



TSI Newsletter



A Quarterly Newsletter from Tribology Society of India

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

FROM THE DESK OF ORGANISING SECRETARY



V. Narayan Sharma
Organising Secretary, ICIT '97

International Conference on Industrial Tribology 1997

ICIT '97 is being organised at Calcutta in the first week of December 1997. The Conference to be held at the Oberoi Grand Hotel situated in the heart of the city, would start late afternoon on Tuesday, 2nd December and would conclude by the evening of Friday, 5th December.

As you are aware, TSI assigns the privilege and responsibility for organising biennial conferences to one or more companies or institutions. ICIT '97 is being organised by Balmer Lawrie & Co. Ltd. and Balmer Lawrie-Fuchs Ltd.

You would have received the Conference Announcements and Calls for papers. If you have not (or if you wish to have subsequent communications regarding the Conference sent to anyone else), please contact the Conference Secretariat.

Technical Sessions

There has been very good response for presentation of papers. Well over a hundred abstracts were received. About sixty have been short-listed; roughly one-fourth of these from abroad. Communication has been sent out to all those who had forwarded abstracts. If you have not received any response, please contact the concerned Session Organiser or the Technical Committee Chairman. (Addresses and fax/phone numbers were given in the last issue of the TSI Newsletter).

Over 400 delegates, including about 50 from abroad, are expected to participate in the Conference. They would be representing a wide spectrum of industries such as Automobiles, Aviation, Bearings, Earthmoving machinery, Engineering, Lubricants, Mining, Power, Railways and Steel apart from renowned Research Institutes and Universities.

Accommodation

Apart from The Oberoi Grand, a number of other hotels are offering accommodation at discounted rates. Details have been given in the second Announcement. As the Conference is taking place in the peak tourist season, it would be prudent to book your accommodation well in advance.

Excursions

Local excursion for delegates/spouses can be arranged on request. The Conference Secretariat can also make arrangements for tours to Puri, Konark, Bhubaneswar, etc. Two to four day packages can be organised immediately after the Conference. Interested delegates may ask for details. Other specific tour requests can also be considered. Tour bookings must however be confirmed by 1st November '97.

Exhibition

Along with the Technical sessions, there would be an exhibition at the conference venue, offering opportunity for display of products and services. As the number of stalls are limited, early booking is suggested.

Sponsorship/Advertisements

Opportunities are available for sponsorship of Conference kits and certain events as well as for advertisements in the Souvenir and newspaper supplements to be published on the occasion. The Conference Secretariat would be glad to provide details.

With your continued cooperation and support, we are sure ICIT '97 would be a major success and it will contribute significantly to the development of the science of Tribology and dissemination of its benefits.

On behalf of the organisers of the Conference I have great pleasure in welcoming you to ICIT '97.

Conference Secretariat:

Balmer Lawrie & Co., Ltd., P-43, Hide Road Extn., Calcutta - 700 088,
India, Phone : +91-33-4492653 / 4392222, Fax : +91-33-4492277 / 2424541

GUIDELINES FOR CREATION AND OPERATION OF LOCAL CHAPTERS OF TRIBOLOGY SOCIETY OF INDIA

The Tribology Society of India (TSI) is committed to providing a common forum for technologists, scientists and industrialists to meet and to foster the advancement of tribo-science through its various activities. Although the Society organises various National level conferences, seminars and workshops at various locations on a periodic basis, need has been felt for further fostering such and other activities on a more active and regular basis through formation of Local Chapters of the Society. As ours is a large country and the local needs vary from region to region, it is perceived that the Local Chapters can effectively address such requirements, and also further strengthen the National level efforts of the Society. In the above background, the Executive Committee of TSI has decided on broad guidelines for creation and operation of Local Chapters for the Society as under:

1. **The Local Chapters will be located at places having at least 15 TSI members and will be named "TSI (.....Local Chapter)"** For example Tribology Society of India (Mumbai Local Chapter).

2. Additional criteria for formation of Local Chapters will be that the proposed location should be a place where tribology is being actively pursued by institutions and/or industry and where facilities for communication by telephone, fax etc. are adequately available. The Chapter must also have access to facilities where meetings can be conducted periodically.

3. **Approval of the Executive Committee of TSI will be necessary for formation of a Local Chapter.** TSI, on considerations of logistics, operational/administrative convenience etc. may approve formation of a Local Chapter, or alternatively, advise the proposers of the Chapter to join another Local Chapter already in existence or under formation. The decision of TSI in this regard will be final and binding on all concerned.

4. **All members of the Local Chapters must be members of TSI.**

5. The Local Chapter should elect a Regional Secretary, a Regional Treasurer

and other members of Local Executive Committee and inform the names of these office bearers to TSI. The tenure of these office bearers should be for a period of two years. However, the Regional Secretary of the Local Chapter will be considered responsible for operating and maintaining the Local Chapter and will be the contact person for TSI, and his election will have to be approved by the President, TSI. Under extraordinary circumstances, President TSI, under the advice of the Executive Committee of TSI may also dissolve the Local Executive Committee and convene fresh elections for a new Local Executive Committee or disband the operations of a Local Chapter.

6. Each Local Chapter will maintain administrative and financial records according to the "Finance Committee (TSI)" guidelines. Copy of these guidelines can be obtained from TSI on request.

7. Each Local Chapter may open an account in a local bank in the name of TSI, Local Chapter with the provision that the account may be operated jointly by the Regional Secretary and the Regional Treasurer.

8. The Regional Secretary will be responsible for all the activities of the Local Chapter including planning of all local events, workshops, meetings, seminars, talks etc. in accordance with the aims and objectives of TSI. The permission of TSI Executive Committee is not required for holding such events/activities, but the Local Chapter should keep TSI Executive Committee informed and also send a report on these activities to TSI on a quarterly basis.

9. **It is expected that the Local Chapters will be self-supporting financially. However, TSI will provide to each Local Chapter, an annual Grant upto Rs.1000/- towards incidental expenses actually incurred for activities in accordance with the aims and objectives of TSI.** Grant for the subsequent year will be released only after the statement of accounts for the earlier year is

(Contd on... 3)

MICRO AND NANO TRIBOLOGY - RECENT DEVELOPMENTS

Prof. M. K. Ghosh - Dept. of Mechanical Engineering, Institute of Technology, Banaras Hindu University, Varanasi.

Surface characteristics play a significant role towards controlling the tribological response of a material. Much finer tribological details need to be investigated pertaining to surface phenomenon.

Furthermore, development of micromachines and their manufacture have raised the issues in Tribology at micro and nano meter scale. In micromachines, the dimension of components decrease, subsequently surface area and volume also decrease in proportion to square and cube of the decrease of linear dimension. Consequently, surface texture and tribological characteristics become extremely important at these dimensions. It is in this context development of micro and nano scale tribology has become the challenge for advancement of futuristic research in Tribology.

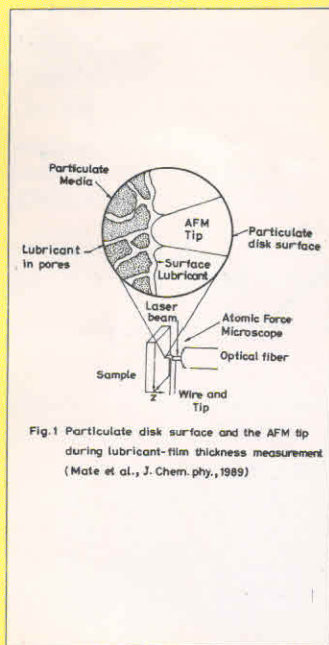


Fig. 1 Particulate disk surface and the AFM tip during lubricant-film thickness measurement (Mate et al., J. Chem. Phys., 1989)

To study tribological characteristics at nano meter scale, specific analytical tools such as Atomic Force Microscope (AFM) and Scanning Tunneling Microscope (STM) have been developed and are being used

currently to characterise surfaces. Basic tribological issues that are involved at these scales which require precise estimation as well as proper governing laws that may adequately describe the phenomena are:

1. Characterisation of surfaces which were hitherto being sufficiently described and measured by stylus and optical profilometry at a submillimeter level.
2. Estimation of forces of adhesion and friction at a nano scale, and wear or removal of ultra thin lubricant coating under these conditions.

Answers to questions arising related to above issues at the micro and nano meters scales have been, to some extent, forthcoming with the development of analytical tools such as AFM (Fig. 1) and STM albeit at a qualitative level so far. Correct assessment of friction, adhesion and wear quantitatively are issues still to be resolved. Therefore, micro and nano meter scale tribology will be in focus in near future. AFM was invented by Binnig et al. [1]. Its use has resulted in significant understanding and proper insight into nano scale surface topography as well as surface interactions. It can be thought of as a nano scale profiler. A sharp tungsten tip (of radius 50 nm) fixed at the end of a lever is brought within atomic dimensions of a surface by piezoelectric transducers (PZTs). The atoms at the end of the tip experience a repulsive force due to orbital overlap with the atoms on the surface. The force acting on the lever causes a deflection which is measured by laser interferometry. The deflection can be measured to within ± 0.02 nm. Accordingly, for a typical lever force constant of 10 N/m, a force as low as 2×10^{-10} N (corresponding normal pressure 1 MPa) could be detected. Surface topographs are obtained by scanning the surface under consideration in X and Y planes while a feedback loop keeps the force or force derivative constant. The AFM operated in this so called repulsive mode is capable of offering vertical and lateral resolutions less than 0.1, 0.2-0.4 nm, respectively. In addition to 3-D profiling of disks with nanometer resolution, the AFM can also be used to map out

lubricant distribution across the asperities. The lubricant thickness is obtained by measuring the forces on the tip as it approaches contacts and pushes through the liquid film. AFM has been used to measure the surface topographs of magnetic disks by Bhushan et al. [2], which span the range from 1 μ m to 2 nm resolution. Lubricant thickness distribution of perfluorinated polyether lubricant have also been studied.

To evaluate nanomechanical and nanotribological properties of thin films a point contact microscope has been developed by Kaneko et al. [3]. It uses a laminated PZT actuator to control the position of a leaf spring cantilever with a sharp tip mounted at its free end. The force applied to the sample surface by the tip is controlled by means of a tube scanner and an optical head. The point contact microscope has been used to measure the hardness of gold films and polycarbonated substrates. Also, micro wear and submicron wear properties of polymers and various thin films such as amorphous carbon, fluorinated silicon containing carbon, boron nitride and carbon implanted silicon, have been studied. [4, 5]

Scanning tunneling microscope developed by Binnig et al. [6] is similar to AFM and has been used to characterise surfaces with a thin coating on nanometer scale. A focusing error detection type optical head mounted on one slider and a tube scanner mounted on the other slider can be moved using the micro screw heads. For the studies, a tip assembly with a sharp tip is mounted on a laminated PZT. The tip can be precisely moved in the Z-direction by the laminated PZT. The sample is mounted on a magnetic sample holder held at the end of the tube scanner by a small magnet. The sample is moved precisely in the X, Y and Z directions by the tube scanner. The movement of the tip in Z-direction is monitored by measuring the deflection of the parallel leaf spring using the optical head. The resolution of less than 1 nm, has been achieved.

A STM is useful to investigate atomic or molecular level physical and chemical properties of surfaces, but

can not directly measure the actual surface of non-conductive layers. An ultra low load (less than 1 μ N) contact profilometer with a very sharp stylus has been developed for observing the non-conductive topography. The tip is supported by a parallel leaf spring unit with a small spring constant (3-50 N/m). PZTs are mounted to move a sample for contacting, loading and scanning. Tip displacement is measured by an optical head. The micro wear is measured by detecting spring displacement at an ultra-low load, (a tenth of wear test load). A rectangular specimen coated with silicon-containing carbon film is designed to reciprocate by means of PZTs. A diamond chip (radius 0.1 μ m) is slid against the specimen surface. The load and friction forces are measured with two pair of parallel plane springs attached to a strain gauge.

In view of the above, it appears that many complex issues involved in surface characteristics of material tribology under different environments will be tackled in the near future with the help of advanced techniques and analytical tools which are being developed now and put to use.

References :

- (1). Binnig, G., Quate, C.F., and Gerber, Ch. 1986, "Atomic Force Microscope" Phys. Rev. Lett., Vol. 56, N. 9 pp 930-933. (2). Bhushan, B and Blackman, G.S., 1991 "Atomic Force Microscopy of Magnetic Rigid Disks and Sliders and its Application to Tribology". Trans. ASME, J1. of Tribology, Vol. 113 pp 452-457. (3). Miyamoto, T., Kaneko, R and Ando, Y., 1990, "Interaction Force Between Thin Film Disk Media and Elastic Solids Investigated by Atomic Force Microscope". Trans. ASME, J1. of Tribology, Vol. 112, N. 3, pp 567-572. July, 1991, pp 452-457. (4). Miyamoto, T., Kaneko, R. and Miyake, S., 1991 "Tribological characteristics of Amorphous Carbon Films Investigated by Point Contact Microscopy" J. Vac. Sci. Technol., B Vol. 9, N. 2 pp 1336-1339. (5). Mate, C.M., Lorenz, M.R. and Novotny, V.J., "Atomic Force Microscopy of Polymeric Liquid Films" J. Chem. Phys., Vol. 90 N. 12, pp 7550-7555. (6). Binnig, G., Rohrer, H., Gerber, Ch., and Weibel, E., 1982 "Surface Studies by scanning Tunneling Microscopy" Phys. Rev. Lett., Vol. 49, pp 57-61.

TECHNICAL INNOVATION

MOTORS WITHOUT BEARINGS AND LUBRICANT

"Motors without Bearings and Lubricant" do not mean the motors without lack of bearing forces, which are necessary in any case to stabilise the rotor, but essentially, the absence of actual bearings and lubricant in the motors. In contrast to the conventional motor drives, the bearing forces in such motors are not built and taken up by separate conventional/magnetic bearings located on both ends of the motor, but in the motor itself. In a

"Motor without Bearings and lubricant" the active motor coils generate not only the torque like in a conventional motor, but also, the radial magnetic bearing force which is needed to suspend the rotor of the motor.

The idea of combining the bearing function and torque generation in an electric motor is quite innovative and unique. In an electric motor two different magnetic forces exist namely the Lorentz

force and the Maxwell force (reluctance force). The Lorentz force acts on a conductor with a current flow and it is in a magnetic field. The formation of the torque in a polyphase motor is based on it. The maxwell forces in a motor are produced in magnetic circuits at the boundary layers of materials with different permeability. Their directions are right angled to the rotor surface and their sum equals zero because of the symmetrical flux distribution. A

displacement of the rotor out of the centre of the motor gives an asymmetrical flux distribution and creates a radial force in the direction of the displacement. This effect is being transformed to develop the "Motors without bearings and lubricant". The principle has been successfully demonstrated by M/S. SULZER.

- Dr Har Prashad,
BHEL, Corporate R&D, Hyd.

MEET OUR EMINENT TRIBOLOGISTS

Dr A. Sethuramaiah initially exposed to tribology as a trainee at the French Petroleum Institute, Paris during 1962-63. Later worked for 3 years as Scientist at IIP, Dehradun and for additional 3 years as Senior Technical Officer, Fuels & Lubricants at Indian Airlines, Bombay. Spent one year during 1969-70 as UNESCO PG fellow in chemistry and chemical engineering at Tokyo Institute of Technology. Continued at the same Institute to obtain D. Engg. in 1973 from the Deptt. of chemical engineering under the able guidance of Prof. T. Sakurai. The research work was in the area of tribochemistry. Later Dr Sethuramaiah served briefly at IIP and HP refinery Bombay during 1974-76. In 1976 joined back at IIP as Scientist E1 heading tribology group and continued till 1984. Since 1984 Dr Sethuramaiah is working as Professor at ITMMEC in the tribology area.

His major experience spread over three decades has been in tribology and related areas. **Initial research activity at IIP was in the areas of boundary lubrication and product development.** In the last 12 years Prof. Sethuramaiah is involved in academic and industrial research at ITMMEC. His major contributions to Tribology are in following areas;

i) **Influence of asperity level conformity as lubrication.**

ii) **Fatigue wear modelling through a study of tribological response of pre-stressed material.**



Dr A. Sethuramaiah

iii) **Development of oblique plastic impact technique to study lubricant behaviour under plastic deformation conditions.**

iv) **Contact modelling of non-gaussian surfaces and its relevance to running-in of honed liner-ring contacts in IC engines.**

Current involvement of Prof. A. Sethuramaiah in industrial projects include estimation of residual life of turbine oils, effective techniques to reduce running-in time for IC engines, possibility of replacing babbit with polymer lining for thrust pads.

Prof. Sethuramaiah served as TSI President during 1991-93. Co-authored more than 30 research papers in the above areas. He is member of editorial board of Lubrication Science published by Leaf Coppins, France, Life member of Tribology Society of India and member of Indian Institute of Chemical Engineers.

TSI is proud of the contributions made by Prof. Sethuramaiah to the Science of Tribology. "TSI News Letter" congratulates Prof. Sethuramaiah on his outstanding contributions.

Dr. Ing. B.V.A. Rao, born on 30th March 1933 in Bangalore, served Indian Institute of Technology, Madras for thirty years. He retired as Professor in 1993, contributing to many areas of Mechanical Engineering, specially his contributions to the field of Industrial Tribology is most significant. **He was one of the pioneers in this area, and was the first to start a postgraduate programme in Industrial Tribology as early as 1973.** He worked closely with the Oil Industry including the Recyclers. **Dr Rao was the first to organise the very first National Conference in 1974 in Madras in Tribology, inviting many major oil companies to contribute.** He was also the first to organise the All India Recycler's Conference in 1980, which helped the recycling industry to get recognition and ministry's clearance for the ISI certification. Seventies was the period of real oil crisis, and his timely support to recycling industry is worth commending. Dr. Rao's works were recognised by the Indian National Academy of Engineering by electing him as a Fellow in 1988.

Dr Rao took his Doctorate Degree in 1961 from the Technical University, Dresden, Germany, and his work was on "Stabilities of Rotors due to oil films in journal bearings" and thereby contributed to the understanding of a problem, which was critical in those days.

One of his works on the LPG Swirl Burner was recognised by the Acoustical Society of India for the Sir CV Raman award in 1994. The same year, he brought out a monogram on "Tribology in Engineering Design" published by National Design and Research Forum



Dr Ing B.V.A. Rao

of the Institution of Engineers (India).

Some of his keynote addresses of Dr Rao worth remembering are: "Industrial Tribology - Innovations and futuristic needs of a developing country" at the National Seminar of TSI in Bombay in 1986, and 'Research on Engine Tribology in India' at the Mushashi Institute of Technology, Tokyo, Japan in 1993. He has large number of publications through the work carried out by him and his students and colleagues in this area. For all these contributions, the Tribology Society of India joined hands with the Indian Institute of Technology, Madras to felicitate him in 1993, on the eve of his retirement and brought out a proceedings on 'Frontiers of Tribology and Condition Monitoring' contributed by his students and well wishers and published by Tata-Magraw Hill.

Tribology Society of India is proud of the contributions made by Dr Rao to the Science of Tribology. "TSI News Letter" congratulates Prof. Rao for his outstanding services in the development of Tribological Practices for improved productivity and economy of our country.

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received and approved by TSI.

10. In addition to the annual grant, TSI may also agree to provide seed money on a case to case basis for Special Events such as Workshops, Seminars, Training Programmes etc. proposed to be organised by the Local Chapter either on its own or in conjunction with TSI/another Local Chapter. In all such cases, seed money will be provided by TSI on the stipulation that 50 percent of the surplus funds generated from such Special Events, along with the seed money, shall be transferred to TSI immediately after the Event. The Regional Secretary will be required to submit a detailed statement of expenditure and income pertaining to each event within one month after the Special Event. For purpose of clarification, any event organised by the Local Chapter for which seed money has been provided by TSI and/or for which a fee has been collected from participants, will be treated as a "Special Event"

11. The Regional Secretary will be required to submit to TSI within one month after the end of each year, detailed accounts of the expenses incurred in the previous year. In case the Local Chapter has also organised a Special Event during the year, the statement of accounts, duly audited and certified by a chartered accountant, will have to be submitted to TSI within three months of the close of the financial year.

12. **Local Chapters are encouraged to have frequent interaction with TSI and other Chapters.** They may also hold joint programmes/events with other Chapters or render help to TSI in organisation of a National Event. 13. In case of any dispute regarding the functioning of a Local Chapter, the decision of the Executive Committee of TSI shall be final.

14. The guidelines indicated herein are indicative and not exhaustive. Advice of TSI Executive Committee may be sought in case any further clarifications are required. **TSI also reserves the right to amend/modify these guidelines from time to time.**

ABSTRACTS OF SOME OF THE LATEST SIGNIFICANT PUBLICATIONS BY THE TSI MEMBERS IN THE REPUTED JOURNALS

An Experimental Investigation on the misalignment effects in journal bearings

Tribology Transaction, Vol.40 (1997), issue 2, pp 235-242 by **B.S. Prabhu**, IIT, Madras.

Abstract :

The author has reported the investigations to evaluate the experimental performance of misaligned cylindrical and three-lobe journal bearings. **The parameters studied are friction through coastdown analysis, unbalance response, film thickness and system damping.** With the decrease in film thickness as the bearing misalignment increases, the friction and system damping are reported to increase.

* * *

Characterization of Nitrogen and Phosphorous components in a multifunctional lubricant additive by NMR and IR Techniques.

Lubrication Engineering, Vol.53, issue 4, April 1997 pp 17-23 by **V Bansal**, M.I.S. Sastry, A.S. Sarpal, S.K. Jain,

S.P. Shrivastava and A.K. Bhatnagar. Indian Oil Corporation Ltd., Research and Development Centre, Faridabad.

Abstract :

This paper highlights the application of ^{31}P , ^1H , ^{13}C -NMR and FT-IR techniques for the compositional analysis of a commercial nitrogen and phosphorous-containing ashless multifunctional additive. The assignment of signals in the ^{31}P , ^1H , ^{13}C -NMR and IR spectra of the sample facilitated the identification of different phosphorous-containing species, i.e., trialkyl phosphate, alkyl amine salt of mono/dialkyl phosphoric acid and polyalkyl phosphate. **The alkyl group in all the phosphorous-containing components has been found to be 2-ethyl hexyl by the ^{13}C -NMR spectral analysis.** Further, these components have been separated by column chromatography and their chemical structures have been confirmed by the above spectroscopic techniques.

* * *

Evaluation of Dynamic Coefficients of a Two-lobe journal bearing using an electric analogy approach

ASME, Journal of Tribology, Volume 118, July 1996, pp 657-662 by **Har Prashad**, BHEL Corporate Research & Development Division, Hyderabad.

Abstract :

The author reports a theoretical approach to evaluating capacitance resistance, capacitive reactance and impedance of the lower and upper lobes of a two-lobe elliptical hydrodynamic journal bearing under various operating conditions. It is established that the change in capacitance and resistance with the change in eccentricity ratios is non-linear. **The capacitance and resistance, thus determined, are correlated with the dynamic coefficients of bearings using an electric analogy.** The analysis may have a potential to diagnose the stability regime of a bearing through the bearing's electrical parameters. **The electrical analogy may be a useful alternative to conventional techniques.**

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Magnetic Flux Density Distribution on the Track Surface of Rolling - Element Bearings - An Experimental

and Theoretical Investigation.

Tribology Transaction, Vol.39 (1996), issue 2, pp 386-391 by **Har Prashad**, BHEL, Corporate R&D, Hyderabad.

Abstract :

This paper brings out the theoretical model to determine the developed magnetic flux density on the track surface of inner race, outer race and rolling elements of a rolling element bearing operated under the influence of electric current. The flux density, analytically determined, is compared with that of the flux density developed on the track surface of races and rolling elements of the bearings tested on the bearing test set-up under the influence of electric current. **Also, the residual magnetic flux density on the damaged bearings of motors and alternators have been measured and the theoretical model is used to determine the amount of current flow through the damaged bearings.** The current flow through the bearings, thus established, has been compared with that of the current evaluated by the measurement of shaft voltage and bearing resistance.

INTERNATIONAL SYMPOSIUM ON FUELS & LUBRICANTS (ISFL)

ISFL is being organised by Indian Oil Corporation from December 8-10, 1997, at New Delhi, so that India's present and future needs on fuels and lubricants are properly understood. And, also to suggest the directions in which the technology for Fuels and Lubricants is to be designed for the next century.

Some of the key speakers during the ISFL are :

Diesel Engine Oils:

D.J. Smith - AVL, U.K.
H. Wagner - AVL, Austria
P. Pritthart - AVL, Austria

Passenger car motor oil:

David Copp - BP, UK
G. Dyer-Ethyl - Asia-Pacific
B.R. Dohner - Lubrizol, USA

Gear and Transmission Oils:

Schiemann - Lubrizol, USA
R. Banavali - ROHM & HAAS
Lubricating Oil Base Stocks:

R. Singhvi - EPA, USA
Himmat Singh - IIP

Fuels:

G.T.Babic - Texaco, USA
Sudhir Singhal - IIP

Grease :

A.K. Bhatnagar - IOC, R&D
Har Prashad - BHEL Corporate R&D Division

Marine Diesel Engine Oils:

D. Friedel - MAN B&W

Emissions:

D. Bastenhof - SEMT Pielstick
Mung Tak - BP, Singapore
C.B. Prakash - Transportation, Canada

Biodegradable Lubricants:

S.M. Zarook - KFUPM, Saudi Arabia
R.J. Nadeau - EPA, USA

Metal Working Oils :

Theo Mang - FUCHS, Germany
D. Anderson - Spectro, USA

Plenary Speakers

1. MARKLOGAN
Oronite Chemicals (Chevron Corp.) USA
- Railroad & Diesel Engine Oils**
2. KARL J. SPRINGER
South West Research Institute, USA
- Emission & Fuel quality aspects.**

For further details please contact: Dr S.P. Shrivastava, Organising Secretary, ISFL, C/o. IOCL, R & D Centre, Sector 13, Faridabad - 121 007.

RESPECTFUL HOMAGE IN THE MEMORY OF PROFESSOR RAM SINHASAN



"With fond remembrance TSI members pay their tributes to the departed soul who devoted his life to the Science of Tribology"

Dr Ram Sinhasan was born on March 12, 1945. He joined the faculty of Mechanical and Industrial Engineering Department in the year 1969. He was awarded Doctorate degree in Mechanical Engineering by University of Roorkee in 1973, and became professor in 1981. Professor Sinhasan was a fellow of Institution of Engineers

(India), Life member of Tribology Society of India & many other professional associations. **He contributed immensely in the field of Tribology for about 26 years by his publications of more than 150 technical papers in International/ National journals and guidance of 16 Ph.D. and 35 M.E. students.** Prof. Sinhasan was consultant to many leading industries in India.

In recognition of his research work in the area of Fluid Film Lubrication, Dynamics of Mechanical System, Vibrations, Rotor Dynamics etc., he received several awards. He was an honest, sincere and hard working professional thoroughly dedicated to his duty. His sudden demise on September 12, 1996 had shocked TSI members. **The academic world has lost an outstanding researcher, a true academician and dedicated Tribologist.**

TSI members pray to the Almighty to bless his noble soul to rest in peace.

LET'S THINK IT OVER

**"Every Evolution is preceded by an Involution"
- Whisper from Eternity**

To our readers - the suggestions are invited for improvement of TSI Newsletter. TSI Members are requested to send short technical communications for Publication in TSI Newsletter to the Editor.