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TSI Salutes Motherland in the 50th year of its Independence.

ICIT'97 - AN OVERVIEW

Dr.J.Bhatia,

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Dr. J. Bhatia

Under the aegis of Tribology Society of India (TSI), ICIT'97 was held at Calcutta from 2-5 December 1997. The conference brought together nearly 250-300 leading tribologists and lubrication specialists from all over the world. The conference had as many as 70 presentations, a number of which were from leading international experts.

Highlights of the conference were key note papers presented by a galaxy of international experts in the field. The paper by Dr. Manfred Fuchs, Chairman of the Fuchs Group gave an overview of the world lubricants market and the emerging trends in the demand for various industrial and automotive lubricants worldwide. Dr.A.K.Bhatnagar, Executive Director, IOC, in his paper "Tribology in India - Waking Up to New Realities" talked about the changing International and Indian scenario of lubes and an attitudinal shift towards quality. A key note paper by Dr.Theo Mang from Fuchs, Germany talked about lubricants for the next century. Dr.Mang in his presentation highlighted that with the use of more efficient functional products, the overall specific consumption in the next century will come down. Mr.Don Surbey of Lubrizol covered recent trends in automotive lubrication and maintenance in his presentation.

The conference had a number of significant international presentations in the field of surface engineering and tribological materials. The presentation by Prof.Kenneth Holmberg of Finland entitled 'Tribological Mechanisms of Coated Surfaces' was very widely appreciated. Another presentation by Prof.L.Gulzman of Italy discussed the tribological behaviour of Nitrogen implanted alloys.

The highlight of presentations in lubrication basics was a paper entitled

'Towards Modelling of Chemical Boundary Lubrication' by Prof.Kenneth C. Ludema from the University of Michigan, USA. Prof.S.K. Biswas, discussed in a very lucid way the generalities and challenges related to sliding wear. There were a number of presentations on both hydrodynamic and antifriction bearings from leading research institutions. The section on metal working operations and lubricants had a number of good international presentations including those from Germany and Spain.

A separate section on Environmental & Rural Engineering focussed on eco-friendly lubricants and the need for tribology in Rural India. Presentations by Prof.W.T. Bartz, Mr.R.A. Rao and Prof.M.C. Dwivedi were particularly noteworthy. Mr. Gopalakrishna of BHEL discussed the tribological problems of heavy industry.

Besides the above topics, there were a number of specialist presentations on Wear Mechanism and Modelling, Automotive Lubricants and Testing & Analytical Techniques in Tribology. A separate section on Condition Monitoring and Simulation as also Industrial Lubricants, Greases and Lubricant Additives covered various aspects of recent developments in this area.

Another highlight of the conference was the organization, for the first time, of two educational courses on Lubrication Basics and Automotive Lubrication respectively. These courses were ably handled by course directors Mr. A.K. Mehta, Prof.A. Sethuramiah and Mr.Sudhir Singhal.

At the conclusion of the conference, a lively interactive discussion was held on Strategy for Wear Control.

The technical papers presented at ICIT'97 reflected state-of-the-art developments and advances in the complex and multi-disciplinary field of Tribology. ICIT'97 was jointly organized by Balmer Lawrie & Co Ltd and Balmer Lawrie - Fuchs Ltd on behalf of TSI. Much of the credit for the success of this conference goes to its numerous authors and key note speakers as also technical experts who played a key role in putting the technical contents of this mega conference together.

TSI MOVES AHEAD Prof.D.V.Singh, President,TSI

The Indian scene indicates a scientific and technological maturity in the field of Tribology. Areas of Tribology are now part of curricula and subject of research in technological institutions. The contributions of industries in the field of Tribology both at basic and applied levels are significant and offer a healthy synergy with similar efforts in academic and research institutions. The high level of indigenous work on lubricants and lubrication, wear, tribological behaviour of ceramics and polymers and in many other areas is now internationally recognized. The Tribology Society of India (TSI) has played a major role in spreading the message of Tribology in terms of its importance to industry and engineering application. TSI has consistently served the Tribology scientists and technologists by regularly providing forums for the expression of their creative work and an interface with tribologists abroad. TSI has been able to sensitize the industry and academics to the pervasive sweep of Tribology and the radical changes taking place in this discipline. The Society will establish more Local Chapters of TSI and encourage activities to bring home forcefully the importance of Tribology in industries. TSI also plans to launch a Journal dedicated to Tribology which will be of a very high standard, comparable to the most prestigious internationally, so that it attracts research papers of outstanding quality. TSI Executive Committee will soon formulate a minimum agenda and define targets for the next two years and beyond.

OUTCOME & RECOMMENDATIONS EMERGING OUT OF THE WORKSHOP ON 'TPRMI-1997'

The workshop on "Tribological Problems and Remedial Measures in Mining and Mineral Industries", was organised jointly by the Tribology Society of India, Bhopal Chapter, and Regional Research Laboratory, Bhopal, on September 29-30, 1997 at RRL, Bhopal.

The theme of the workshop was to deal with tribological problems related to materials in the mining sector and to discuss about the possible remedial measures to reduce the severity of the problems. A series of technical presentations were made on the theme including possible utilization of alternate/modified materials. Delegates from industries, mining sectors and R&D institutions had actively participated in the workshop. It emerged during the course of deliberations to utilize advanced techniques for solving various problems of the mining sector. A proper understanding of the influence of microstructural & compositional aspects on the overall performance of components is emerged as a determinant factor for their more efficient working. A healthy coordination amongst users, manufacturers and R&D institutions was stressed to make such activities more meaningful. The delegates strongly felt the necessity of such workshops at a regular periodicity.

"TSI News Letter" congratulates the organizers of "TPRMI-97" for their efforts in successfully organizing the workshop.



His Excellency, The Governor of West Bengal, Shri K. V. Raghunatha Reddy releasing the Conference Proceedings titled "Advances in Industrial Tribology" on the occasion of Inauguration of ICIT '97 on 2nd December, 1997.

MEET OUR EMINENT TRIBOLOGIST



Prof. D. V. Singh

Prof. D.V. Singh, born in December 1934 took his B.Sc. degree (1953) from Allahabad University, B.E. Mechanical (1956) and B.E. Civil (1957) from the University of Roorkee, and M.S. (1962) and Ph.D. (1964) from the University of Wisconsin, USA.

He joined the faculty of University of Roorkee in 1958 and became Professor in Mechanical Engineering in 1967. He held the tenure position of the Head of Department, Dean (Academic), and Dean (Research) in the University. He has guided several M.E. and Ph.D. theses, many of which are in the area of Tribology.

He joined CSIR as the Director of a National Laboratory of CSIR in August 1990 and after completing his tenure, he took over as the Vice-Chairman of the All India Council for Technical Education in October 1996.

Prof. Singh is a Fellow of four distinguished Academies in India. He is a member of the Board of Trustees of the International Foundation for Science (Stockholm), the Board of Directors of the International Road Federation (Washington DC) and the Board of Directors of the World Interchange Network, (Montreal).

He has published more than 150 papers in Journals and Conference Proceedings. For his outstanding research contributions he was awarded Shanti Swarup Bhatnagar Prize in Engineering Sciences (1978) and many other awards and prizes. He has written a monograph "Bearings, Lubricants and Lubrication". His research work in the area of Tribology is summarized below:

The flow-fields in the clearance spaces of hydrodynamic and hydrostatic journal bearings and fluid seals, taking into account the complexities of configurations of these machine elements and also those arising out of nonlinear constitutive behavior of lubricating fluids, have been extensively studied by Prof. Singh. The former includes micron shapes with and without offsets, multilobe geometries, and tilting and rolling pad supports. The latter includes Newtonian and non-Newtonian fluids (effect of additives), micropolar fluids (particulate contamination) laminar and superlaminar flow, magnetohydrodynamic lubrication, elastohydrodynamic lubrication and also the more complex but more accurate piezothermoviscous behaviour of liquid lubricants. His work includes gas bearings (compressible fluids) used in very high speed applications. His studies of hydrostatic bearings with restrictor compensation through a unified analysis lead to a very effective tool for optimal design of bearing-restrictor systems. The prolific work of Prof. Singh in this area has been published in national and international journals, is widely referred to and has been used in industrial applications. In early 70's he was among the few first in India to use FEM to solve complex flow-fields in the clearance space of bearings and seals.

TSI is proud of the contributions made by Prof. Singh to the Science of Tribology. "TSI News Letter" congratulates Prof. D.V. Singh for his commendable achievements. And, Tribology Society of India is immensely proud to elect Prof. D.V. Singh as President of TSI for the tenure 1997-1999.

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REVIEW AND ANALYSIS OF ADVANCES IN INDUSTRIAL TRIBOLOGY - ICIT '97 SCENARIO

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The International Conference on Industrial Tribology, ICIT '97 was held at Calcutta, India, December 2-5, 1997. It covers all the significant topics of interest to the modern day Industrial Tribologist. All the papers of multi-discipline sciences as appeared in proceedings have been reviewed and gist



Dr. Har Prashad

of the papers is given under the broadly clubbed significant titles for the benefit of Tribologists.

1 WEAR MECHANISM, SURFACE ENGINEERING & TRIBOLOGICAL MATERIALS

Three papers on Aluminium Alloys have been presented(1-3). Das and et.al.(1) have characterized microstructural features and abrasive wear properties of an Al-Si alloy and Al alloy particle composite. Analysis was carried out pertaining to the distribution of Zircon dispersed phase and abrasive wear characteristics studied and conclusions drawn accordingly. Thakur et.al.(2)

reported studies carried out on wear characteristics and surface finish of hypereutectic Aluminium - silicon alloy (used as piston and bearing material) treated with Cerium based misch-metal. Effectiveness of Lanthanum and Neodymium based misch-metals have also been compared. Guzman et.al.(3) have reported intensive work carried out for Tribological behaviour of Nitrogen implanted Al-alloys. Authors have brought out that Nitrogen implanted layers, inspite of their shallow thickness, behave better than hard Tin-coated surfaces because of 5 fold increase in microhardness and reduction in friction by a factor of 2. Findings have been

confirmed by field trials. Choudhary and Sahoo(4) described a generalized fractal based analysis of adhesion and friction between rough solids and the results have been found to be more realistic and compared with the conventional approach using stochastic models. Castanho, Ramos and Vieira(5) investigated tribological behaviour of sputtered multilayer media. Authors analyzed the coatings formed by Carbon and Chromium, and compared the results with that of a single carbon coating. The importance of Nitrogen has also been investigated similar to that of the work carried out by Guzman et.al.(3) apart from complete characterization of coatings by

friction and wear characteristics. Dua et.al.(6) reported the importance and application of Diamond-like Carbon (DLC) coatings. Authors have discussed that the DLC contains both Sp^2 and Sp^3 hybrid bonds, and depending on deposition and proportion of these bonds affect the properties of the coatings.

Sliding wear behaviour of a Zinc-based alloy was compared with a Lead-tin bronze by Pandey and Prasad(7). Bijwe and et.al.(8) reported the influence of short fibre reinforcement on tribological characteristics of polymer composite. And, Hebbar and et.al.(9) studied the properties of discontinuous glass fibre reinforced polypropylene composites. Also, analysis of the abrasive behaviour of Redmud filled PVC was carried out by Navin Chand and Hashmi(10). Kohli and Braham Prakash(11) investigated the tribological performance of Molybdenum Disulphide films and brought out that the load carrying capacity of bonded MoS_2 is superior to that of burnished films, but any of these films do not indicate significant life in water. Rajesh and et.al.(12) have tried to develop theoretical model for non-Gaussian Honed surfaces.

2. BEARINGS

Three papers on the rolling-element bearings pertaining to temperature prediction, diagnostic monitoring techniques and prediction of performance parameters of rolling/sliding thermal EHL line contacts were presented.(13-15). Reddy et.al.(13) used finite difference method for steady state temperature prediction and Sen(14) discussed envelope and spectral emitted energy techniques along with significant illustrations for health monitoring of rolling-element bearings. Ghosh and Pandey (15) developed empirical relations for film thickness, temperature and sliding traction coefficients for hard EHL contacts for wide range of operating parameters with significant conclusions. Non-linear analysis of electromagnetic bearings using FEM was reported by Nair and et.al.(16). Prashad(17) has developed a non-conventional electrical analogy approach for assessing dynamic coefficients of cylindrical and elliptical bearings and compared values with the existing conventional approach. Chaudhari and et.al.(18) discussed importance of the use of polymer layer for thrust bearings and compared the tribological test data with the conventional babbitt lining. Reddy and et.al.(19) have given the analysis for simultaneous solution of Reynold, Energy and Elastic equations iteratively for evaluating the dynamic coefficients of large tilting pad journal bearings based on FEM approach and the alternative approach to that of the pad assembly method. Jain and et.al.(20,21) have given dynamic performance characteristic of Hybrid journal bearing with Non-newtonian lubricant and under turbulent regime. For evaluating the dynamic coefficients and design of journal bearings technique given by Reason and Narang has been used in a modified form by Hirani and et.al.(22). An approximate thermal analysis of engine bearing has been developed using an unique approach by Hirani and et.al.(23) by considering the ratio of heat convected to heat conducted being geometry dependent and equal to eccentricity ratio and found results closely matching with that of the experimental values. Besides

this, performance characteristics of journal bearing with floating bush in turbulent regime was analyzed by Soni and Jain(24).

3. ADDITIVES, AUTOMOTIVE AND METAL WORKING LUBRICANTS

Three types of viscosity modifiers (VM); viz. : Polymethacrylates (PMA), Olefin Copolymers (OCP) and hydrogenated Styrene-isoprene Copolymer (SIP) types have been investigated for antiwear, and thickening performance at different VM concentrations in base stocks by Pantar and Ghosh.(25) VM have shown antiwear properties. Also, authors have investigated that the thickening effect was in the order of $SIP > OCP > PMA$. Verma et.al.(26) have studied evaluation of Tribological properties of formamidinothiocarbamides and their Mo-S complexes as potential EP additives and significant conclusions drawn. Organo-sulphur EP additives were studied by Tuli, et.al.(27). The authors have concluded that facile cleavage of S-S and C-S bond make an organo-sulphur compound as an effective EP additive. Anand, Chaudhari and Bist(28) have reported that the reaction of iron powder with methyl ricinoleate, its sulfurised and phospho sulfurised derivatives, the isolation and structural characteristics of the chemisorbed films formed on iron surfaces and their relationship to friction and wear characteristics.

Bisht and Singhal(29) discussed the indigenous test method developed by IIP named as VAV-382. The method uses an Amsler machine under under sliding conditions between the discs and is included in the ISI 1118-92 specification for multipurpose gear oils for GL-4 level oils. Approaches for characterization of running-in by asperity level conformity, fourier transform analysis of roughness profiles and bearing length curve have been discussed by Tyagi and et.al. (30). These approaches found to complement each other as brought out by authors.

Zoya and Krishnamurthy(31) illustrated data for on-line monitoring of process indicators i.e. cutting force and temperature during turning of Titanium alloy using coated carbide cutting inserts. In depth studies have been reported using Artificial Neural Network (ANN) for an effective condition monitoring of tool status by multi-sensory technique by Kumudha,et.al.(32). Also, authors have investigated that the adaptation of learning rate parameter using fuzzy logic shows improvement in estimation of tool status. Marik, et.al.(33) have reported the reduction in wear of work roll by 15-20% by introducing the optimum and effective roll cooling system during the process of hot rolling of plates. Plasma aided hot machining of difficult-to-machine materials has resulted in significant improvement in volume of metal removal rate and no adverse metallurgical effect on the work piece detected. These have been claimed by Roy, et.al.(34) in their investigations. On the other hand, Dietrich Hoerner(35) gave the new direction to improve manufacturing technologies to the metal working industries by the introduction of low evaporating and low misting cutting fluids. The author has emphasized that the cutting fluid must provide best possible environment and work place protection and not only minimum Quantity

Lubrication. Formulation, designing and evaluation experience gained by IOC R&D Centre for steel cold rolling oils have been discussed by Shrivastava and et.al.(36). Overall development, background and latest state of art for steel cold rolling oils in European Rolling Mills have been very clearly brought out by Mascaro and Gaillard(37). The authors have concluded that the latest technological development in rolling oils can save significantly in energy consumption and work rolls duration apart from reduction in cost of rolling by 33%, ensure surface cleanliness, and quality by Constant Lubrication Performance Additive Package and reduction in Fe generation. Banerjee, Jagga and Sethuramiah(38) have reported the development of a new laboratory technique for boundary lubrication studies for approximate evaluation of friction coefficient for analyzing the lubricant behaviour.

4. INDUSTRIAL LUBRICANTS AND GREASES

Anoop Kumar and et.al.(39) discussed the characteristics, advantages, field evaluation and toxicological studies of Titanium Complex Greases developed by IOC, R and D. Singh and Sait(40) investigated the tribological properties of developed polyurea greases. Metal-additive interaction was studied using EDAX and SEM techniques by the authors. Evaluation of Refrigerant lubricant using Digraph Matrix analysis has been reported by Ansari and et.al.(41). The authors have established the selectivity index of different lubricants. Mahendra Pal(42) established the tribological behaviour of oils containing tallows in different proportions in sliding concentrated contacts and significant conclusions drawn by investigations.

5. CONDITION MONITORING AND SIMULATION

Ghorai and Tomer(43) emphasized the use of 'Soap Analysis' for predictive maintenance of Air Bus engines along with the vibration diagnostics. A comprehensive study to increase the life of coal feed bunkers has been carried out by employing NDT such as MPT, LPT radiography etc including that of in-situ metallography by Pandey and et.al.(44). Moudgil and Rao(45) used oil contamination monitoring for control of Hydraulic Equipments. Off-line expert system for condition monitoring of a rotating machine has been developed in an Object Oriented Programming Framework using C++ by Sarath Kumar and Prabhu(46). The expert system predicts the machine condition severity, type of malfunction and gives recommendation for safe running of the rotating machinery. Role of oil on the performance of heavy duty gear box employed in coal pulverisers of 500MW thermal power station has been analyzed by Santham(47). Benefits drawn by condition based maintenance with case studies from opencast coal mines have been highlighted by Akala, Alam and Singh (48).

6. TESTING AND ANALYTICAL TECHNIQUES

Karmakar and Sethuramiah(49) have modelled wear on the basis of damage of asperity microcontacts due to repetitive tensile stressing utilizing the one-pass test information. Authors have found that the number of cycles needed for layered

removal for a given level of prestressing and its thickness in one-pass sliding can form a good basis for characterizing wear resistance of tribopairs used as higher kinematics pairs like gears as exemplified by disc machine tests. Espinoux and Constans(50) have described the Tribological and mechanical testing in the Laboratory, in which all the mechanical test on 'friction simulators' for lubricants or fuels are carried out. Authors gave the overview of the laboratory and its standardization activities. A high temperature high pressure water tribometer has been designed by Kohli, Limaya and Agarwal(51) to make use of an existing high temperature high pressure facility called Integral Thermal Facility in the Organization for intake of controlled chemistry water. Authors have used the Tribometer to measure wear by measuring weightloss and friction coefficient by on line measurement of friction force.

7. ENVIRONMENT AND RURAL ENGINEERING

Lubricants and its effect on the environment has been critically reviewed by Bartz(52). The author is of the opinion that for all cases of direct contact between lubricants on one side and human being and the nature on the other side the compatibility has to be checked. Also, the environmental compatibility tests has to be understood by all those who are working in the fields of production, application, and disposal of lubricants. The frameworks of laws regarding these aspects, either have not been framed or have been unequivocal. Dasgupta, et.al.(53) reported the effect of hardfacing on the wear properties of steels used in agricultural components and brought out that the most common type of wear encountered is the abrasion. The authors have recommended the appropriate technical remedies to overcome the problems. Rao(54) in his short communication has given thought provoking ideas as to how Tribology can start playing some useful role that can impact on the large segment of Indian population. Mahendra Pal and Singhal(55) reviewed the essential requirements of environment adapted lubricant including chemical composition, eco-toxicity, biodegradability, bioaccumulation, eco-labelling scheme and life cycle analysis. Dwivedi(56) has analyzed relative advantages and associated problems with water-polymer solutions as compared to petroleum based, synthetics, and even water-emulsion functional fluids. Also, author highlighted the major changes to be made in the machines to adapt to this system of functional fluids as these have high degree of water washability. Preliminary work carried out by Datta and et.al.(57) to investigate reasons for fast depletion of fatty matters in the rolling oils and its adverse performance in cold rolling operations by various techniques adopted, revealed that the degradation of fatty ingredients occur in the system by microbes.

8. SPECIAL TOPICS IN TRIBOLOGY

Ludema(58) in his thought provoking paper has expressed lucidly that there is yet no way to formally express the adequacy of marginal lubrication in terms of resulting friction, wear or propensity for catastrophic surface failure (CSF). The author has stressed that a point of great confusion in the literature is that friction,

in the literature is that friction, wear and CSF are all used as measures of adequacy of lubrication, but there is no connection between them. That is, high friction is not always connected with high wear rates, and neither is high wear rate is connected with the tendency of CSF. Broadly, the paper constitute the unfinished work in Tribology. Biswas(59) has reviewed the state of knowledge with respect to sliding wear where planes are parallel and separated by roughness of bodies. Also, the author has highlighted some novel challenges which have emerged; the role of in-situ tribofilm formation on mild wear, the role of material instabilities and strain rate response on severe wear mechanism and nano-scale wear. Holmberg, Mattews and Ronkainen(60) have described the tribological mechanisms of coated surfaces using a generalized holistic approach in dry sliding contacts. The authors have illustrated the differences by experimental results in mechanisms of dry, water and oil lubricated contacts from diamond-like coatings sliding against steel and alumina balls. The developed approach is based on macro, micro, nanophysical and nanochemical contact mechanism and material transfer. Manfred Fuch(61) described the scenario of lubricant market of the world and has highlighted that in the lubricant industry there will always be a place for those concentrating on their particular strengths and doing their 'homework' keeping performance as a main goal. Bhatnagar et.al.(62) gave overall view of the Tribology in Indian scenario. The authors have discussed the importance of optimum tribological practices, energy efficient lubricants, invention of new products and tribology research in India. Mang(63) discussed the lubricants for the next century and expressed that the efforts will be diverted for the reduction in the system costs by extended service intervals initiated by machinery manufacturers. And also the requirement for lubricant development will continue to be environmental and safety-at-work effects. In general author has focussed discussions on the future base oil developments. Other paper on the recent trends was by Surbey(64) which discussed about maintenance and automotive lubrication. Gopalakrishna(65) described the tribological problems in heavy industry dealing with power plant equipments including turbines, motors, pumps etc. The importance of testing of extreme pressure and antiwear lubricants used in bearings and gear mechanisms was highlighted by Alliston-Greiner and Plint(65). The authors gave outlined relationships of wear and failure to energy dissipation and provided some guidance over the design for the evaluation of elastohydrodynamic lubricated contacts.

9. CONCLUSIONS

By the gist summary of the technical papers presented in ICIT '97, it seems that in the field of Tribology although much work has been done but still it is exiguous. There is an exigent requirement for fundamental lucidity in various aspects of Tribology.

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LET'S THINK IT OVER

"All pains, sorrows and misfortunes come by a process of undeviating and perfect law because you deserve them. That, by first enduring, and then understanding them, you may be made more stronger, wise and nobler".

Whisper from Eternity

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