REPORT

Gujarat Technological University

organized

ICATES

INTERNATIONAL CONFERENCE ON ADVANCES IN TRIBOLOGY & ENGINEERING SYSTEMS

in collaboration with

L. D. College of Engineering,
Ahmedabad, Gujarat, India.

15-16-17 October, 2013

Our sincere thanks to :
Gujarat Council on Science & Technology
GUJCOST

Venue :
Gujarat Technological University, Chandkheda, Ahmedabad (Gujarat), India.

About:

This international conference is shortly popular as ICATES. The preparation of this conference was started in December 2012 under the kind guidance of Hon. Vice Chancellor, Gujarat Technological University and Principal, L D College of Engineering. This programme was announced and admin by the website www.icates2013.com and announced in website of GTU, LDCE, Tribology Society of India and Tribology conferences. Dr. Akshai Aggarwal, Hon. Vice Chancellor as Patron, Dr. M. N. Patel, Principal, LDCE as Chairman, and Dr, H. C. Patel, Associate Professor, LDCE as Coordinator have contributed in Steering Committee. Dr. H. S. Patel, Principal, GEC Patan and Dr. S. M. Mehta have also work as coordinators in Steering Committee. The international advisory committee, review committee, state advisory committee, website committee and committee of editors formed in favour of ICATES. The well-known and eminent experts from Europe, China and India have contributed in this conference. This programme was proposed with only 36 papers and in totals 60 authors/participants and later it was extending for more participants in benefit of PG students and faculties. The last date of acceptance of extended abstracts was set 30th June for peer review process. We received 77 extended abstracts and after review process we had sent 44 papers to Springer for the publication of Conference Proceeding. The pre conference seminars in different zones of Gujarat State was arranged as per the direction of Dr. Akshai Aggarwal, Hon. Vice Chancellor (Patron) and Dr. M. N. Patel, Principal, LDCE(Chairman). It was innovative idea in Gujarat State to popularize Tribology and ICATES. It was implemented at L D College of Engineering, GIDC Engineering College, G. H. Patel College, and Marwadi Group of Institutions respectively at Ahmedabad, Navsari, Vallabh Vidhyanagar and Rajkot. (1) Dr. K. N. Mistry, Tribologist and Principal GIDC Engineering College Navsari, (2) Dr. D. V. Bhatt, Professor, Mechanical Engineering Department, SVNIT, (3) Dr. H. N. Shah, Principal, Venus International Engineering College, (4) Mr. Janmesh Pandya, DGM, Essar Steel India Pvt. Ltd., (5) Mr. Devesh Patel, Hyundai, (6) Dr. K. Prabhakaran Nair, Professor and Head NIT, Calicut, (7) Mr. Shantnu Sharma, Exxon Mobile Pvt. Ltd., (8) Mr. Mahendra Shastri, Consultant, TQM, (9) Mr. Ashok Mehta, Executive Director, Tribology Society of India contributed as experts in these seminars titled "Fundamentals of Tribology". All these experts have contributed in the favour of Gujarat Technological University, for the promotion of activity of Gujarat Technological University, for the benefit of students, faculties of Gujarat Technological University. The conference is having contributions of 11 persons from foreign countries. (1) Dr. Braham Prakash, Sweden, (2) Dr. Patrik Wong, Hongkong, (3) Dr. Wang Wen, Shanghai (4) Dr. Stephane Panier, France (5) Dr. Amaya Igartua, Spain (6) Dr. Guido Paolicelli, Italy, (7) Dr. Manoj Tripathi, Italy (8) Dr. Kuldeep Mistry, USA, (9) Dr. Mohit Sharma, Singapore, (10) LitHerng HENG, Singapore (11) Steve Shaffer, USA.

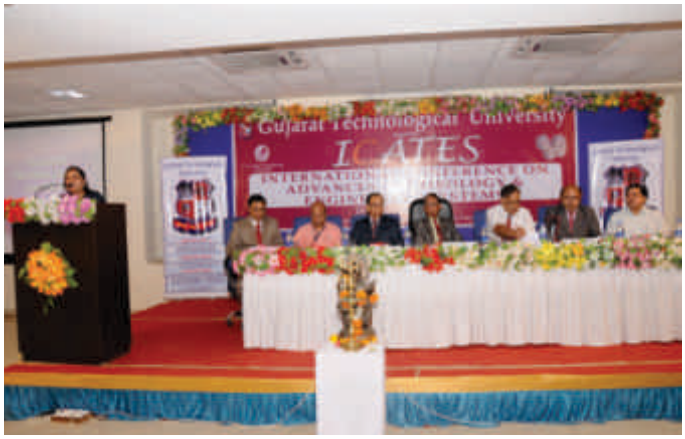
Dr. Bo Persson, from Germany, Dr. Zulfiqar Khan, from UK, Dr. Sudeep Ingole from USA could not attend the conference due to some reasons. The conference is having contributions from (1) Dr. Barun Chakrabarty, Mumbai, (2) Dr. Satish Vasu Kailas, Bangalore, (3) Dr. Rakesh Sehgal, Hamirpur, (4) Dr. Jayashree Bijwe, Delhi, (5) Dr. Sujeetkumar Sinha, Kanpur, (6) Dr. D V Bhatt, Surat, (7) Harish Hirani, Delhi, (8) Dr. N. L. Soni, Mumbai at national level.

The following industry persons joined with conference.

1. Anton Paar India Pvt. Limited, Gurgaon, Haryana.
2. Bruker Nano Surfaces Division, Bruker Center of Excellence/ Bruker AXS Analytical Instruments Pvt. Ltd., Bangalore.
3. Larsen & Toubro Limited, Mumbai
4. Tekniker, Spain
5. Bhabha Atomic Research Centre, Mumbai
6. The Timken Company, Ohio, USA
7. Saket Projects Ltd.
8. iGate Solution Pvt. Ltd.
9. Vishwa Industries
10. General Motors Ltd.
11. ICON analytical Equipments
12. Konepaja Facor Ltd.
13. Texspin Bearings Ltd.
14. Omega Elevators Ltd.

Inauguration function:

The function is inaugurated by Dr. Akshai Aggarwal, Hon. Vice Chancellor (Patron – ICATES) in the presence of Dr. Barun Chakrabarti (General Manager & Head (R&D) Larsen & Toubro Limited), Dr. Satish Vasu Kailas (Professor, Mechanical Engineering Department, Indian Institute of Science, Bangalore), Dr. K. N. Mistry (Principal, GIDC Engineering College, Navsari), Dr. M. N. Patel, Principal, L D College of Engineering, Ahmedabad (Chairman – ICATES), Dr. G. P. Vadodaria, Registrar - GTU, and Dr. H. C. Patel, Associate Professor and Head, Mathematics Department, L D College of Engineering (Coordinator – ICATES). This programme was anchored nicely by Prof. Poonam Modi, L D College of Engineering. Mrs. Aggrwal was remaining present for the inauguration and for the blessing to this conference. Mr. Rajubhai Parmar, Ex. MP, Government of India was also present in the conference.



The following sequence shows the events of inauguration function.

Dr. Barun Chakrabarti (Plenary Talk)

Head (R&D) – Hydrocarbon IC, Secretary – Tribology Society of India
Larsen & Toubro Limited, Mumbai, Maharashtra, India – 400072, (bc@LNTENC.com)

A Holistic Approach towards Tribology Education, Research and Practice in India: The Challenges and Imperatives

This paper articulates the need for a holistic approach towards Tribology education, research and industrial applications in India. The author reviews the current state of art in the country pertaining to these areas and highlights the perceived challenges. It has been nearly half a century since the term "Tribology" was formally coined by Prof. Peter Jost. Soon after this development, Tribology-related activities were initiated in India in the early Nineteen Seventies. Since then Tribology initiatives in India have been mostly limited to conferences and training programs, academic research and publication of technical papers. These efforts have been mostly driven by individuals, educational institutes and professional societies (such as the Tribology Society of India). At the National level, Tribology is still treated as a topic for "awareness development" programs.

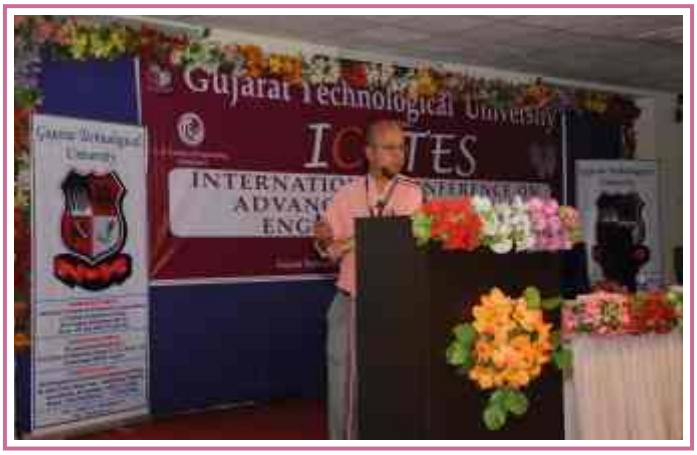
The potential economic benefits that can be derived by a nation through systematic adoption and practice of Tribological principles in industry are huge, as established by several studies conducted in different countries over the years. Tribology can make a significant impact on national wealth creation and sustainability, through material and energy conservation, loss prevention and extension of useful life of industrial assets. However, to realize such benefits, it will be essential to design and implement a comprehensive policy at the National level, which integrates Tribology Education, Research and Application seamlessly.

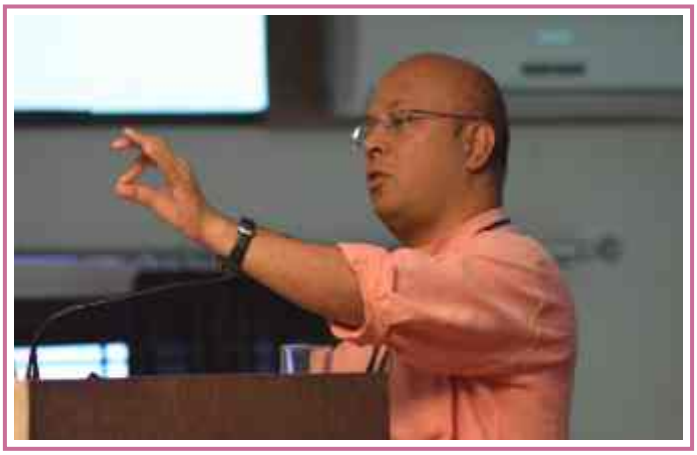
The paper highlights several constraints and challenges which have so far hindered such seamless progress of Tribology in India. It also proposes several actions in the area of technical education, Public / Private Sector R&D and industrial applications, which can accelerate the understanding and practice of Tribology. The paper concludes that, for India to attain a global leadership in the domain of Tribology, it will be imperative to launch a National Mission involving all stakeholders such as the Government, Industry and Academia.

Dr. Satish V. Kailas
Professor, Department of Mechanical Engineering,
Indian Institute of Science, Bangalore 560 012

Effect of Surface Roughness on Friction

Among the many factors that influence friction, surface roughness is one of the important parameters. In the present investigation, various kinds of textures were attained on the steel surfaces. Roughness of the textures was varied using different grits of emery papers or polishing powders. Pins made of various metals were then slid against prepared steel plate surfaces at various numbers of cycles using an inclined pin-on-plate sliding tester. Tests were conducted at a sliding velocity of 2mm/s in ambient conditions under both dry and lubricated conditions. Normal loads were increased up to 110N during the tests. The morphologies of the steel surfaces of the pins and the formation of transfer layer on the counter surfaces were observed using a scanning electron microscope. Surface roughness parameters of the plate were measured using an optical profilometer. In the experiments, it was observed that the coefficient of friction and formation of a transfer layer (under dry and lubricated conditions) only depended on surface texture and not on the surface roughness. It is postulated that a surface that promotes plane strain conditions of plastic deformation at the asperity level results in a higher ploughing component of friction resulting in a higher friction coefficient for a given material. The talk also briefly touches upon the effect of strain rate response of material in transfer layer formation.

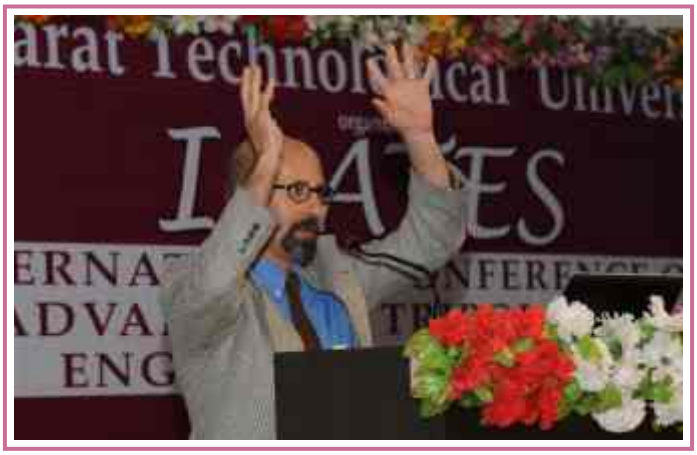




Dr. Arun Sikder
Sr. Applications Scientist, Bruker Nano Surfaces Division, Bruker Center of Excellence,
Bangalore 560 092, India

Defining and Designing an Efficient Tribo-Test

There is a steadily increasing demand for better materials to be used in applications such asscratch-resistant or self-healing coatings, machining, bearings, gears and metal forming where friction, lubrication and wear play an important role. Compared with other engineering or physical science disciplines, tribology is one of the most interdisciplinary subjects known. The objective of this presentation is to provide engineers and researchers an overview of the important tribological considerations (such as surface roughness, material compatibility, contact stresses, etc.) required for designing or manufacturing products, or designing of tribology experiments. As co-efficient of friction and wear are system properties it is utmost important to perform a tribo-test in an appropriate conditions. This talk will put emphasis on how tribological evaluation and testing under the proper conditions can guide researchers and engineers to choose correct materials, predict the lifetime of a component or system, choose the correct lubricant or coating for a given application, or to solve a tribological issue which has arisen in the subsequent release of a product. If the tribo-system of interest is properly understood and characterized, it is often possible to design a relatively simple tribo-test to provide the answers we seek, and with a high degree of confidence. Presentation will be concluded with series of example of tribo – test.



Dr. Rakesh Sehgal
Department of Mechanical Engineering, NIT Hamirpur, Hamirpur, Himachal Pradesh 177007, India,
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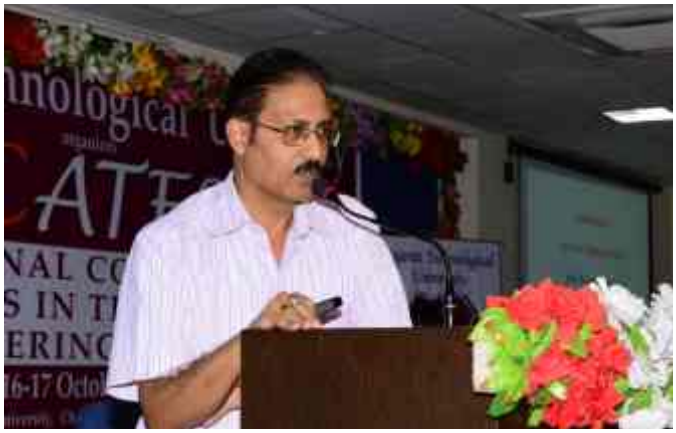
Experimental Thermal Analysis of Bronze Elliptical and Offset-Halves Journal Bearing Profiles

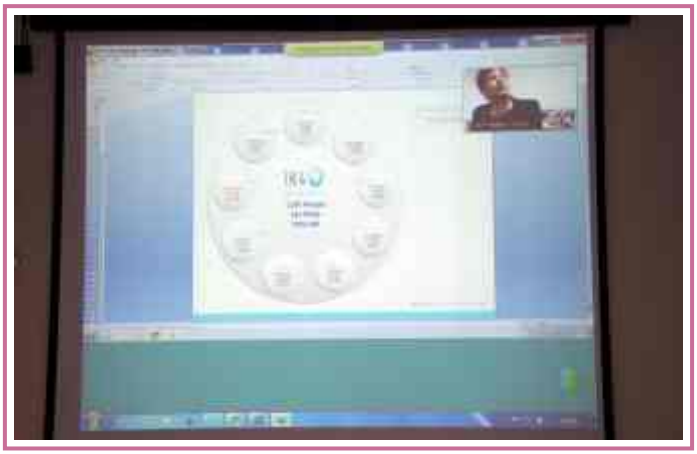
The present research study is aimed at experimental and theoretical investigation of the thermal behavior of metallic (Phosphor Bronze) elliptical and offset-halves journal bearing configurations of same geometrical size under low to high operating conditions (loads ranging from 800 to 1,900 N and speeds ranging from 2,000 to 5,000 rpm) using three different commercially available grades of oils (Hydrol 68, 2T and Mak Multigrade oil). Experimentally, it is established that offset-halves journal bearing runs cooler than elliptical bearing for all the three grades of oils under all operating conditions thus making it suitable for all operating loads and speeds. The lowest operating temperatures are obtained for 2T oil (oil 2) thus making it most suitable for use under all operating conditions.



Dr. Amaya Igartua
Director, Unit of Tribology, Tekniker, Spain. Contact: 0034 680656085,
e-mail: amaya.igartua@tekniker.es

Research Activities IK4-TEKNIKER In Tribology

The talk will deal with an introduction about Tribology, the different wear mechanisms illustrated with examples of tests carried out in TEKNIKER to select different materials and lubricants, trying to avoid different wear mechanisms (abrasion, adhesion, fretting, pitting, scuffing, corrosion or wear corrosion). The presentation includes an explanation about possible solutions applying surface treatments for engine components, gears or bearings, making special emphasis in the Physical Vapour Deposition Coatings, applied with machines manufactured in TEKNIKER. Finally, the talk will explain the possibilities to lubricate mechanical components with environmentally friendly lubricants. This presentation illustrates also some of the results that are included in 3 book chapters written by TEKNIKER, one of them published in India.



Tribology under Vacuum and Ultra High Vacuum

The talk will deal with the explanation of the tests bench constructed in TEKNIKER to test lubricants, coatings and material under vacuum and ultrahigh vacuum. The DEMETRA machine will serve to evaluate the evaporation properties of the lubricants, paints, polymer. and the CATRI Machine, allows to evaluate the friction, wear and tribodesorption properties of the lubricants. Examples are given for the evaluation of ionic liquids, PVD coatings and lubricants with the CATRI Machine.

Dr. Dharmesh Gala
Anton Paar India Pvt. Ltd.

Temperature-Dependent Rheology and Tribology of Lubrication Greases

Compared to oils greases have a number of advantages with respect to the construction and service of lubricated components. However, due to the visco-elastic behavior of greases there are certain constraints to consider regarding the flow and tribological properties. Therefore having an instrument and methods to investigate the visco-elastic and frictional behavior of greases over an extended temperature range is highly desirable.

A tribometer as well as a rheometer requires speed and normal force control, and torque measurement to acquire tribological data. An air bearing supported rotational rheometer allows the measurement in the whole range necessary for advanced rheological measurements.

Oscillatory amplitude sweeps are very well suited to investigate the visco-elastic behavior and consistency of lubrication greases. Valuable information on the visco-elastic behavior, i.e. the storage and the loss moduli as well as on the stress values at the flow point, i.e. the yield stress, is obtained.

Further, rheometers allow for tribological measurements of lubricating greases employing a ball-on-three-plates measuring accessory. Measurements, e.g. Stribeck-curves, at a broad range of speeds especially down to very low speeds with high accuracy are possible. In addition a special ball bearing fixture is available, thus allowing the measurements of friction factors as well as the static friction.

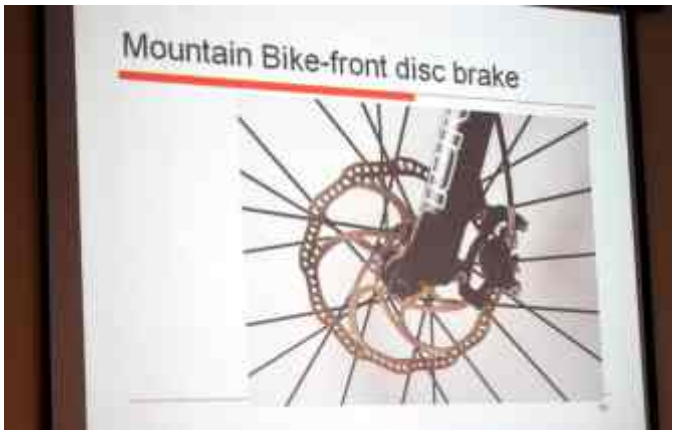
Both rheological and tribological measurements on model grease samples in a temperature range from –40°C up to 60°C are presented. The impact of temperature was monitored and a correlation between rheology and tribology was found.

Prof. Jayashree Bijwe
Industrial Tribology Machine Dynamics & Maintenance Engineering Centre (ITMMEC)
Indian Institute of Technology Delhi, Hauz Khas, New Delhi 110016 India

Initial Concepts about Brakes & Friction Materials; A class of tribo-materials

"Brake" is the most important part of a moving system because it is related to the safety of human life and machines. Automotives, locomotives and aircrafts have special concern for brakes. The efficiency of the braking system depends on the design of the brake, operating conditions and the friction couple, which is the most vital part of a brake. The friction material lining fixed on the sliding part (pad/shoe/block/strip), when pressed against the rotating component (disc or drum) fixed on the wheel, converts kinetic energy into heat energy due to friction process during braking.

The friction material is sacrificial in nature (wears preferentially and saves the drum/disc from wearing) and continues to get deteriorated as a result of braking over the years. The most important function of friction material is to provide adequate friction with minimal damage to the pad-surface, which would otherwise affect the performance in consecutive braking process. Thus, the heart of the braking device is this friction material, which is expected to continue its functioning reliably and efficiently for a long time in adverse operating conditions. The performance expectations from the friction couple, however, have changed drastically due to advances in the braking technology. There have been increasing demands to produce more powerful vehicles (higher speeds with larger sizes and weights) with higher performance to power ratio and better aerodynamic properties. The present lecture discusses about the evolution of brake-materials and their various aspects including some testing aspects in the laboratory.



Dr. Braham Prakash
Luleå University of Technology, Department of Engineering Sciences and Mathematics,
SE- 971 87 Luleå, Sweden

High temperature tribology research: needs and opportunities

There are many applications where tribological contacts are exposed to high temperatures, e.g. in aerospace, power generation and metal working industries. Formation of oxide, glaze or nanostructured layers are among several phenomena occurring under such severe conditions. They significantly affect friction and wear but the physical properties of these near-surface layers and the way they interact in a tribological contact are still not adequately understood. Moreover, when coming to wear modeling, it appears that most of the commonly used models are based on bulk material properties, which are expected to significantly differ from the near-surface ones due to scale effects. This paper attempts to provide a framework to discuss about the main phenomena to consider as far as a contact operating at elevated.

Dr. Sujeet K. Sinha
Department of Mechanical Engineering, Indian Institute of Technology, Kanpur 208016, India.
E-mail: sujeet@iitk.ac.in

Lubrication for Microsystems

Tribology plays an important role in the performance and life of any mechanical machine. This is even more so for micro-scale devices such as micro-electro-mechanical systems (MEMS) because of the large surface area to volume ratios of their components. Large surface area leads to high surface adhesion and friction. Devices fail by stiction or wear as a result. In order to keep up the progress in micro- and nano-technology, it is vital that nanotribological research is advanced further, and appropriate lubrication solutions are found which are specific to microsystems. In this talk, we will present recent research results on several solutions for nanolubrication. A number of chemical and surface textural modifications of the surface of materials such as Si/SiO2 and SU-8, which are the most used structural materials for MEMS, have been employed with the aims of reducing friction and increasing wear life.

Paper Presentation on 16th October 2013.

Sr no	Name Author	Title of the paper with co author	Session	Time (Hours)	Hall No	Name of Session Chair Person
1	Sudhir Tiwari	Enhancement of Tribological Properties of CF-PEI Composites through Surface Treatment of Fibers S. Tiwari, J. Bijwe, S. Panier	1A	13.30 to 14.00	B0	Dr.Braham Prakash
2	Wang Wen	Side Edge Effect on Elastic Contact Stress and Deformation W. Wang, P.L. Wong, Z.M. Zhang	1A	14.00 to14.30	B0	Dr.Braham Prakash
3	Chacko Preno Koshy	Experimental Evaluation of the Tribological Properties of CuO Nano-lubricants at Elevated Temperatures Chacko Preno Koshy, P K Rajendrakumar and Manu V Thottackkad	1A	14.30 to 14.50	B0	Dr.D.V.Bhatt
4	Nirav Maniyar	Design & Development of Rotary Fixture for CNC with rapheme considerations of Mechanics Analysis and Dynamic Balancing as Pre-mortem Tool Nirav P. Maniar and D. P. Vakharia	1A	14.50 to 15.10	B0	Dr.D.V.Bhatt
5	S D Sukla	Rough Porous Circular Convex Pad Slider Bearing Lubricated with a Magnetic Fluid S.D.Shukla and G.M.Deheri	1A	15.10 to 15.30	B0	Dr.D.V.Bhatt

6	K. K. Mistry	Boundary Lubrication: Understanding lubrication mechanism of additive chemistries on Diamond-like Carbon coating K. K. Mistry, A. Neville, A. Morina and A. Erdemir	1B	13.30 to 14.00	A0	Steve Shaffer
7	Mohit Sharma	Fiber surface modification to endorse tribological performance of advanced polymer nano-composites K. Dagar, M. Sharma, A. Kadiyala, J. Bijwe, Y.W. Leong	1B	14.00 to14.30	A0	Steve Shaffer
8	B. K. Sonigra	Study on the Effect of Blend Oil with Based Oil Analysis Dr. B. M. Sutaria, Dr. M. K. Bhatt, Mr. B. K. Sonigra Dr. D. V. Bhatt	1B	14.30 to 14.50	A0	Dr.S.K.Sinha
9	Wang Wen	Smart Journal Bearing using Giant Magnetostrictive Actuators Z. M. Fang, Z. Li and W. Wang	1B	14.50 to 15.10	A0	Dr.S.K.Sinha
10	Shah H N	Synthesis and Micro-structural Characterization of CrAlN Coatings by Reactive Magnetron Sputtering Hetal N. Shah and R. Jayaganthan	1B	15.10 to 15.30	A0	Dr.S.K.Sinha
11	Ajay Kumar Kadiyala	Strengthening Fiber-Matrix Adhesion To Improve Tribo-Performance Of Composites Ajay Kumar Kadiyala, Jayashree Bijwe	1C	13.30 to 13.50	A1	Dr.Guido Paolicelli

12	Piyush Gohil	Investigations of friction and wear in pultruded glass fibre epoxy composites Piyush P. Gohil, Hiral H. Parikh, Vimal B. Patel	1C	13.50 to 14.10	A1	Dr.Guido Paolicelli
13	P M Patel	Experimental Investigation On Life Cycle Analysis of The Moly (Mo) Coated Piston Ring In C. I. Engine P D Patel, R N Patel, H C Patel, Pradip M Patel	1C	14.10 to 14.30	A1	Dr.Guido Paolicelli
14	Mukesh Shimpi	Effect of bearing deformation on the performance of a magnetic fluid based infinitely rough short porous journal bearing M. E. Shimpi and G. M. Deheri	1C	14.30 to 14.50	A1	Dr. K. N. Mistri
15	S. S. Panda	Power Law Fluid Film Lubrication of Journal Bearing With Squeezing and Temperature Effects Dr. Dhaneshwar Prasad , S.S. Panda, S.V. Subrahmanyam	1C	14.50 to 15.10	A1	Dr. K. N. Mistri
16	N. S. Patel	The Performance Analysis Of A Magnetic Fluid Based Hydrodynamic Long Journal Bearing N. S. Patel, D. P. Vakharia, G. M.Deheri, H.C.Patel	1C	15.10 to 15.30	A1	Dr. K. N. Mistri
17	Eshan Singh	Prediction of useful life of rolling contact bearings using Monte-Carlo Simulation technique Eshan Singh, G. D. Thakre, P. K. Arya and B. M. Shukla	1D	13.30 to 13.50	A211	Dr. P. L. Wong

Dr. P. L. Wong
Professor, Department of Mechanical and Biomedical Engineering,
City University of Hong Kong, Hong Kong, China.

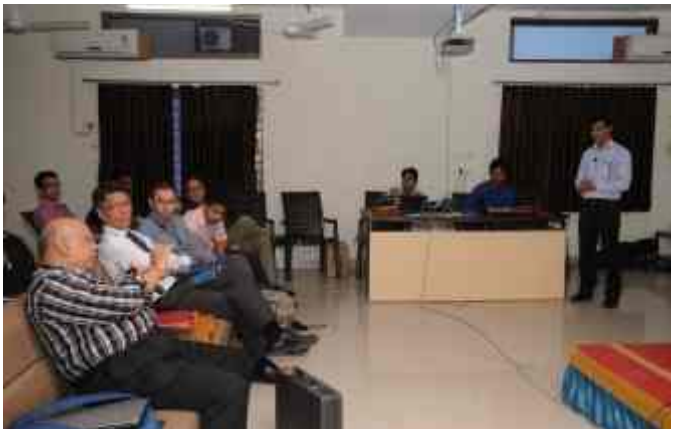
Interfacial Effect on Elastohydrodynamic Lubrication (EHL)

This piece of work was to study the effect of surfaces of different surface energies on EHL. Conventional optical EHL tests were carried out under pure sliding conditions. A stationary steel ball was run separately on two glass discs of different coatings. They were namely (i) Cr (Cr coating on glass disc), and (ii) SiO2 (coated on top of the partial reflective Cr layer). SiO2 has much higher surface energy than Cr. In order to eliminate any thermal effect in the study, the tests were run with very viscous polybutene oil, such that full EHL film can be generated under even very slow speeds. Comparing directly the two sets of results, the steel/Cr contact, which has lower surface energy, has lower friction and readily generates anomalous EHL film. The abnormal EHL film profile is characterized with a tiny dimple at the inlet area, which was attributed to the boundary slip effect. The oil is hardly dragged into the central contact area and thus accumulated and formed a dimple at the inlet. In conclusion, a surface of lower surface energy (like Cr, comparing to SiO2 in the current study) promotes boundary slip, which leads to reduction in overall friction.

Dr. Harish Hirani
Associate Professor, Mechanical engineering Department,
IIT Delhi, India

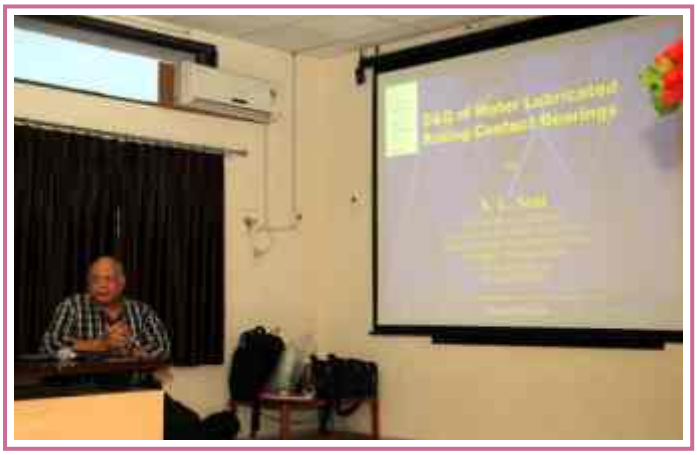
Lubrication by Molybdenum Disulphide

"Moly-lubricants": Moly-lubricants are popular due to their characteristic of transferring a lubricant layer on the mating surfaces. The lubricant properties comes due to lesser cohesive shear strength of moly-lubricant compared to shear strength of adhesive bond made between moly-lubricant and metallic surfaces. Agglomeration of nano-particles and relatively high hardness are two major drawbacks of moly-lubricants. Appropriate surfactants to avoid agglomeration and anti-wear additives are essential to obtain optimum performance from moly-lubricants.



Dr. N. L. Soni
Outstanding Scientist & Head, Fluid Power & Tribology Section,
Refuelling Technology Division, Bhabha Atomic Research Centre, Trombay, Mumbai- 400 085

Design & Development of Water Lubricated Rolling Contact Bearings



Conventional bearings are giving poor performance in water environment due to highly corrosive and low viscous media. For such under water applications, Stainless Steel bearings have been developed. Attempt has been also made to use electro-less Nickel (EN) coated conventional Carbon Steel bearings in similar under water applications. EN coating is an hard, anti-corrosive adherent coating. The carbon steel bearings with larger clearances were coated with en coating and tested for various loading under water environment. The load carrying capacity was also found reasonably good.

The stainless steel (SS-440c) water lubricated ball bearings load carrying capacity reduces drastically due to

a) Poor lubricating property of water.

b) Lower hardness of Stainless Steel compare to standard carbon ball bearing steel.

c) Larger clearances are to be provided between races and balls

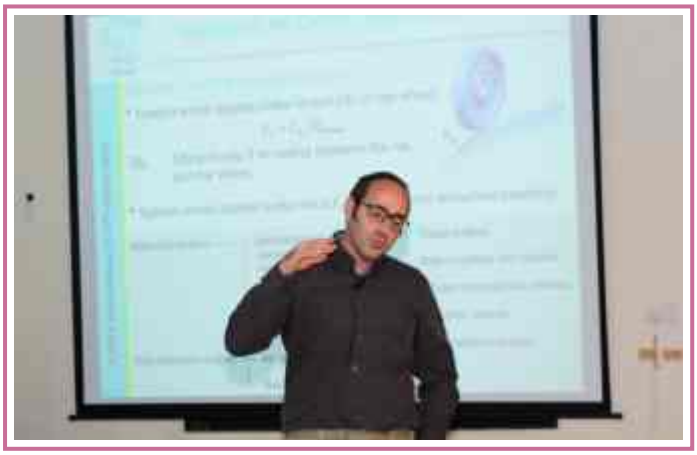
The load rating of these bearings drastically reduces. Same size of water lubricated bearing will have ¼ load carrying capacity with conventional Carbon Steel ball bearings.

Apart from this, microstructure of heat treated Stainless Steel 440c may contain retained Austenite un-dissolve Carbides. These local carbides structure have poor strength compare to martensitic structure. These weak minute local structures located at the high stressed race surfaces of ball bearing will drastically reduce the performance of these bearings. Therefore designer has to take care of homogeneous heat treatment of these special Stainless Steel. The clearances are to be increase for smooth operation in water corrosive environment. In Nuclear applications, most of this type of water lubricated rolling friction bearings are running at very low speed. Therefore with down rated load carrying capacity of these bearings, the chances of fatigue failure is not much. The failures of these bearings are only due to severe rubbing of races and catastrophic failure due to accumulation of minute carbide structure failure on highly stressed races tracks.

The paper will thoroughly discuss the design aspect of these bearings, material selection, proper heat treatment and manufacturing process, thoroughly testing and predicting their L-10 life.

Dr. Stéphane PANIER
Professor, Polymers and Composites Technology & Mechanical Engineering Department,
Mines Douai, Douai, France

On hot-spotting in railway disc brakes



The braking system in the high speed trains are subjected to severe thermomechanical solicitations. We can observe on the disc brakes the presence of hot spots which can lead to a decrease in performance braking system (judder, brake fade) even in the extreme case to cracking of the disc. A review of the various approaches used in the study of automotive braking is given. It's shown that they cannot be applied in the case of railway braking. To study the typical phenomenon of railway braking, an experimental study on a test bench enabled to highlight the different types of thermal gradients in the disc brakes from infrared measurements. A detailed investigation of the most damaging thermal gradients, called macroscopic hot spots (MHS), is given. Influence of parameters such as pad stiffness and pad contact length on the mechanism leading to hot spots occurrence is studied. Based on these experimental results, a new approach, called Progressive Waviness Distortion, based on a process in three steps, is proposed. Three major effects have to be considered: the structural response of the disc and the pads, realistic boundary conditions, both geometric and loading, and the thermal-elastic-plastic behaviour of the material. Finite element simulations based on the proposed model are agreed with experimental observations in the case of the French high speed train braking. In the last part, numerical simulation shows that the thermomechanical solicitation due to the macroscopic hot spots may induce thermal low cycle

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Exploring tribological characteristics of nano-systems with the Atomic Force Microscope: from FFM to manipulation of nano-objects

In this contribution first I will introduce some of the main Friction Force Experiments performed in the last decade with the Atomic Force Microscope (AFM) with nanoscale lateral resolution. Then I will present and discuss our recent results on nano-objects controlled movements by AFM.

The AFM initially developed to achieve ultimate surface imaging was immediately recognized as a key instrument to perform nanoscale . Nowadays can be considered an invaluable tool in biology and a general characterization technique in surface science. The AFM is also exploited as a versatile tool in the field of nanotechnology, to locally modify surfaces at the nanoscale, to build up artificial nanostructures and to control and precisely manipulate surface nano-objects.

Recently has been proposed that clusters manipulation by AFM could be exploited to extract information on isolated, well-defined nano-contacts. The subject has been explored systematically only in the last few years after the pioneering work of Luthi et al. on C60 molecules in 1994. Two different approaches have been developed to manipulate nano-clusters and to obtain information from these measurements. The

first one is evident, the AFM is used in contact mode to push the cluster by the side or to drag it with the tip placed on top of the cluster. In that case friction forces are measured from the torsional bending of the cantilever like in a standard Friction Force Microscopy (FFM) experiment. The underlying hypothesis is that tip–cluster interaction gives a contribution to the overall bending that can be either properly subtracted or neglected with respect to the cluster/surface contribution. The second approach relies on the use of the AFM in dynamic mode with amplitude modulation feedback (AM-AFM or tapping mode,. In this method, depinning and movements are induced by the intermittent tip pushing on the cluster and this effect is correlated to

the energy dissipation signal reconstructed from phase shift measurements. The direct evaluation of a friction force corresponding to the induced cluster movement is the main advantage of measuring in contact mode. Nevertheless, particles having an overall dimension comparable or smaller than the typical tip apex cannot be easily addressed because aligning the sliding path of the cluster to the torsional movement of the cantilever may result in a very critical issue. The opposite situation characterizes the dynamic manipulation mode. The periodic tip–cluster interaction, typical of AM-AFM, has been proved to induce depinning events with particles having comparable dimensions with respect to tip apex and to produce smooth cluster movements along a precise direction. Nevertheless, the connection of the corresponding energy dissipation signal to the friction forces acting on the system cluster/surface requires an elaborate modeling.

Independent of the particular mode adopted to induce clusters movement and to extract friction information, the main advantage of this method as compared to FFM is on the control of the sliding interface. The contact region between the cluster and the substrate now represents the interface we are measuring on, while the AFM tip is part of our apparatus and it is ideally disentangled from the physical system in exam. Using well-established

deposition techniques, clean and controlled nano-interfaces can be obtained by preparing first the surface and then depositing the overlayer in the form of nano-clusters. In comparison, during FFM measurements only the substrate can be properly cleaned and characterized while the tip, which is the sliding counterpart, is usually much more difficult to prepare and to maintain in stable conditions. Moreover, the use of nano-clusters allows a better control on shape and size of the interface. The contact area can be varied by simply choosing a cluster with a proper size and its shape can be monitored before and after the measurement. Especially for that reason this class of experiments can shed light into the fundamental problem of contact area dependence of frictional forces at the nano scales.

Paper Presentation on 17th October 2013.

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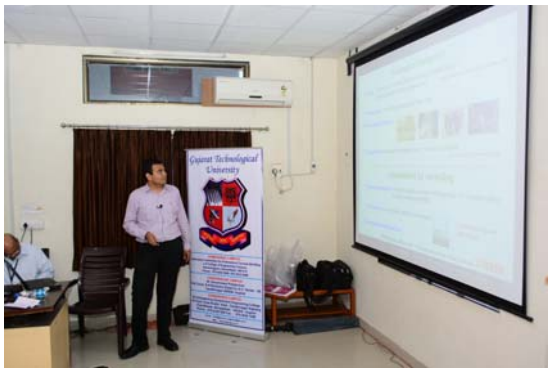

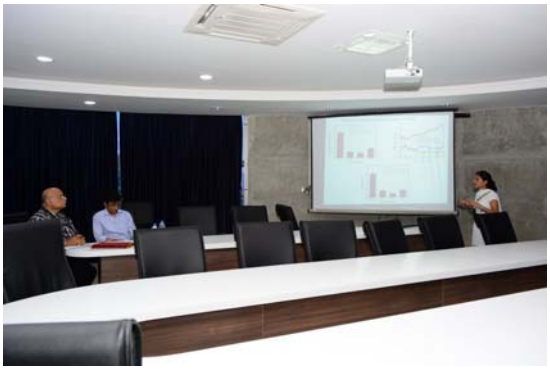

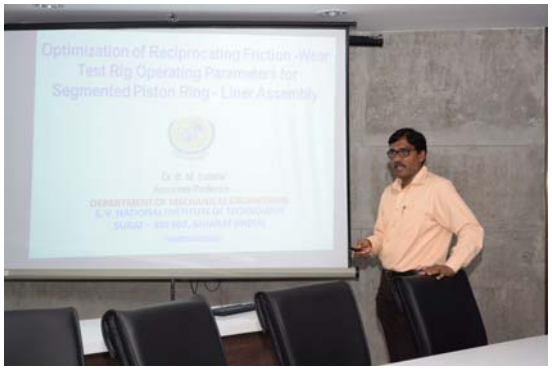

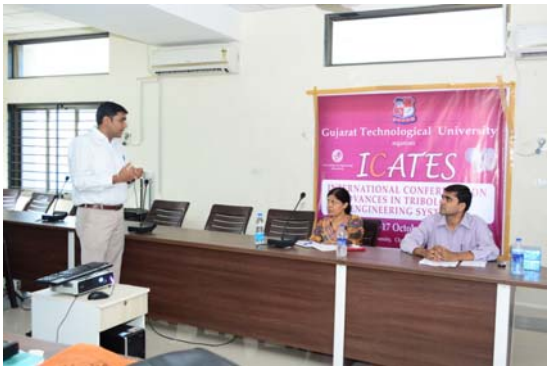

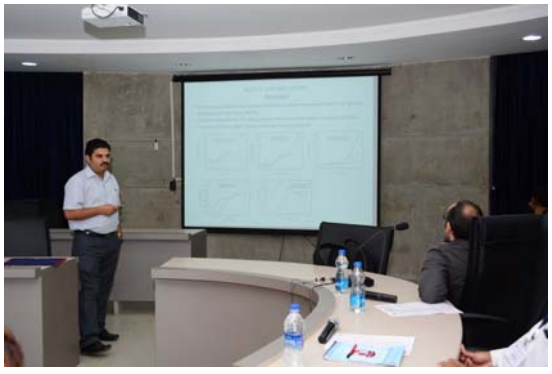

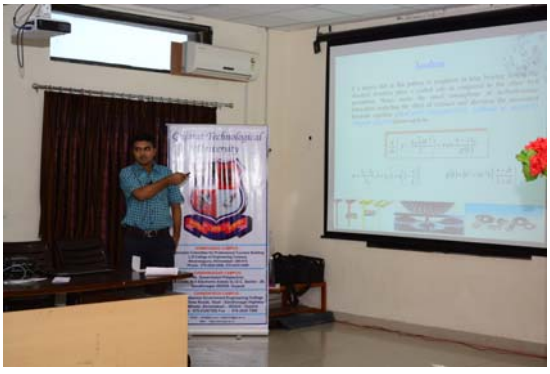

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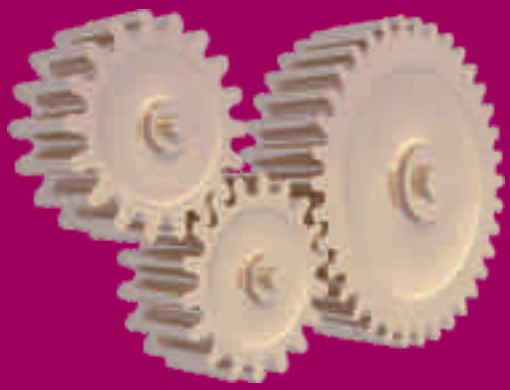

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Our sincere thanks to :

Gujarat Council on Science & Technology

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Report prepared by L. D. College of Engineering, Ahmedabad.

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