Kumar Prajapati[1], Krishnamurti Singh[1], Mayank Tiwari[1]*
[1*]Department of Mechanical Engineering, IIT Patna

High power density (power throughput/ weight) machines (such as wind turbines, OHV's, mining equipment's etc.) frequently fail due to asperity interactions when subjected to rolling/sliding or oscillatory types of motion. It is difficult to track the change in surface topographies (contact pressure, contact area, asperity radius) during relative motion of solid components. The objective of the work being done is to reveal the dependency of wear mechanisms with progressive increase in operational cycles[1]. Interfacial phenomenon such as adhesion, friction, rolling contact fatigue, fretting fatigue and fatigue resistance are affected by surface topography. Characterization of surface topography is an essential step for designing tribological components which can be done by using statistical and fractal methodologies [2]. In the statistical method, most of the topography parameters are determined by utilizing statistical data of roughness heights. In fractal method, topography parameters are solely calculated by utilizing power spectral density of the rough surfaces. For better understanding of fractal geometry, it is important to develop a method for determining the applicability of fractal theory. A relation between surface roughness and fractal signature establishes a basis for developing more advance surface characterization methods. Thorough study under rolling sliding conditions, of the effect of surface topography on contact characteristics, mixed-EHL traction coefficient [3,4], and wear reveals that topography parameters can be successfully correlated with wear mechanisms and their transient evolution provide in-depth understanding on performance of the components. Similarly, for fretting motion, wear mechanism and friction characteristics are different in each regimes of fretting wear [5]. The transition of fretting regimes with time may cause premature failure of the components. Therefore, a basic understanding of the characteristics of fretting wear regimes and its transition with time should be of value in controlling the fretting wear at metal interfaces, and in designing engineering components.

KEY WORDS: Surface Topography, Wear, Mixed Lubrication, Fretting, Rolling-Sliding

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Dr. Gopakumar Parameswaran
3M (Mechanical or Industrial Engineering)
Bengaluru, Karnataka (India)

ACHIEVING EXTREMELY LOW SLIDING FRICTION IN SPARSELY LUBRICATED AL-STEEL TRIBO-SYSTEM THROUGH CONTROLLED MICRO-TOPOGRAPHY OF THE STEEL COUNTER SURFACE

While studying the effect of surface topographies on reducing the average coefficient of sliding friction in an Al-Steel tribo-system, results suggested an extraordinary preference for certain topographies which were not necessarily smoother or rougher than those of other specimens. These surface topographies were created on a lab scale table grinder using coated abrasive sheets on Steel specimens; friction at surface contacts of the Aluminum Pin was tested on a reciprocating tribometer having a velocity profile of a scotch yoke follower mechanism. These topographies were found to interact in a tribo-system with the sliding velocity and the base oil viscosity and generated frictional force plots, some of which were significantly different from those predicted by classical Stribeck principles. Specific three-dimensional areal surface parameters derived from the areal material ratio curve were established using a 3D optical profilometer. Surface parameters pertaining to the area occupied by the peaks in relation to the core surface area were found to predict the shape of the frictional force plots in this tribo-system. The influence of the micro-topography of hard contacting surfaces on the topography evolution of the soft counter surface during sliding will be shown. Physical tribo-films formed from boundary layer additives were used to find the effect of topography modification and tribofilm formation at the contact zone during sliding; these features, along with the influence of speed of reciprocation and wear debris on frictional force plots will be discussed in conjunction with the reasons for the departure from the expected Stribeck principles.

KEY WORDS: Sliding Friction, Lubrication


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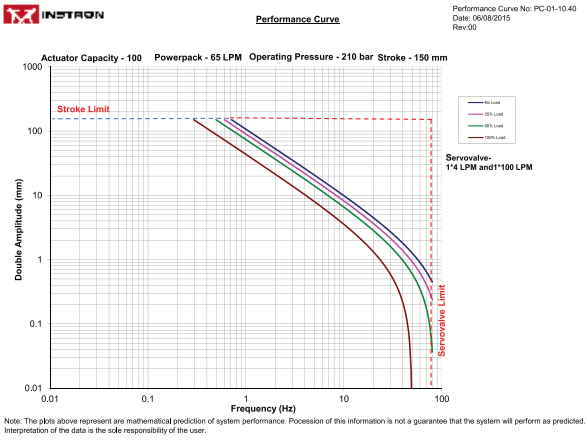

Worldwide Headquarters
825 University Ave, Norwood, MA 02062-2643, USA
Tel: +1 800 564 8378 or +1 781 575 5000

India Headquarters
No. 497E, 14th Cross, 4th Phase, PIA, Bangalore – 560 058, India
Tel: +91 (80) 28360184

KiPro Technologies Private Limited

HO: 515, Vipul Trade Centre, Sector 48,
Gurugram, Haryana -122101, INDIA
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Note

Note

Note

Dr. Arun Kumar Sikder
SABIC Research & Technology Pvt. Ltd, India

EFFECT OF TIP SIZE AND EXPERIMENTAL CONDITIONS ON NANO-SCALE FRICTION TESTING

Assessment of Nano-tribological properties (friction and wear) on polymer surface helps to understand their scratch, mar and wear properties. More polymers are used now for automotive, electronics, appliances, and building and constructions industries due to aesthetics and design freedom. Owing to their lower mechanical properties, polymers are vulnerable to surface damage and deteriorate their morphology, functionality, and aesthetics with time. Understanding surface friction and their dependence on the testing parameters and tip geometry is important for polymer surface characterization.

Usually adhesive behavior between the tip and substrate significantly affect the polymer scratch, mar and wear properties. In this study, Nano-indenter was used for measuring friction and wear properties varying test parameters and indenter tips. A Berkovich tip (B-tip) with radius of ~50 nm and a conical tip (C-tip) with 60° cone angle and tip radius of 1000 nm were used. Poly Oxy methyl (POM) with additives were chosen for friction testing. Higher coefficient of friction (COF) for C-tip was observed compared to B-tip and this explained based on the higher tip-material interactional area for C-tip. COF was decreased with higher additive concentration and same trend was followed for wear depth for the B-tip. For C-tip, COF was increased with the testing loads and corresponding wear depth were higher for higher load. Change of COF with test velocity was not showing any specific trend. Shallow wear depth using B-tip compared to C-tip may be better for probing top surface of the materials.

Nano-scale tribo-mechanical evaluation techniques are uniquely suited for fundamental understanding and screening many additives quickly. Observed wear properties not only depend on the additives added to the formulation but may also get influenced by the geometry of the tip.

KEY WORDS: Nano-scratch; Friction; wear resistant polymer; Nano-tribology; Berkovich tip; Wear track

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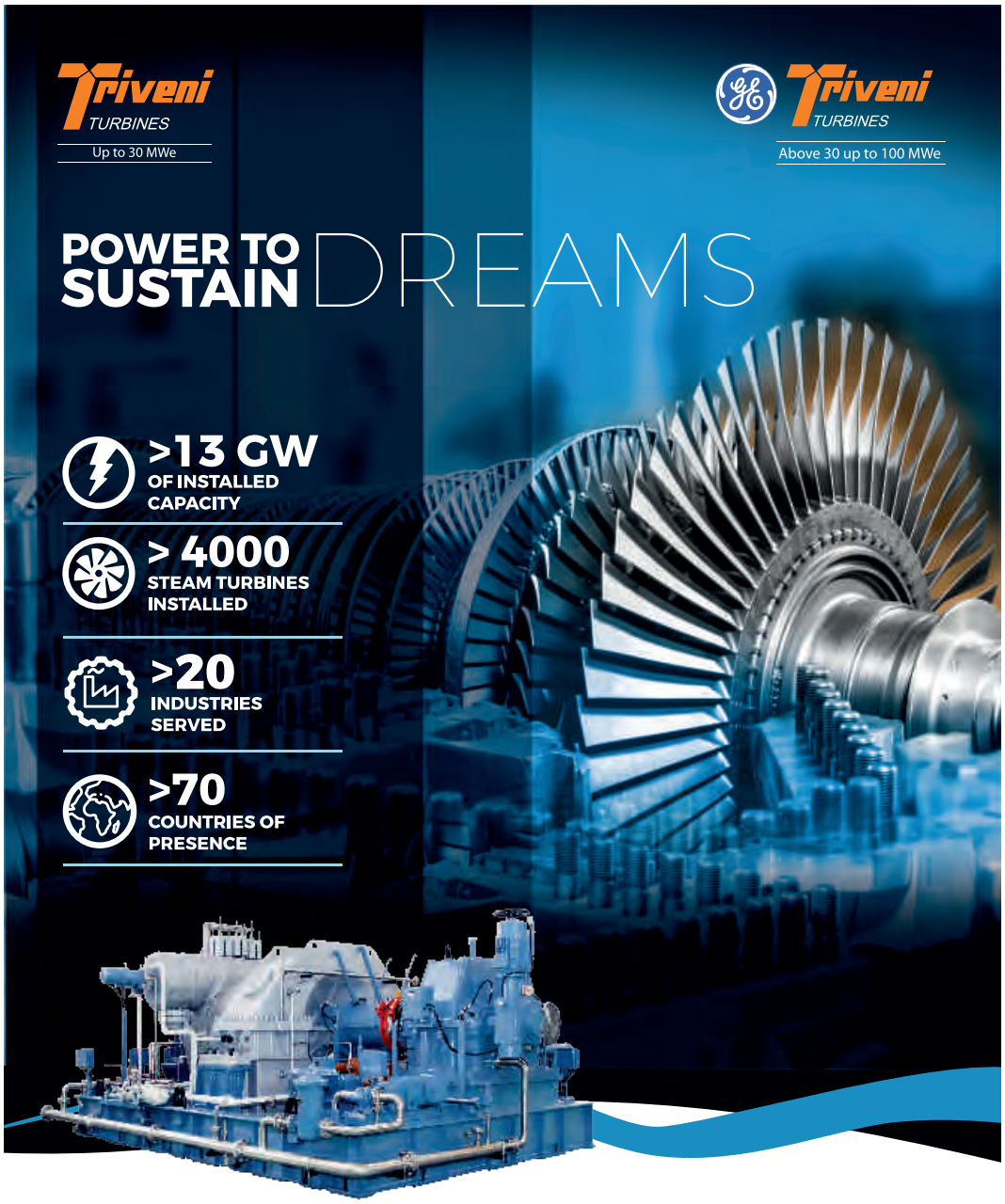

Contact Us

12-A Peenya Industrial Area, Phase 1, Bengaluru 560058, Karnataka, India
Email: mktg@triveniturbines.com, Phone: +91 80 22164000 Fax: +91 80 22164100

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