Foreword

The changing paradigm of the mobility sector demands the urgent development of innovative and sustainable vehicular technologies. With contraindicative challenges of energy security, decarbonization, and overall economic value, the contours of technological interventions need to be precisely drawn and meticulously planned. Journal of Mobility by ARAI is a platform that keeps us abreast with the latest developments in the field of mobility.

Like the rise and ebb of pandemic peaks, it may be equally harder to picture the pathway to climate change management. In this context, IndianOil and its R&D Centre are focusing on multiple alternatives for discovering the solutions that will initially result in flattening the emissions curve and further bending it downwards.

The journey towards net-zero begins by enhancing the energy efficiency from the existing processes & products. Differentiated fuels & lubricants by IndianOil is a step in the direction. The flexibilities in the refineries to optimize the product slate and enhance the octane number of gasoline are other low-hanging fruits enabling energy transition. Govt. of India’s mandate to increase the adoption of biofuels like ethanol, biodiesel, compressed biogas, and bio-ATF is going to change the slope of the GHG emission curve for the country during this decade. IOC is enabling such measures through its technological prowess and scale.

The disruptions envisaged through the electrification of the drive trains have brought battery-operated vehicles to the forefront. IndianOil has been pioneering efforts in the battery space through the setting up of EV charging infrastructure at its retail outlets. Having understood the constraints around lithium availability, IndianOil is exploring other innovative chemistries which shall qualify as the optimal solution for enabling e-drives but without centralizing our dependence on “few select countries”, thereby shifting the geo-political equilibrium. The metal-air batteries consisting of a recipe based on abundant aluminum or zinc reserves are being explored to realize our dream of electric mobility.

Hydrogen has emerged at the centre stage and the Indian journey of green hydrogen is set to transform the mobility sector as well. Our recent experiments with HCNG fuel in 50 buses in Delhi have demonstrated significant emission and fuel economy benefits. The country’s first fuel cell bus development and demonstration program by IndianOil R&D would be hitting the ground as we expect the prototypes on the road by the end of this year.

The Indian landscape is under metamorphosis and this journal is a great link to capture the developments happening in the area of advanced mobility in the country. Apart from the industrial community, the extended outreach of this Journal to the budding scientists & engineering students would really accelerate their interest in selecting the mobility field as their career path towards the collective realization of the net-zero goal through frugal innovation.

Dr. S.S.V. Ramakumar
Director (R&D) and Board Member
Indian Oil Corporation Limited
Faridabad, India.
ADVISORY BOARD MEMBERS

Dr. Reji Mathai (Chairman)
Director,
ARAI, Pune

Dr. SSV Ramakumar
Director (R&D) and Board Member
Indian Oil Corporation
Faridabad, India

Mr. Rajendra Petkar
President / CTO
Tata Motors Limited
Pune

Prof. Anil D. Sahasrabudhe
Chairman
All India Council for Technical Education (AICTE), New Delhi

Dr. N. T. Rao
Vice Chancellor
MIT World Peace University
Pune

Dr. Jabez Dhinagar
Vice-President (Advanced Engineering Group)
TVS Motor Company Limited
Hosur, Tamilnadu

Dr. Ramesh, A.
Institute Chair Professor
Indian Institute of Technology-Madras
Chennai

Prof. Anindya Deb
Professor
Indian Institute of Science (IISc)
Bangalore

Mr. Arindam Lahiri
Chief Executive Officer
Automotive Skills Development Council (ASDC)
New Delhi

Dr. Anuradda Ganesh
Chief Technical Advisor and Director
Cummins Technologies India Pvt Limited
Emeritus Professor, IIT-B, Mumbai
SUBJECT EXPERTS

Dr. Abhijeet Marathe  
General Manager  
Automotive Research Association of India, Pune

Dr. Akella Sharma  
Vice President, Automotive Sector  
Mahindra & Mahindra Limited, Chennai

Dr. Arun Jaura  
Managing Director - MITC  
Michelin, Pune

Dr. B. Ashok  
Associate Professor  
VIT University, Vellore

Dr. Bharatkumar Ahuja  
Professor & Director  
College of Engineering Pune (CoEP), Pune

Dr. Fangwu (Mike) Ma  
Lead Professor  
Jilin University, China

Dr. K. C. Vora  
Emeritus Professor  
College of Engineering Pune (CoEP), Pune

Dr. Luděk Hynčík  
Associate Professor  
University of West Bohemia, Czechia

Dr. M. Suresh  
Assistant Professor  
Karunya Institute of Technology and Sciences, Tamil Nadu

Dr. M.V. Uchgoankar  
Sr. Deputy Director  
Automotive Research Association of India, Pune

Dr. Mohan Godse  
Proprietor  
U 2 I, Pune

Dr. Mohd Rafiq B. Agrewale  
Manager  
Automotive Research Association of India, Pune

Dr. Nagesh H. Walke  
Deputy Director  
Automotive Research Association of India, Pune

Dr. P A Lakshminarayanan  
Former - Technical Advisor  
Simpson & Co. Ltd., Chennai

Dr. P. P. Chattaraj  
Additional Director  
National Automotive Testing and R&D Infrastructure Project (NATRiP)

Dr. P.K. Ajeet Babu  
Manager  
Automotive Research Association of India, Pune

Dr. R Basargekar  
Head, Research & Technology Centre and Technical Director  
APPL Industries, Pune

Dr. Ravindra Utgikar  
Vice President - Corporate Strategy & Marketing  
Praj Industries Ltd., Pune

Dr. Sanjay A Patil  
General Manager  
Automotive Research Association of India, Pune

Dr. Sanjay Arole  
Director - Automotive Materials & Manufacturing Engineering Services  
SMA Engineering Solutions, Pune

Dr. Sarit Kumar Das  
Institute Chair Professor  
Indian Institute of Technology-Madras
Dr. Satyam Sahay
John Deere Fellow
John Deere Technology Centre India, Pune

Dr. Senthil Muthu Kumar Thiagamani
Associate Professor
Kalasalingam Academy of Research and Education, Tamil Nadu

Dr. Srinivas Gunti
Sr. Deputy General Manager, Automotive Sector
Mahindra & Mahindra Limited, Chennai

Dr. Sundarapandian Vaidyanathan
Professor (R & D Centre)
Vel-Tech University, Chennai

Dr. Sushil S. Ramdasi
Deputy Director
Automotive Research Association of India, Pune

Dr. Vijay Narkhede
Senior Manager (R&D)
Süd-Chemie India, Gujarat

Dr. Y.K. Bhateshvar
Faculty – ARAI Academy
Automotive Research Association of India, Pune

Mr. A. A. Gaikwad
Deputy General Manager
Automotive Research Association of India, Pune

Mr. Alok Jaitley
Senior Vice President
Maruti Suzuki India Ltd., New Delhi

Mr. Alok Sethi
General Manager – Transportation Technology Solutions
Delhi Integrated Multi Modal Transit System Ltd. (DIMTS), New Delhi

Mr. Arun Komawar
Consultant, Pune

Mr. Ashwin Subramanian
Dy. General Manager
Automotive Research Association of India, Pune

Mr. Atul Pol
Program Manager
Tata Technologies, Pune

Mr. Ayush Maheshwari
Researcher (Automotive System Design)
Akar International, Singapore

Mr. Devendra Mandke
Technical Specialist
John Deere India Pvt. Ltd., Pune

Mr. Karthik Kaliappan
Sr. Manager- Product Safety and Compliance, Standards
John Deere Equip. Pvt. Ltd., Shikrapur

Mr. M K Chaudhari
Consultant, Pune

Mr. Mahadevan Pichandi
Domain Head – Chassis Engineering & Vehicle Dynamics (AGM-PD), LCV Division
Ashok Leyland Limited, Chennai

Mr. Mahesh Masurkar
Chief Manager - Embedded Software Development
John Deere India Pvt Ltd., Pune

Mr. Mouqtiq Bawase
General Manager
Automotive Research Association of India, Pune

Mr. P. R. Pawar
General Manager
Automotive Research Association of India, Pune
Mr. Pradeep Chandrasekaran
Associate Director
Ola Electric Mobility Pvt. Ltd., Bangalore

Mr. Prakash V. Sardesai
Head, Application Engg & Business Development
Sud-chemie-India-Pvt Ltd., Gujarat

Mr. Prashant Mahale
Asst. General Manager
Fiat Chrysler, Mumbai

Mr. R M Cursetji
Head-Technology Department
Sud Chemie India Pvt. Ltd., Gujarat

Mr. Rahul Mahajan
Dy. Director
Automotive Research Association of India, Pune

Mr. S Bhattacharya
Director - Technical Sales
Huegli Tech AG Switzerland

Mr. S S Marathe
Engineering Consultant, Pune

Mr. S. B. Sonawane
Manager
Automotive Research Association of India, Pune

Mr. Sanjay Deshpande
EX. Vice President
Mahindra & Mahindra, Nasik

Mr. Srinivasan Raju
Automotive Consultant, Pune

Mr. T.C. Kamath
Deputy General Manager-Design Standards
MRF Limited, Chennai

Mr. Vikram A. Tandon
General Manager
Automotive Research Association of India, Pune

Mr. Vinay Mundada
Consultant, Pune

Mr. Vinit Jawale
Systems Engineering Leader
JOHN DEERE INDIA PRIVATE LIMITED, Pune

Mr. Yogesh Thipse
General Manager
Automotive Research Association of India, Pune

Mr. Z. A. Mujawar
Consultant, Pune

Mrs. Swati Athavale
Engineering Consultant, Pune

Ms. Jyoti Kirve
General Manager
Automotive Research Association of India, Pune
ABOUT THE JOURNAL

ARAI Journal of Mobility Technology is a print and online technical journal in automotive and its related fields. It is a publication from ARAI in collaboration with BSP Books Pvt. Ltd., Hyderabad. It is a quarterly print and online publication, covering automotive and related topics, with the main aim of meeting the needs of professionals, academia, and industry, as well as furthering the dissemination of original research in all the fields of automotive technology. One of the objectives of this journal is to provide a platform for the publication of articles covering a wide range of automotive and its allied subjects. A manuscript published in this journal will receive very high publicity and acquire a very high reputation in the automotive and research communities. This journal invites technical papers from scholars, academicians and professionals associated with the field of Automotive from academia and industry.

Papers: High quality research papers / articles are invited for upcoming issues from scholars, academicians, and professionals associated with the field of automotive from academia and industry. Manuscripts of sufficient quality that are relevant to the AJMT's aims and scope will be reviewed. To submit papers, please go to the link https://araijournal.com/index.php/arai/about/submissions

Paper Type:

1. Research Papers: They should include hypothesis, background study, methods, results, interpretation of findings, and a discussion of possible implications.
2. Review Papers: Articles should provide a critical and constructive analysis of existing published literature in a field, through summary, analysis, and comparison, often identifying specific gaps or problems and providing recommendations for future research.

Subscriptions: Subscribers will receive four print copies annually as well as immediate access to the online journal, which includes full online access to all current and back articles. Two types of subscriptions:

1. Degree offering Colleges / University: Rs. 5000/- yearly subscription for print & online access.
2. Corporate / Individual / R&D Institute / Government Institute: Rs. 8000/- yearly subscription for print & online access.

For more information, please visit our journal's website at https://araijournal.com/index.php/arai/index

PUBLISHING PARTNER

BSP Books Pvt. Ltd., Hyderabad.
4-4-309, Giriraj Lane, Sultan Bazar,
Hyderabad 500 095, Telangana.

PUBLISHING COORDINATORS

1. Dr. A. Madhava Rao, ARAI, Pune.
DISCLAIMER

The publisher, editor(s), or any editorial or advisory board members are not responsible for the accuracy of the content, author statements, expressed opinions, or data in this journal. ARAI and its publishing partners, BSP Books Pvt. Ltd., take a neutral stance on jurisdictional claims in published papers and institutional affiliations. The authors are solely responsible for the contents published in the paper.

DECLARATION

<table>
<thead>
<tr>
<th>(a)Name of the Publisher and Printer</th>
<th>The Automotive Research Association of India</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)Printing Press with Address</td>
<td>Aditya offset Process (I) Pvt. Ltd.</td>
</tr>
<tr>
<td></td>
<td>H.No:- # 3-1/7, Survey No.56/1, Jalapally Village, Saroornagar Mandal, Ranga Reddy Dist. Hyderabad 500005.</td>
</tr>
<tr>
<td>(c)Place of Publication with Address</td>
<td>Survey No. 102, Vetal Hill, off Paud Road, Kothrud, Pune - 411 038</td>
</tr>
<tr>
<td></td>
<td>P. B. No. 832, Pune - 411 004</td>
</tr>
<tr>
<td>(d)Name of the Editor-in-Chief</td>
<td>Dr. Sukrut S. Thipse</td>
</tr>
<tr>
<td></td>
<td>Sr. Deputy Director</td>
</tr>
<tr>
<td></td>
<td>ARAI, Pune</td>
</tr>
</tbody>
</table>

For Manuscript Submission

Dr. A. Madhava Rao (Assistant Editor)  
Manager, ARAI, Pune  
Email: madhavrao.lib@araiindia.com

For Subscription

Mr. Nikunjesh Shah (Marketing Head)  
BSP Books Pvt. Ltd., Hyderabad  
E-mail: nikunjesh.shah@bspbooks.net
Research Papers

- Failure Analysis of Friction Weld in Rear Axle Casing
  G. Ramya and G.K. Sivakumar ................................................................. 83

- Systematic Approach for Static Steering Effort Reduction through Linkages Optimization in Small Commercial Vehicles (SCV)
  Mahadevan Pichandi...................................................................................... 87

- Analytical Modeling and Thermal Insulation of Insulating Material
  Faizan A Shakh, R.S. Hosmath and P.P. Revankar........................................ 96

- Simulation of Room Temperature Vulcanized Gasket Failure at Engine T-Joints
  Ricky Shaji and Naveen Kumar N................................................................. 108

- Rear Wheel Roll Steering (Passive) Suspension Mechanism
  Gauraang Singh Baghel.................................................................................. 112

- The Effect of Material Change from 20MnCr5 to EN 353 on Fatigue Performance of Crown Wheel Pinion (Hypoid Gear Sets) of Full Float Axles-Case Study
  Yathish Rao ................................................................................................. 125

- Design, Simulation and Analysis of Components for Electric Auto Conversion
  Basil John, Prajul M.P, Jesvin Varughese Jose, Sujay K and Jayadevan P.C .................. 131

- Model Predictive Control based Direct Matrix Converter Fed Permanent Magnet Synchronous Machine Drives for Traction and Electric Mobility Applications
  Balaji B and Anunciya J.D............................................................................. 140

- Optimization of Electric Vehicle Radiator Fan Duty Cycle using KULI 1D Transient Simulation
  K. Raviteja Reddy and N. Kiran...................................................................... 152

- Modal Analysis of Passive Engine Mount Assembly Using Finite Element Analysis
  Pramukh Bharadwaj K S, Rohith S Holla, Mridhul S, T. Vishnu and Santhosh Kumar H V .................. 159