

# **ARAI** Journal of Mobility Technology

---

A Quarterly Peer-Reviewed Journal

<https://araijournal.com>

---

**Volume 2, Issue 1, January-March, 2022**

## *Editor-in-Chief*

**Dr. Sukrut S. Thipse**

Sr. Deputy Director – ARAI

Pune - Maharashtra

## *Associate Editor*

**Dr. B.V. Shamsundara**

Deputy Director – ARAI

Pune - Maharashtra

## *Assistant Editor*

**Dr. A. Madhava Rao**

Manager - ARAI

Pune - Maharashtra

Publication from

**ARAI**<sup>®</sup>  
*Progress through Research*



**The Automotive Research Association of India**

An ISO 9001, ISO 14001, ISO 27001, OHSAS 18001 and NABL Accredited R&D Institute

Published by



**BSP Books Pvt. Ltd.**





## Foreword

The changing paradigm of the mobility sector demands the urgent development of innovative and sustainable vehicular technologies. With contra indicative 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.



# **ARAI** Journal of **Mobility Technology**

---

**A Quarterly Peer-Reviewed Journal**

## **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

**Mr. Arindam Lahiri**

Chief Executive Officer  
Automotive Skills Development Council  
(ASDC)  
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

**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 Hynčič**

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. Mouqtik 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 R 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.
2. Mr. Nikunjesh Shah, BSP Books, Hyderabad.
3. Mr. Naresh Davergave, BSP Books, Hyderabad.

# **ARAI** Journal of Mobility Technology

ARAI J. Mobi. Tech (AJMT); *Online Access & Print Journal*

<https://araijournal.com>

## **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**

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

### **For Manuscript Submission**

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

### **For Subscription**

**Mr. Nikunjesh Shah (Marketing Head)**  
BSP Books Pvt. Ltd., Hyderabad  
E-mail: [nikunjesh.shah@bspbooks.net](mailto:nikunjesh.shah@bspbooks.net)

# **ARAI** Journal of Mobility Technology

**A Quarterly Peer-Reviewed Journal**

## **CONTENTS**

### **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  
*GauraangSingh 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

