

EMERGING TRENDS IN TRIBOLOGY

ICIT '01

APRIL 8 - 11, 2002

JAMSHEDPUR, INDIA

A large, embossed gear design is centered on the cover. It features a large gear with a smaller gear inside it, both with intricate teeth and concentric circles. The embossing is subtle, blending into the light blue background.

***Proceedings of the
Third International Conference
on Industrial Tribology***

Edited by C. Mishra



ICIT '01

EMERGING TRENDS IN TRIBOLOGY

Proceedings of

The Third International Conference

on Industrial Tribology

April 8-11, 2002

Jamshedpur, India

Edited by

**C. Mishra
Chief of Mechanical Technology Group
Tata Steel**

ICIT '01

**THIRD INTERNATIONAL CONFERENCE
ON
INDUSTRIAL TRIBOLOGY**

**APRIL 8-11, 2002
JAMSHEDPUR, INDIA**

Organised by

TATA STEEL

Under the Aegis of

TRIBOLOGY SOCIETY OF INDIA



NATIONAL STEERING COMMITTEE

Dr. A. K. Bhatnagar
Director (R&D), Indian Oil Corporation Ltd.,
Faridabad

Dr. Anil Kakodkar
Chairman, AEC & Secretary, DAE,
Mumbai

Dr. Bikash Sinha
Director, Variable Energy Cyclotron Centre,
Kolkata

Dr. V. Siddhartha
Officer on Special Duty,
Ministry of Defence, New Delhi

Lt. Gen Amarjit Singh
Ministry of Defence,
New Delhi

Shri Sudhir Singhal
Director, Indian Institute of Petroleum,
Dehradun

Dr. N. Ramakrishnan
Director, Regional Research Laboratory,
Bhopal

Prof. D. V. Singh
Ex Vice Chancellor,
University of Roorkee

Prof. Govardhan Mehta
Director, Indian Institute of Science,
Bangalore

Shri S. K. Kapoor
Director (M), Hindustan Petroleum Corporation
Ltd., Mumbai

Dr. S. K. Bhattacharya
Managing Director, Durgapur Steel Plant,
Durgapur

Shri S. Rammohan
CMD, CPCL,
Chennai

Dr. John Battersby
Managing Director, Lubrizol India Ltd.,
Mumbai

Prof. A. Sethuramiah
ITMMEC, IIT,
New Delhi

Shri Dipankar Sen Gupta
EIC (Shared Services), Tata Steel,
Jamshedpur

Prof. M. C. Dwivedi
Prof. Emeritus, Department of Chemical
Engineering, IIT, Mumbai

Prof. B. C. Majumdar
Department of Mechanical Engineering,
Indian Institute of Technology, Kharagpur

Prof. S. K. Biswas
Dy. Director,
Indian Institute of Science, Bangalore

Shri Sanjay Krishanmurthi
Executive Director (Lubricants), Bharat Petroleum
Corporation Ltd., New Delhi

Shri M. C. Sachdeva
Executive Director (Eastern Region),
Indian Oil Corporation Ltd., Kolkata

Shri Arun Jyoti
Executive Director (Western Region),
Indian Oil Corporation Ltd., Mumbai

Dr. J. Bhatia
Chairman, Envirotech India,
Mumbai

Dr. U. Muralidharan
General Manager (R&D), Timken Engineering and
Research India (P) Ltd., Bangalore

Shri N. R. Raje
General Manager (L-T), Indian Oil Corporation Ltd.,
Faridabad

Shri V. N. Sharma
General Manager, Balmer Lawrie & Co. Ltd.,
Kolkata

Shri P. Jagannathan
General Manager (Mechanical), Bharat Heavy
Electricals Ltd. R&D, Hyderabad

Organising Secretary

Shri C. Mishra
Chief of Mechanical Technology Group
Tata Steel, Jamshedpur

NATIONAL PLANNING COMMITTEE AND BOARD OF EDITORS

Dr. A. K. Bhatnagar
Indian Oil Corporation Ltd.,
Faridabad

Prof. D. V. Singh
Ex Vice Chancellor,
University of Roorkee

Prof. S. C. Jain
Indian Institute of Technology,
Roorkee

Prof. B. C. Majumdar
Indian Institute of Technology,
Kharagpur

Shri Sudhir Singhal
Indian Institute of Petroleum,
Dehradun

Dr. G. K. Sharma
Indian Oil Corporation Ltd.,
Faridabad

Shri A. K. Mehta
Indian Oil Corporation Ltd.,
Faridabad

Dr. J. Bhatia
Envirotech India
Mumbai

Dr. Har Prashad
Bharat Heavy Electricals Ltd.
Hyderabad

Prof. G. S. Yadava
Indian Institute of Technology,
New Delhi

Dr. M. R. Tyagi
Indian Institute of Petroleum,
Dehradun

Dr. O. N. Mohanty
Tata Steel
Jamshedpur

Shri Sudhakar Jha
RDCIS SAIL
Ranchi

Dr. K. P. Naithani
Indian Oil Corporation,
Faridabad

Shri C. Mishra
Tata Steel,
Jamshedpur

Shri V. N. Sharma
Balmer Lawrie & Co. Ltd.,
Kolkata

Prof. S. K. Biswas
Indian Institute of Science,
Bangalore

Prof. S. Ray
Indian Institute of Technology,
Roorkee

Dr. U. Muralidharan
Timken Engineering and Research India (P) Ltd.,
Bangalore

Shri N. R. Raje
Indian Oil Corporation Ltd.,
Faridabad

Shri P. Jagannathan
Bharat Heavy Electricals Ltd. R&D,
Hyderabad

Shri V. Martin
Indian Oil Corporation Ltd.,
Faridabad

Shri Mukesh Gupta
Castrol India
Mumbai

Shri Barun Chakraborty
Larsen and Toubro,
Mumbai

Shri Ajay Kumar
Indian Oil Corporation Ltd.,
Faridabad

Shri N. M. Dubey
Bangalore Local Chapter,
TSl

Dr. A. L. Ravimohan
Castrol India,
Mumbai

LOCAL STEERING COMMITTEE

Shri C. Mishra	Shri Suresh Kumar
Dr. M. D. Maheshwari	Shri Sanjay Singh
Shri Sarvesh Khanna	Shri B. K. Singh
Shri B. K. Das	Shri Hemant Kharkar
Shri D. N. Jha	Shri D. P. Deshpande
Shri Rajiv Mangal	Shri M. Ranganathan
Shri S. K. Roy	Shri H. Jha
Shri S. Mokashi	Shri Sanjiv Paul
Shri R. Battish	Shri P. K. Ghosh
Shri D. M. Choudhary	Shri V. Balasubramanian
Shri P. Sarode	Shri R. B. Iyer
Shri O. B. Krishna	

LOCAL ORGANISING COMMITTEE

Shri C. Mishra	Shri Rajesh Dubey
Shri Amresh Pandey	Smt. Santosh Ranjan
Shri Shailesh kumar	Shri Rajesn Kumar
Shri Sanjay	Shri Suresh Kumar
Shri C. Ramaswamy	Shri B. Surendranath
Shri S. Muncherji	

SPONSORS

- * Tata Steel
- * Tribology Society of India
- * Indian Oil Corporation
- * Hindustan Petroleum Corporation
- * Bharat Petroleum Corporation
- * Balmer Lawrie & Co.
- * Bharat Shell
- * Fuchs India

CO-SPONSORS

- * TIMKEN India
- * Lubrizol
- * ONGC
- * BHEL
- * Tata Power
- * Indo Mobil
- * Total Fina Elf
- * Empire Instrumentation
- * Ador Fontech
- * Tega India

FOREWORD

Over the years, Tribology has come to be recognised as a very important aspect in all industrial operations. Tribology as it is understood today was introduced as a concept in 1966. Since then, several studies were conducted in UK, Germany, USA, Japan and China to estimate the economic impact of tribology. All these reports show that the industries all over the world loose a huge amount of money every year as a result of loss of power caused by friction and loss of material caused by wear. These studies have also highlighted that systematic application of existing scientific knowledge in the area of design, material science, lubrication, physics and chemistry etc. would result in substantial savings to the industries across the world. This has triggered a concerted effort in understanding the tribological phenomenon of interacting surfaces and applying inter-disciplinary systems approach for removing the root causes of problems for effective control of friction and wear. Over the years a great deal of scientific analysis and R&D work have been carried out to provide solutions to the problems caused by friction and wear. This has gone a long way in enhancing the life of plant and machinery, improving efficiency of operations, reducing consumption of energy significantly and preventing expensive unplanned outages.

To promote awareness and provide a platform for meaningful interaction between practising engineers, researchers and academicians Tribology Society of India (TSI) has been playing an active role since its inception in 1989. A series of National and International conferences were organised to fulfil this objective. The first international conference organised at Kolkata in 1997 had its theme "War Against Wear". "Tribology in 2000 and beyond" was the theme of the second international conference held in Hyderabad in 1999. The theme for the third International conference being organised at Jamshedpur, "Emerging Trends in Tribology", is very apt in view of the great challenges that maintenance is required to address in the 21st century.

The emerging trends in the wide spectrum of tribology namely lubricants and lubrication, maintenance, wear behaviour and modelling, condition monitoring, advanced material and coatings, current issues in tribology and the related topics are scheduled to be deliberated during the conference. About 79 papers from different industries, academia and research organizations were accepted for publication in the proceedings of the conference. I am sure the papers published in the proceedings will help in

providing answers to many of the problems faced in the industry today and set direction for future research and development work in the area of tribology, which would help the industry in reducing operational costs substantially. I am sure the delegates will have fruitful interactions during the conference and they will be in a position to prioritise the future plan of action in this respect.

The conference was scheduled from November 27 to November 30, 2001. However, due to the disturbance caused by the terrorist attack in September 2001 and the subsequent development in Afghanistan the National Executive Committee postponed the conference on requests from a large number of foreign delegates and the invitees. I feel sorry for the inconvenience caused to all concerned due to rescheduling of the conference, which was done under extraordinary circumstances.

I gratefully acknowledge the support provided by the management of Tata Steel in organising this conference. I am particularly grateful to Dr. J. J. Irani and Mr. B. Muthuraman, MD, Tata Steel, who provided generous support and guidance without which such a big event could not have been organised. I would also like to thank Mr. D. Sen Gupta, EIC (SS), Tata Steel, for his valuable contribution in organising this conference.

I am thankful to Dr. A. K. Bhatnagar, President, TSI for his continuous guidance and support which he extended to me and my team so generously. Thanks are due to Mr. V. Martin, Secretary, TSI and all the members of TSI secretariat, National Planning and Editorial Committee and the local committee members for their support, guidance and valuable work.

A core group had been working tirelessly for about two years to organise various aspects of the conference at Jamshedpur. I wish to thank particularly my colleagues Mr. Suresh Kumar, Mr. B. Sardana, Mr. Shailesh Kumar, Mr. P. D. Mundhra, Mr. Somnath Dutta, Mr. Rajesh Dubey, Mr. Rajesh Kumar, Mr. Amresh Pande, Mr. Sanjay Singh, Mrs. Santosh Ranjan, Mr. B. Surendranath, Mr. C. Ramaswamy and others who have worked together to make this conference a grand success.

C. Mishra
Chief of Mechanical Technology Group, Tata Steel and
Organising Secretary, ICIT '01

CONTENTS

SECTION 1: MATERIALS AND WEAR BEHAVIOUR

1. Influence of Test Parameters and Material Composition on The Wear Performance of Zinc-Aluminium Alloys 1-1
B.K.Prasad, O.P.Modi, A.K.Jha, S.Das, Rupa Dasgupta, M.Singh and A.H.Yegneswaran
2. Wear Resistant Inter-Metallic Materials 1-10
C.Bhavani Sankar
3. Abrasive Wear Behaviour of Poly (Aryl) Ether Ketone Composites 1-16
A.P.Harsha and U.S.Tewari
4. Study of Dry Sliding Wear of Aluminum Flyash Metal Matrix Composite 1-31
K.V.Mahendra and Dr. K. Radhakrishna
5. Tribological Studies of Y-Psz and Al₂O₃ Ceramic – Ceramic Composites 1-38
T.Sornakumar, R.Krishnamurthy, C.V.Gokularathnam and M.Balasubramanian
6. Toughness and Wear Behavior of Transformation Toughened Ceramics 1-46
B.Basu, J.Vleugels and O.Van Der Biest
7. Latest Solutions for Combating Wear 1-59
S.Gopala Krishnan
8. Review on The Friction and Wear Resistance Properties of Metal Matrix Composites 1-65
S.Charles and Dr. V.P.Arunachalam
9. Wear Management in Cement Plants: A Challenging Task 1-76
A.N.Singh, P.Bandyopadhyay and A.K.Pathak
10. Wear Studies on Al-Si-Sic Composites 1-87
K.Chandrashekara, Dr.A.Ramachandra, Pyrasad and S.Suresha
11. Influence of Chromium Addition on Mechanical and Abrasive Wear Properties of A Hadfield Steel 1-95
T.S.V.C.Rao, O.P.Modi, A.K.Jha, B.K.Prasad, S.Das, Rupa Dasgupta and A.H.Yegneswaran

SECTION 2: WEAR MECHANISM AND MODELING

12. Mechanism of Material Removal in Al-Sic Composite During Two-Body Abrasive Wear 2-1
S.Das, D.P.Mondal, S.Sawla, S.Dixit and A.H.Yegneswaran
13. Effect of Experimental Parameters on The Mechanism of Material Removal Under High Stress Abrasive Wear Conditions 2-11
R.Dasgupta, O.P.Modi, M.S.Yadav and A.H.Yegneswaran
14. A Regression Analysis of Factors Affecting The High Stress Abrasive Behaviour of Steel 2-17
R.Dasgupta, B.Govindrajan, A.K.Jha and B.K. Prasad

- | | | |
|-----|---|------|
| 15. | Electrical Wear of MOP Thrust-Bearing of Steam-Turbine:
A Case Study
<i>S.Dutta and C.Mishra</i> | 2-23 |
| 16. | A Theoretical Model for Predicting Small Scale Wear
<i>S.K.Roy Chowdhury</i> | 2-31 |
| 17. | Fretting Wear Behavior of SIALON Ceramics
<i>B. Basu, J. Vleugels, M. Kalin and O. Van Der Biest</i> | 2-41 |

SECTION 3: SURFACE ENGINEERING

- | | | |
|-----|---|------|
| 18. | Effect of Burnishing on Titanium Alloys
<i>R.Ravinder Rao, and N.V.Narasimha Rao</i> | 3-1 |
| 19. | Coating Selection: A Case Study of Boron Impregnation
<i>Somnath Basu, Krishna M. Gupta and H. Hirani</i> | 3-7 |
| 20. | Studies on Scuffing Performance of Surface Treated AISI4340 Steels
<i>M.Ramprasad, Dr. R.Gnanamoorthy and Dr. M.M. Mayuram</i> | 3-19 |
| 21. | Salt-Bath Nitro-Carburising Process An Experience To Improve The Performance of Hot Worked Tool Steels At Ring Plant
<i>A.K.Verma, G.N. Rao and Gyan Ratna</i> | 3-27 |

SECTION 4: LUBRICANTS AND LUBRICATION BASICS

- | | | |
|-----|--|------|
| 22. | Dynamic Characteristics of Finite Hydrodynamic Porous Oil Journal Bearings in Turbulent Regime with Tangential Velocity Slip
<i>Ashok Kumar and Dr. Anjani Kumar</i> | 4-1 |
| 23. | Experimental Studies on Dynamically Loaded Journal Bearing
<i>H.Hirani, K.Athre and S.Biswas</i> | 4-9 |
| 24. | Experimental Studies on Water Lubricated Journal Bearings for Different Groove Configurations
<i>A.N. Hari Rao, Dr.A. Ramachandra and Nitin R.Wali</i> | 4-16 |
| 25. | Effect of Size of a Hole on The Performance of a Capillary Compensated Hole-Entry Hybrid Journal Bearing
<i>Satish C.Sharma, S.C.Jain and Rajneesh Kumar</i> | 4-22 |
| 26. | The Influence of Geometric Shape of Recess on The Performance of Multirecess Hybrid Journal Bearing
<i>Narendra Singh, Satish C.Sharma and S.C.Jain</i> | 4-31 |
| 27. | Performance of Constant Flow Valve Compensated Hole-Entry Hybrid Journal Bearing Including Surface Roughness Effects
<i>T.Nagaraju, Satish C. Sharma and S.C.Jain</i> | 4-41 |
| 28. | Modeling of The Effects of Surface Roughness and Polymer Additives on The Elastohydrodynamic Lubrication of Rolling / Sliding Line Contacts
<i>Punit Kumar, S. C. Jain and S. Ray</i> | 4-50 |

29. EHD Film Forming Characteristics of Base Oils: Molecular Structure-Property Correlation Studies 4-58
A.S.Sarpal, Ajay Kumar, V.Bansal, V.Martin, M.I.S.Sastry, S.S.V.Ramakumar, R.T.Mookan, G.K.Sharma, A.K.Mehta and A.K.Bhatnagar
30. The Role of Electron Spectroscopy for Chemical Analysis (ESCA) in Understanding The Boundary Lubrication in Tribology 4-74
M.C.Jain, J.Christopher, V.Martin, A.K.Mehta and A.K.Bhatnagar
31. Lithium Complex Grease with Extreme Pressure and Water Resistance Properties 4-82
T.Singh and A.K.Bhan
32. Esters Base Stocks in Lubrication – An Overview 4-90
G.Vasudev, Y.P.Rao and R.D.A.Paulmer
33. Lubricating Oils and Greases Used in Steel Mills 4-100
Wolfgang Bock, Rolf-Peter Heckler and Dr. Georg Lingg
34. Performance of Orifice Compensated Hole-Entry Hybrid Journal Bearing Including Thermal Effects 4-119
Vijay Kumar, Satish C.Sharma and S.C.Jain
35. Tribological Characteristics of Certain Antimony Dithiocarbamates as EP and Antiwear Additives 4-127
V.K.Verma, R.Singh, Vandana Srivastava and A.K.Tripathi
36. A Calculated Method for The Dynamic Coefficients of Oil-Lubricated Journal Bearings 4-134
B.B.Maharathi, A.K.Behera, S.N.Mishra, C.Kar and R.R.Das
37. Development of Noise Resistant Grease for Various Applications 4-144
P.Senthivel, G.S.Mishra, Anoop Kumar, K.P.Naithani, N.R.Raje and A.K.Bhatnagar
38. Tilting – Pad – Thrust Bearings During Starting and Stopping 4-153
Dr. T.G.Rajaswamy, B.Sai Vamsidhar and P.Smita

SECTION 5: TRIBOLOGY OF MACHINERY AND FORMING PROCESS

39. Hydrodynamic Lubrication of Diesel Engine Journal Bearings - Practical Limits to Key Performance Factors 5-1
P.S.Virdi and S.S.Banwait
40. Evaluation of Boundary Friction in Metalworking Processes 5-11
Regalla Srinivasa Prakash, U.R.K.Rao, A. Sethuramaiah and Sridhar Idapalapati
41. Improvement In Performance of A Semi-Synthetic Rolling Oil for Cold Reversing Mill 5-19
P.Pathak, R.R.Bhaskar, S.Rath and M.L.Das
42. Tribology in Steel Wire Rope 5-28
M.Mashiruddin and Dr. S.S.Mishra
43. Open Gear Lubrication in Cement Plants 5-35
P.S.Natesh
44. Effect of Contaminated Lubricant on Turbine Bearing Material 5-41
Anand Prabhakaran and C.R.Jagga

SECTION 6: AUTOMOTIVE AND POWER TRANSMISSION LUBRICANTS

45. Studies on Development of Running-In Procedure on Single Cylinder Engine 6-1
M.R.Tyagi, M.Abraham, V.R.K.Sastry, Mohan Lal, Seth Pal, S.Singhal, S.D.Saranathan, Reji Mathai, G.K.Sharma, N.R. Raje and A.K.Bhatnagar
46. Perspectives on Laboratory Evaluation Towards Rationalizing a Medium Speed Diesel Engine Oil for Severe Railroad Service 6-9
S.K.Mazumdar, O.P.Tiwari, D.M.Chaubey and A.M.Rao
47. Development and Field Evaluation of 2-Stroke Gasoline Engine Oil Containing Fuel Additive and Lubricity Improver for Cleaner Environment 6-18
A.K.Jain, A.B.Shah, M.P.Bangwal, D.V.Prasad and A.K.Bhan
48. Coconut Oil As An Alternative Lubricant for Two-Stroke Si Engines – A Performance Study 6-26
A.Kalaisselvane and H.Mohammed Raffiq
49. Understanding Relationships between NMR Derived Compositional Parameters and Lubricity (HFRR Test Results) of Diesel Fuels 6-32
G.S.Kapur, A.S.Sarpal, Ajay Kumar, V.Martin, A.K.Mehta and A.K.Bhatnagar
50. Running-in and Steady State Wear Studies on Cast Iron Cylinder Liner 6-43
Rajesh Kumar, Braham Prakash and A.Sethuramiah

SECTION 7: ENVIRONMENT AND LUBRICANTS

51. Study of Synthetic Esters as Ecofriendly Base Fluid for Steel Cold Rolling Oil 7-1
B.M. Shukla, R.P.S. Bisht, Savita Kaul, P. Nagendramma and V.R.K. Sastry
52. Technical, Commercial and Marketing Aspects of Environment Friendly Lubricants - Emerging Asian and Indian Perspectives 7-5
Jitendra Bhatia and Sukumar Mahanti
53. Re-Refining of Used Oils- Case Studies 7-17
S.L.Dinesh and Dr.S.R.Jayaram
54. Role of Tribology to Improve Performance of HEMM vis-à-vis Energy Conservation - A Case Study from Opencast Mine of Central Coalfields Limited 7-25
Kamal Mukherjee
55. Replacement of Chlorinated Paraffins in Metal Working Fluids: The Role of Complex Polymeric Esters as An Environmental Friendly Option 7-33
Philip Miller, Harish Patel, Paul Nai and Shivaji Nehe
56. Effective Maintenance of Electrostatic Precipitator for Cleaner Environment 7-39
Rakesh Ambastha, C. Mishra and Suresh Kumar

SECTION 8: CONDITION MONITORING AND DIAGNOSTICS

- | | | |
|-----|---|------|
| 57. | Combating Vibration with Mechanical Couplings
<i>R.K.Biswas, A.K.Mukhopadhyay, J.Basu and A.Chattopadhyay</i> | 8-1 |
| 58. | Vibration Diagnostics as Applied to Sugar Factory Machinery
<i>S.P.Chavan and G.D.Bhide</i> | 8-10 |
| 59. | Oil & Debris Analysis - A Tool for Condition Monitoring of Heavy Earth Moving Machines
<i>R.P. Sinha and B. Sikdar</i> | 8-17 |
| 60. | Quality Evaluation of Rolling Element Bearings
<i>Dr. S.C. Nidhi and Dr. R. Sen</i> | 8-30 |

SECTION 9: SPECIAL TOPICS IN TRIBOLOGY

- | | | |
|-----|---|------|
| 61. | Tribo-Fatigue Studies of Gear Oils on a Rolling Contact 4-Ball Machine
<i>V.R.K. Sastry, B.M. Shukla, R.P.S. Bisht and M.R. Tyagi</i> | 9-1 |
| 62. | Semi Solid Lubricant Based on Silahydrocarbon for Space Applications - Studies on
<i>V.K.Kundra, Fahimuddin, H.C.Srivastava, Tandra Nandi and G.N. Mathur</i> | 9-6 |
| 63. | Phosphites, Phosphates and Phosphorothionates Chemistry and Tribology Relationship
<i>Arora, R.Ranjan, R.Sarin, D.K.Tuli, A.S.Sarpal, V.Martin, N.R.Raje and A.K.Bhatnagar</i> | 9-14 |
| 64. | Industrially Simulated Experimental Rolling Mill – An Effective Tool for Evaluation of Steel Cold Rolling Oils
<i>S.P.Dubey, R.Mahapatra, Dr. S.Paul, Dr. G.K.Sharma, N.R.Raje and Dr. A.K.Bhatnagar</i> | 9-21 |
| 65. | Static Analysis of The Hard Disk Drive Air Bearing Slider Using Slip Flow Theory
<i>T.V.V.L.N.Rao and H.Hirani</i> | 9-29 |
| 66. | A Simplified Inverse Solution To The Liquid Lubricated Head-Disk Interface
<i>H.Hirani and A.Chawla</i> | 9-37 |
| 67. | Parametric Studies Related to Static Stiffness of Elastomers to be Used as Dampers for Rotating Systems
<i>V.Arun Kumar, Soumendu Jana, L.Srikanth</i> | 9-46 |
| 68. | Chaotic Vibrations In High Speed Rolling Element Bearings
<i>Suraj Prakash Harsh, Ravi Prakash and Sandeep Kumar</i> | 9-57 |
| 69. | Design Optimization, Stress Analysis and Study of Natural Frequencies Characteristics of Carbon Fibre Epoxy High Speed Shaft in Aerostatic Conical Journal Bearings
<i>R.B.Ingle, B.B.Ahuja and S.K.Basu</i> | 9-65 |

70. Subcutaneous Asperity Induced Surface Distress in Hertz Contact Components – A Case Study 9-76
M.B.Das, S.Sarkar, I.Chakrabarti and M.D.Maheshwari
71. Energy Conservation Through Tribology in An Integrated Steel Plant 9-90
C.Mishra

SECTION 10: ADDITIONAL PAPERS

72. Improving Abrasive Wear Properties through Thermal Spraying 10-1
A.K.Jha, Rupa Dasgupta, O.P.Modi, M.Singh and A.H.Yegneswaran
73. Wear Control Strategy for Steel Plant Hydraulics 10-9
P.D. Mundhra, C. Mishra, Sumit Sarkar and M. Shariq
74. Development of Al-Complex Base Greases Suitable for Different Industrial Applications 10-22
S. C.Nagar, J. P.Antony, Anoop Kumar, P.Senthivel, Ajay Kumar, K. P. Naithani, A. K. Mehta, N. R. Raje and A. K. Bhatnagar
75. Significance of Sensitive Parameters for Dynamical Analysis of Rotor-Bearing Systems 10-29
B.B. Maharathi, A.K. Behera, P.R. Das, P. Acharya and C. Kar
76. Mill Drive Gear Box – The challenge for Tribologists 10-40
Suresh Kumar, C. Mishra, Rajesh Dubey and Rakesh Ambastha
77. Effect of Various Detergent Systems on the Asphalt Dispersion Characteristics of Trunk Piston Engine Oils 10-60
S.S.V.Ramakumar, Neelam Aggarwal, N.Sarangapani, A.M.Rao, Ajay Kumar and A.K.Bhatnagar
78. Abrasive Wear Behaviour of GFRP Composites: A Microstructural Study 10-68
Navin Chand and Somit Neogi
79. Condition Monitoring Based Predictive Maintenance Programme 10-88
A. K. Chatterjee, C. Mishra, S. Muncherji, Rajesh Dubey

INDEX OF AUTHORS