ARAI® Progress through Research Update

Towards Safer, Cleaner & Quieter World ...

Design, Development and Testing Services at ARAI

Index Issue 2016-2017

❑ Simulation Approach to Study Production Tolerances Band Sensitivity on Engine Performance and Emissions

Background:

Setting right tolerance band is important to meet stringent regulatory and customer requirements based on the combustion stability through robust analysis. Setting up wrong tolerance band may seriously affect conformity of product and field performance as well. Many times product launch happens without extensive testing of product tolerance variations influence on performance and emissions, which may lead to product conformity failures. So understanding the influence of production tolerance band of critical parameters on performance and emissions is very important to control wide performance variations and get product consistency. Assessment of production tolerances is a challenging task, which requires preparation of hardware configurations with all combinations. This assessment gives insight on system robustness on performance and emissions. However, it is very expensive to prepare hardware with all combinations for testing and also involve high experimentation cost. Entire physical evaluation process also requires lot of time to complete the process, which may lead to delayed product launch.

In general, Simulation approach reduces experimental cost and time, however, tolerance parameters interaction study is computationally expensive and time taking task. In this regard, Powertrain Engineering (PTE) of ARAI has developed cost effective approach to reduce computational expenses and time by integrating the benefits of statistical tools with 3-D combustion simulation. This method allows analyzing the effect of influence of parameters production tolerance variations on performance and emissions; and it is easy to understand odd parameter combinations without much experiments.

PTE Department has performed **case study** with an objective to assess impact of important product tolerance variations (e.g. Compression Ratio, Injection timing, spray cone angle, swirl, fueling and bumping clearance) on performance and emissions, and it is described below:

Assessment Procedure Followed

Combustion simulation is computationally expensive because of its complexity, involving second order partial differential equations with multi-fluid, multi-phase mass and energy transfer governing equations. So, realizing that execution of all full factorial cases in simulations will be computationally time consuming and expensive. Statistical approach (DOE) is used for building response model to predict results. However, quality of response model is (important to get quality and quantitative results) maintained by various check points and by cross checking sample cases through combustion simulation. Figure 1 shows R^2 value and surface model, which indicates quality of predictions.

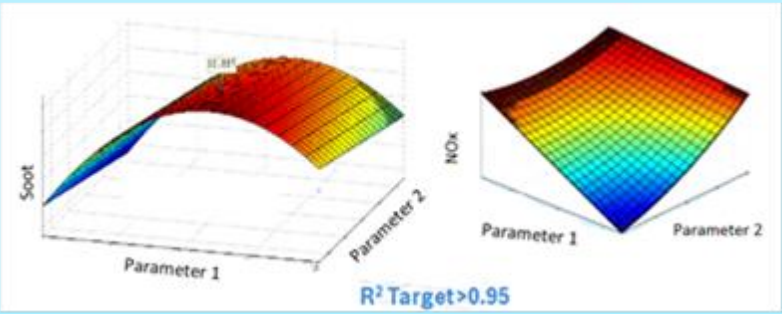

Figure 1: Critical part of this approach – High Quality Model Development

Case Study

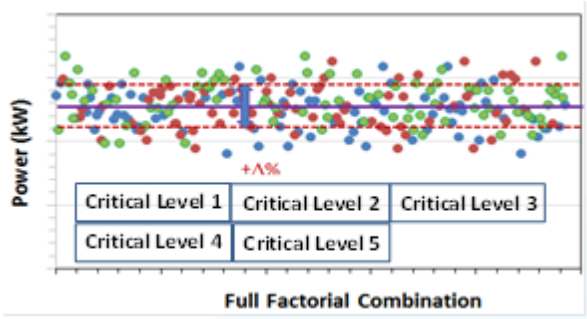

Figure 2: Engine power output will all combinations

Figure 2 shows engine power with all parameter combinations and many combinations are outside the limit zone. It means that combination of few parameters with defined tolerance band is out of target zone. Through this approach, it is possible to identify failure combinations and also possible to rank parameter's criticality level along with ranking of risk.

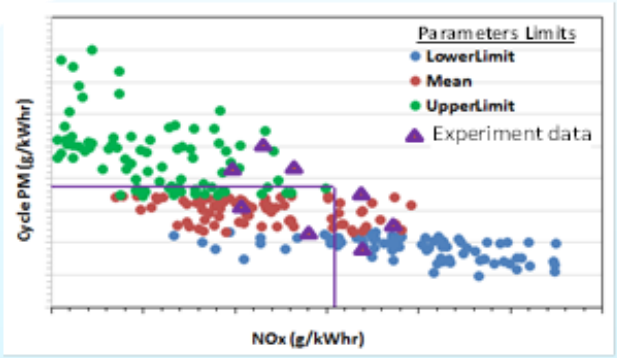

Figure 3: Cycle NOx vs. PM will all combinations

Figure 3 shows cycle NOx and PM emissions for all full factorial combinations. One critical parameter selected and results plotted with combination of other parameters. It is showing that upper limit is highly influence on emissions and 70% of combinations are outside the limits of cycle NOx and PM - indicating that selected tolerance limits are not appropriate. Triangles points in Figure 3 and Figure 4 show, 8-test results and only two are falling within limit zone. These 8-tests verified and validated in simulation and build the model for tolerance variations study.

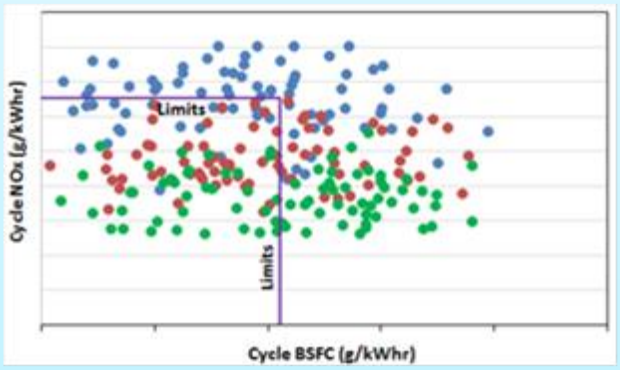

Figure 4: Cycle NOx vs. Cycle BSFC will all combination

Figure 4 shows majority of combinations cycle BSFC on higher side than the target cycle BSFC. This happens mainly due to interaction of parameters with wrongly set limits for highly critical parameter, e.g. wrong selection of pump characteristics & injectors and bowl design, etc.

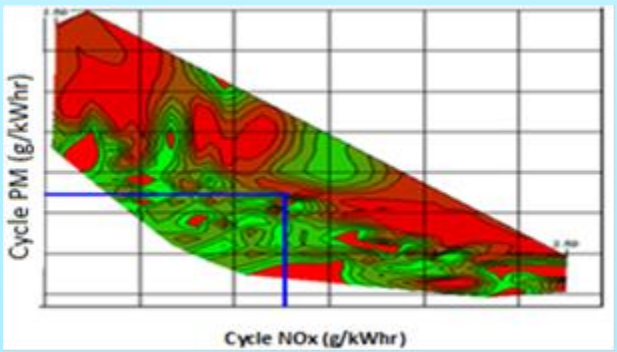

Figure 5: Cycle NOx vs. Cycle PM 2D Contours

Figure 5 shows 2-D coutour graphs for cycle NOx and PM. This analysis provide more sight to tolerance limits zone of parameters.

This approach is very useful to understand production robustness and sensitivity of design parameters for performance and emissions. This can help to relax unnecessary tightened parameters and control sensitivity to achieve production robustness for performance and emissions. This approach can used for selection of optimum BS VI package.

Power Train Engineering Dept. of ARAI offers services for analysis of ***"production tolerances band impact emissions and performance for passenger car diesel engines, HD engines, tractor/CEV engines and genset engines",*** using statistical and computational tools in cost effective way.

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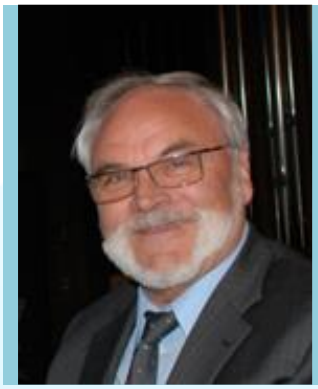
ARAI joins hands with Dr. Lothar Issler for Metallurgical Failure Analysis

Automotive Materials Laboratory (AML) of ARAI is offers various services for Metallurgical Failure Analysis. It has rich experience of more than thousand case studies, covering different sectors (automotive as well as non-automotive), variety of materials and for OEMs as well as various component and material manufacturers. ARAI has now joined hands with Prof. Dr. Lothar Issler of Esslingen University, Germany. Therefore, failure analysis reports of ARAI will also contain expert opinion and inputs of Prof. Dr. Issler.



Prof. Dr.-Ing. Lothar Issler, born in 1943, is an Emeritus Professor at the University of Applied Sciences Esslingen (Germany), Department of Automotive Engineering. He is Director of Steinbeis-Transfer Centre and Innovation Centre BWF "Strength and Safety of Components, Material and Joining Technology".

Dr. Issler graduated in 1969 in Mechanical Engineering at University of Stuttgart and completed his Ph.D. degree in "Fatigue of Metallic Materials under Out-of-Phase-Loading" in 1974. He was responsible at Material Testing Institute, University of Stuttgart, for Nuclear Research programs in the field of safety of light-water reactor components. From 1981 to 1988, he was professor for Strength of Materials at University of Applied Sciences Esslingen.

AML services in the field of Metallurgical Failure Analysis are the most sought after services in the industry. To cope up with the rising demand, one more Scanning Electron Microscope with advanced features (Tescan Vega 3) is recently installed. This will enable us serve the customers within the scheduled time frame.

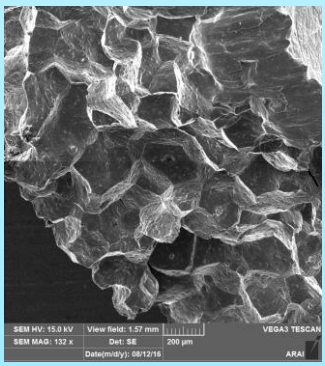
Advanced Capabilities of AML

Fractography and Failure Analysis

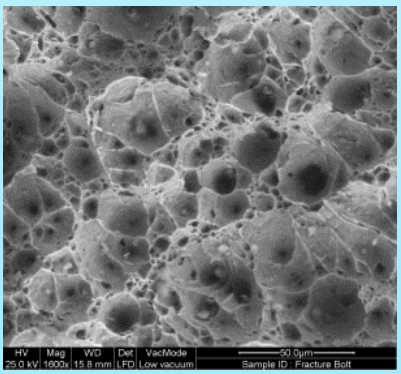
Fractography is done to understand root cause of failure, which will help in avoiding future failures. Scanning Electron Microscopy (SEM) is widely used for fractography. AML has got advanced SEM facilities where all variety of engineering materials, such as metals, plastics, rubbers, ceramics, etc. can be analyzed. These equipment are also coupled with Energy Dispersive Spectroscopy (EDS), wherein one can understand elemental composition at minute particle level or at defects. SEM analysis is complemented by routine material characterization tests such as tensile, hardness, microstructural analysis. The laboratory has vast experience of failure analysis with more than thousand case studies.

Salient features of SEM

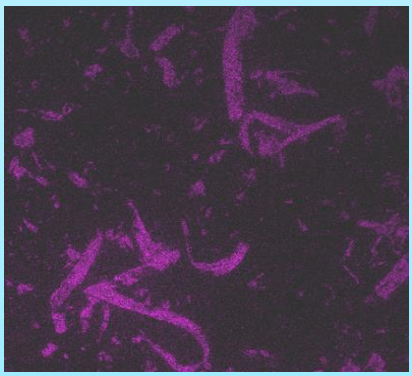
- SE and BSE detectors for **structural and compositional images**
- EDS analysis for **inclusion and defect analysis**
- **Elements' distribution** mapping
- Particle analysis such as **Particle size, shape and distribution measurement**
- **Image stitching** to build large image of local zone



Intergranular Fracture in Aluminum

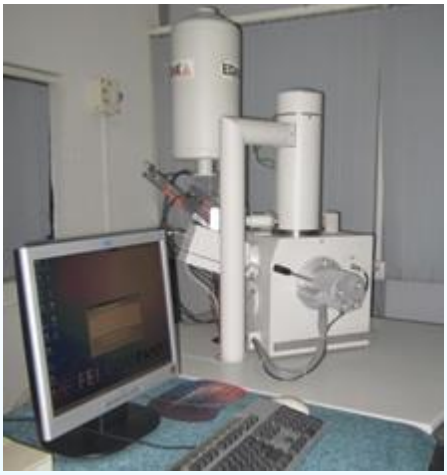


Ductile Fracture in Forged Steel



Elemental Mapping of Gray Cast Iron Showing Graphite Flakes

Vega – 3 LMU
Make: Tescan Brno, Czech Republic



ESEM Quanta – 200
Make: FEI, USA

Crystallographic Analysis (Residual Stress Analysis, Phase Analysis)

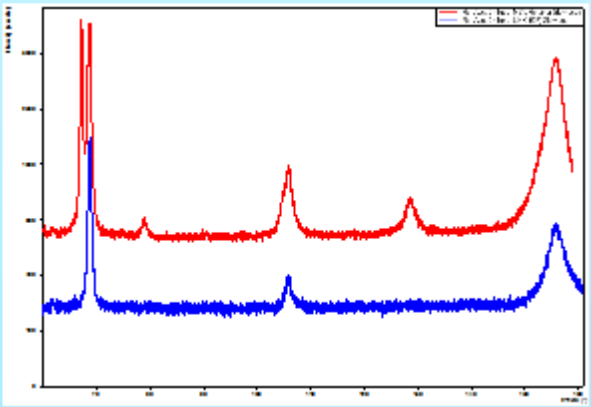
Crystallographic studies are carried out to get insight of material atomic structure. Materials may be made up of multiple phases, which govern material properties. X Ray Diffractometer (XRD) is used for correct identification of these phases and their quantification. This also enables measurement of Residual Stresses in the component, which affects its fatigue life. These tests are non-destructive and repeatable in nature.

Applications

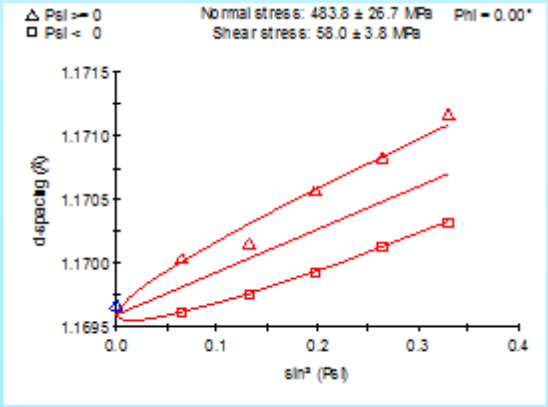
- ✓ Phase Identification
  - Quantification of **Retained Austenite**
  - Analysis of **scales and corrosion products**

- ✓ Residual stress analysis
  - **Mapping of stresses** on component
  - **Depth profiling** of stresses

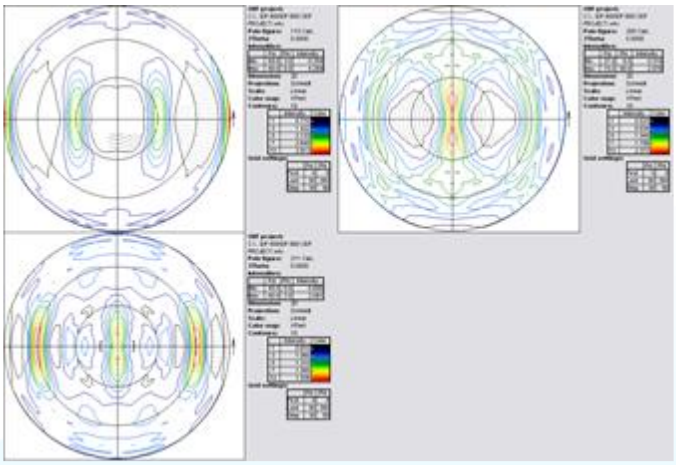
- ✓ Crystallographic **Texture analysis**



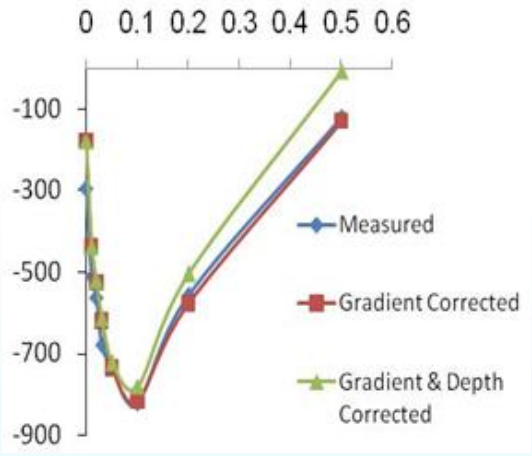
Comparison of XRD Patterns of Samples with 1 and 10% Retained Austenite



Residual Stress Measurement of Steel

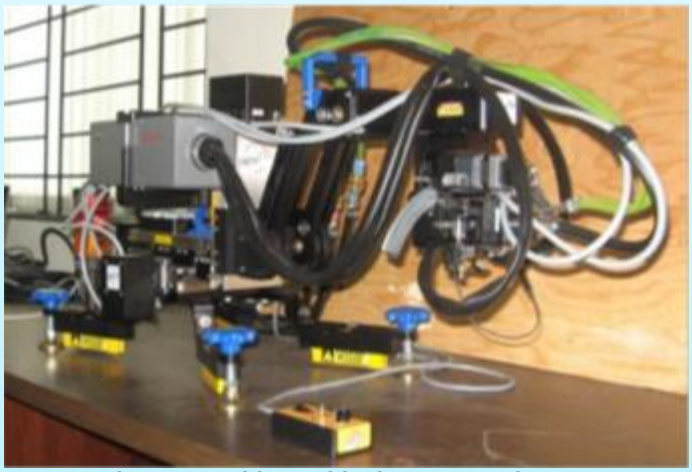


Texture Measurement (Pole Figure)



Depth Profiling of Residual Stresses of Shot Peened Component

X'PERT Pro Multi-purpose XRD
Make: PANalytical, The Netherlands



iXRD Portable Residual Stress Analyzer,
Make: Proto, Canada

AML also offers wide range of services for Material Characterization, such as mechanical, fatigue, chemical, environmental durability, etc. For more information and proposal, please Click here.

Indigenous and Cost Effective Development of Adaptive Front Lighting System by ARAI

ARAI has developed indigenous and cost effective technology solution for Adaptive Front Lighting System (AFS) for mid-segment cars. The algorithm is designed to address needs of Indian road and traffic conditions. AFS adapts headlamp beam pattern to driving conditions encountered by the vehicle. AFS operates in four different modes, viz. Expressway Mode, Country Mode, Town Mode and Weather Mode. The developed prototype, AFS ECU, has been integrated with Utility Vehicle's Electrical and Electronic architecture via CAN network to achieve these modes.

Major functions employed in this AFS ECU are:

- Town Mode
- Country Mode
- Expressway Mode
- Dynamic Swivel
- Automatic Head Lamp Leveling

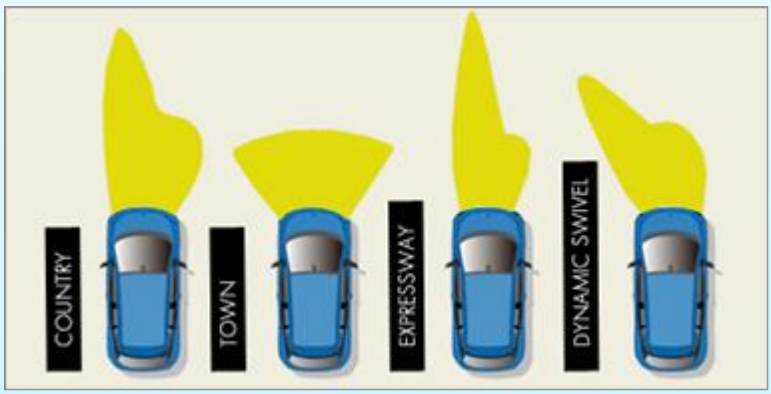


Figure 1 Adaptive Front Lighting System Modes

These AFS modes are achieved with less sensor inputs as compared to similar solutions available in the market, on existing mid-segment utility vehicle architecture. Vehicle speed thresholds are optimized to meet Indian traffic requirements. The speed thresholds to exit Town mode and enter Country mode are altered according to Indian traffic scenario. Passenger occupancy is derived by reading the chassis level sensor, which is newly added in the project vehicle. This algorithm was designed for HID-projector lamps and can be extended to LED-projector lamps or other light sources.

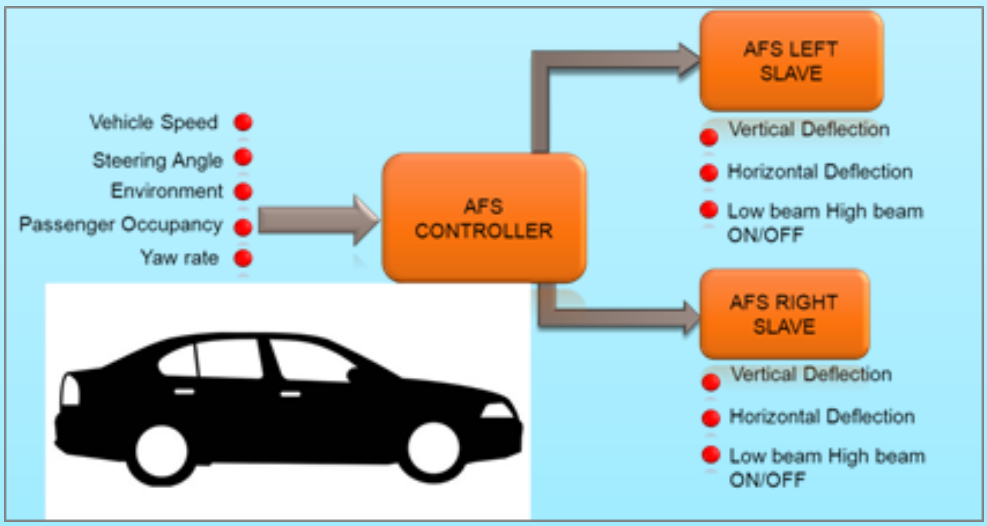


Figure 2 Input and Output Signals for AFS Controller

HID projector based headlamps were integrated with the Project Vehicle, which was driven through hilly terrain sections for verification of Dynamic Swivel and on expressway for high speed related testing. Calibration and verification of this system was carried out on test tracks and steering pad. Dynamic Swiveling was observed to be the most useful function in AFS in Indian scenario. The Dynamic swivel function encourages the driver to use passing beam over main beam. This function has market potential for mid-segment passenger cars in India, which is a part of the offered solution. These key functions can be implemented with the existing EE architecture, hence making ARAI AFS a good option to pave a way forward from the existing Non-AFS Halogen and HID lamps.

ARAI offer this solution on technology transfer basis to the industry.

With the development of AFS technology, ARAI is now able to offer following development services in automotive lighting.

- Functional Architecture Development
- Control Algorithm development for Intelligent Lighting Technologies
- Software development using Matlab and Simulink/ C
- Verification and Validation Methodologies
- Consultancy for AFS development and new technologies in the area of lighting

ARAI is also keen to develop similar AFS technologies for two-wheeler and commercial vehicle segment.

❑ ARAI – Winner of Golden Peacock Environment Management Award 2016

In the Golden Jubilee Year (1966-2016) of ARAI, yet another milestone in the history of ARAI.

ARAI's contribution towards Safety and commitment towards protection of Environment has received one more accolade in the form of GOLDEN PEACOCK ENVIRONMENT MANAGEMENT AWARD 2016. This award in Research & Consultancy category, was received by Director–ARAI in the special function in New Delhi.

Director- ARAI receiving Golden Peacock Award

Developing Technology solutions for CNG / LPG as alternate fuels, hybrid and Electric vehicles, formulation of emission and noise standards for vehicles and generators, designing lightweight materials for better fuel efficiency. ARAI assists Government of India in implementation of FAME (Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India) India Scheme for achieving desired objectives. ARAI is also assisting Government in establishing norms for control of in-use vehicles and recyclability / re-usability directives.

Golden Peacock Environment Management Award will stimulate and help ARAI to rapidly accelerate the pace of sustainable and effective Environment Management System. The award would inspire and align entire work force, management functions and lead to improved organizational performance. ARAI is committed to environment protection and will continue its research work in green technologies to safeguard national interest.

❑ Drive-in 4-Poster with Integrated Climatic Chamber

Full-Vehicle Simultaneous Vibration, Noise & Environment Performance & Durability Evaluation

This is to announce establishment of state-of-the-art facility for full vehicle multi-disciplinary simultaneous evaluation at Fatigue and Materials Centre of Excellence (FMCE) at Homologation and Technology Centre (HTC), ARAI, Chakan. This facility is useful not only for evaluation of performance, but also ultimate durability as well. Four Post Test System can perform variety of test applications, including structural durability, vehicle dynamics, squeak and rattle evaluations. Four poster in combination with Drive in Environmental chamber facility is available for perform tests, including fit and finish dimensional change studies at various temperature / humidity / sun-load combinations and hybrid or electric powertrain cold start tests.

Use of 4-Poster Chamber: 4-Poster Chamber is used for:

- ✓ Track Simulation
- ✓ Heat Ageing
- ✓ BSR (Buzz, Squeak, Rattle)
- ✓ Sun Simulation
- ✓ Durability
- ✓ Pure Vibration
- ✓ Characterization
- ✓ Electric Vehicles & Battery Tests
- ✓ *Temperature & Humidity control*
- ✓ Ride quality, Comfort

& … the way we can explore….

Vehicle inside Drive-in 4-Poster with Integrated Climatic Chamber

4-Poster-Chamber - Test System Applications

In the highly competitive global automotive market, need to develop high quality products and achieve product excellence in all areas to obtain market leadership is critical. Elements in determining quality of vehicle are performance, durability, safety along with noise & vibrations. Earlier, these elements could be validated individually with predefined conditions of other elements. These scenarios may cause incomplete validations, cost and time expenditure when validated individually.

Now, ARAI has established 'Drive-in 4-Poster with Integrated Climatic Chamber', a complete validation solution, for simultaneous assessment of vehicle in terms of durability, vibrations, noise, along with environmental -- sun, humidity, temperature simulations. This will certainly benefit vehicle manufacturers to build confidence in vehicle quality excellence with faster vehicle development time.

We say, we are "*Working forward* → *from* Software-in-Loop (SIL) -*to*- Component-in-Loop (CIL) -*to*- Human-in-Loop" thus bringing road to laboratory : Laboratory to Desk : with Human-in-Loop.

Vehicle manufacturer performs following tests regularly:

- Four-poster drive file creation (lab simulation) and durability test
- AIS-006 Bumper validation test
- Heat ageing
- BSR (Buzz, Squeak & Rattle) test

These and other feasible tests can now be performed using the unique "***4-Poster in Chamber",*** the first of its kind facility in India.

Test Methodologies

Four-Poster Test: This methodology is generally used for durability testing of frame and suspension. In this 4-poster testing, data like force, acceleration, strain, etc. is acquired while vehicle running on track. In lab, vehicle mounted on 4 actuators is excited to simulate acquired track signals. Product development time of vehicle is reduced, in this case, as simultaneous validation of components, aggregates and in terms of Full Vehicle occurs with accelerated durability testing methodology.

Bumper Validation: AIS-006 standard establishes requirements for approval of vehicles of category M1 (Cars, SUVs) with regard to integrity of anchorages of front and rear bumpers to the vehicle. Four poster test procedure for evaluation of bumper fitment is specified in the standard.

BSR (Buzz, Squeak, Rattle) Evaluation: Full vehicle BSR evaluation is conducted on the tire coupled four-poster road simulator. For BSR evaluation trained observer has to sit inside the vehicle while assessing vibrations on the four-poster. As the customer perceives irritating noises like buzz, squeak, rattler as direct indicator of vehicle build quality and durability, BSR performances are evaluated till vehicle end-of-life, in early development process itself. BSR problems can be attributed to structural deficiencies, incompatible material pairs, poor geometric control and alignments, etc.

Heat Ageing : In this, material under test can be exposed to rapid (but controlled) changes in temperature, humidity, sun load, etc. to simulate effect of day and night for the defined period. It is used to estimate deterioration in performance and useful life span of product. Generally polymers / rubbers are kept at elevated environmental conditions, in order to accelerate chemical breakdown.

Actual Site Photo:

Test System Specifications

CAR /SUV Four Poster Test System Technical	
Parameter	**Details**
Max Sprung Mass/Corner	1300 kg
Max Unsprung Mass/Corner	100 kg
Wheelbase length	1800 to 3200 mm
Track width	1200 to 1800 mm
Actuator force per corner	51 kN
Max Velocity	4 m/s
Max Displacement	+/- 125 mm
Wheel pan tire sizes	135/70R12 to 275/35R20
Resonant frequency@ 60 kg	100 Hz
Minimum test frequency	0.85 Hz

Environmental Chamber Technical	
Parameter	**Details**
Insulation chamber (Internal dimensions)	Height : 5000 mm, Width : 6000 mm, Depth : 8000 mm.
Main test vehicle entrance door:	Height : 3500 mm, Width : 3000 mm
Temperature Range & Rate:	-45ºC to +80ºC without solar Rate: ±1ºC/minute
Sun Simulation	0ºC to 70ºC with solar simulation
Humidity Control **Range**	10 to 95 % r.h. for Temp. +10 to +80ºC

Metallurgical Failure Analysis and Process Improvement Projects at Materials Lab of ARAI-Forging Industry Division

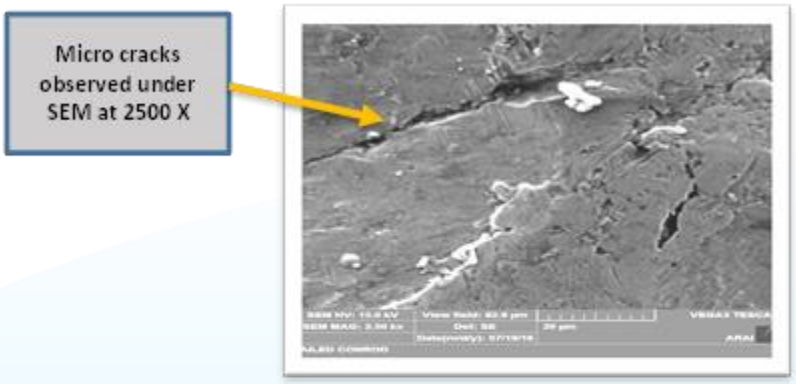
ARAI-Forging Industry Division (ARAI-FID) is conveniently located at Chakan Industrial hub, near Pune city where industry, among others, avails the services related to material testing, metallurgical analysis and quality assurance test certificates. Also, research & development projects related to materials and manufacturing processes are carried out at ARAI-FID.

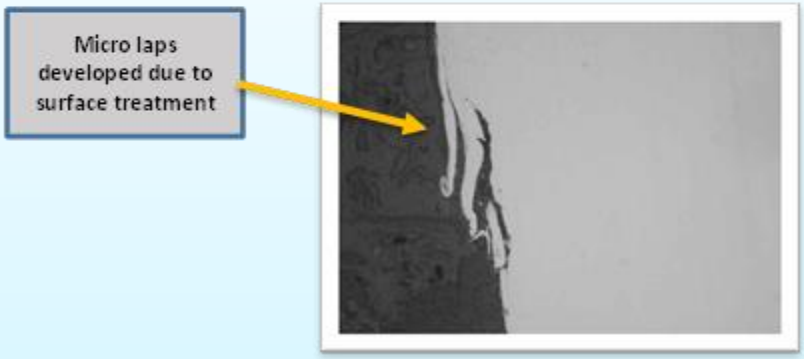
Materials Lab of ARAI-FID has expertise in metallurgical failure analysis and testing of all types of automotive and non-automotive components manufactured by different processes like forging, casting, rolling, etc., to find out root cause of failure and provide solutions to avoid such failures in future. The Lab is equipped with state-of-the-art instruments like X-Ray Diffraction (XRD), Residual Stress Analyser, Optical Emission Spectrometer (OES), Quenching Dilatometer, Metallurgical Microscope with Image Analyser and Hot microscopy. The Lab is also equipped with Forging plant and heat treatment facility for manufacturing of prototype components to establish new forging and heat treatment processes. The Lab works in close association with Automotive Materials Lab at ARAI, Pune, which also has many advanced facilities and expertise developed over the years

Scanning Electron Microscope with EDS, Model Vega3 LMU, Tescan, Czech Republic make

Sample case studies are presented here, along with probable root causes of component failure, found after conducting various metallurgical tests, including destructive and non-destructive tests like chemical, mechanical, residual stress analysis, microstructural examination and scanning electron microscopy studies.

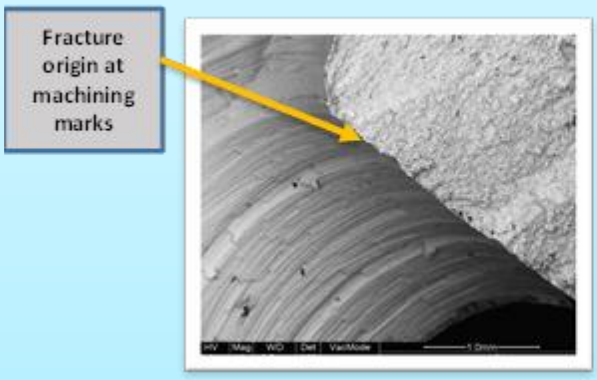
Case study 1 – Connecting Rod

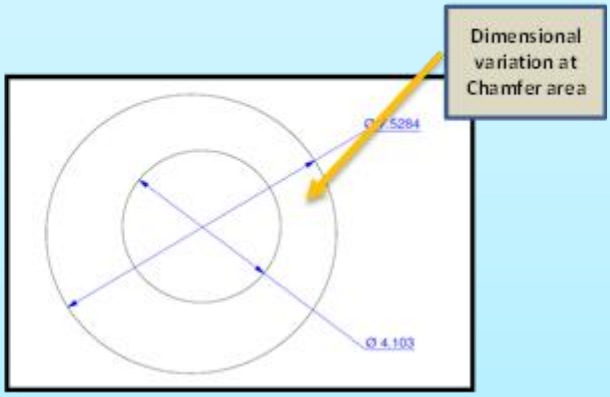




Presence of Micro cracks / laps on surface of connecting rod near and away from region of fracture

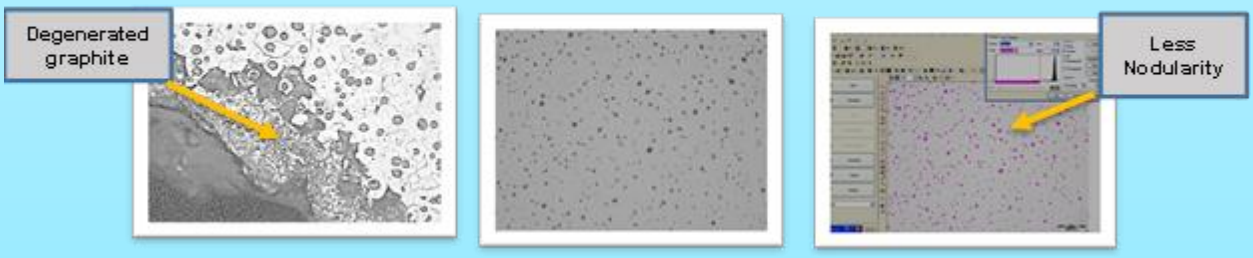
Case Study 2 – Connecting Rod





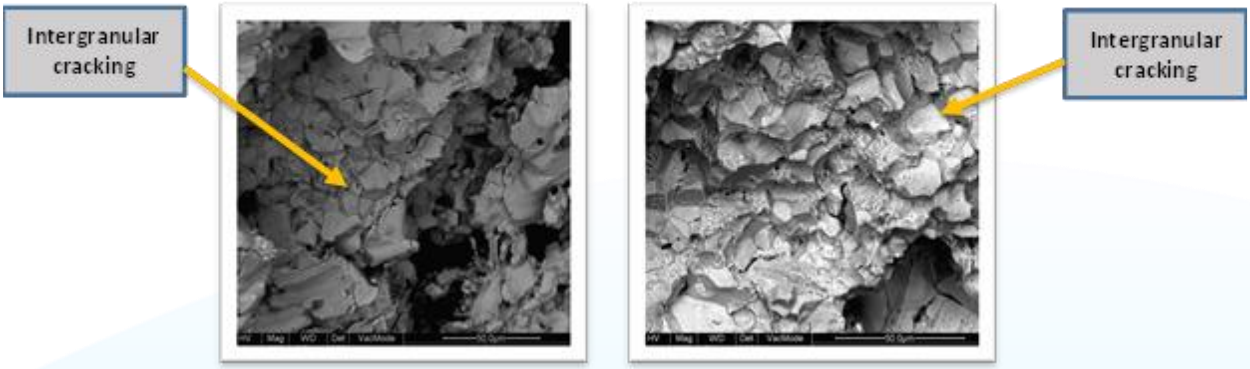
Premature failure during fatigue testing occurred due to improper machining and dimensional variation of chamfer at oil hole of connecting rod

Case Study 3 – Cast Iron Component



Failure of Cast iron component probably due to degenerated graphite and less nodularity

Case Study 4 – Gear



SEM photographs at 1600x & 2000x, showing inter granular cracking on fractured surface of gear occurs due to embrittlement - probable reason of failure

❑ Offline & Real-Time Simulator for Electric and Hybrid Electric Vehicles

Brief Description

With Faster Adoption and Manufacturing of Hybrid and Electric vehicles in India (FAME-India) scheme bunches under the scheme National Electric Mobility Mission Plan (NEMMP), E-mobility has become a buzz word today. ARAI has identified E-mobility as a key development platform and had started working early (2012). A consortium approach consisting four agencies: ARAI, CDAC(T), IISc, IITB, by utilizing their complementary strengths for "**Development of Offline & Real-Time Simulator for Electric and Hybrid Electric Vehicle**" is an initiative towards it.

Need of Simulation in EV / HEV

- Involves multiple control systems
- Multiple systems can be easily configured and tested in simulation, all with the same facility
- Multiple configurations and iterations possible in less time
- Multiple configurations and test cases possible which may be difficult with conventional system
- Saves time, effort and money

What is offline & Real-Time simulator?	**Where can it be used?**
Offline Simulator is a simulation tool which simulates behavior of intended system, including sub-systems in various external scenarios / environments. EV/HEV Plant model offline simulator will be a vehicle behavior simulator driven by electric machine. To execute this offline model in Real-time environment, RT Simulator is required.	• Component sizing such as Motor capacity, gear ratio requirement, battery sizing for specific requirements. • Performance comparison with different types of components / sub-systems. • Design level configuration and performance estimation such as range, energy consumption, peak speed, acceleration, etc. • Hybrid Controller design and development. • Controller calibration and V&V.

Offline & RT Simulator packages are available internationally with licensed packages at higher prices as a black box. Presently, India has no public IP on the Simulation of EV systems. A cost effective indigenous Offline and Real-Time simulation package is not available.

The objective of the project was to develop an indigenous offline and real time simulator system for EV/HEV systems. The offline and real time simulator developed, is first of its kind indigenous simulation platform, which can be used by academic institutes as well as Indian industry as well. It is an open development platform, giving flexibility of modifications / additions to the user to suit specific requirements. The simulator outcome has been benchmarked with internationally available similar simulators.

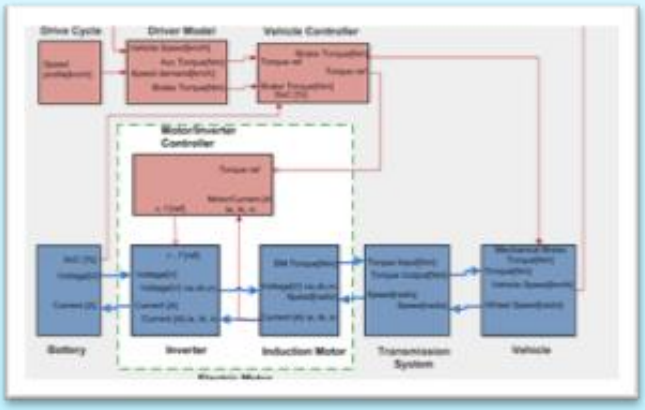
Project Highlights

- First Indigenous Offline Simulator for Electric & Hybrid Electric Vehicles
- Open Design and Development Platform for EV-HEV Systems
- Benchmarking with other internationally available simulators is done to ensure that developed models are at par with the available models
- One of the very projects, in which collaborative work with Research Institute & Academia has led to Industry ready and industry acceptable product; which is at par with international products / offerings.

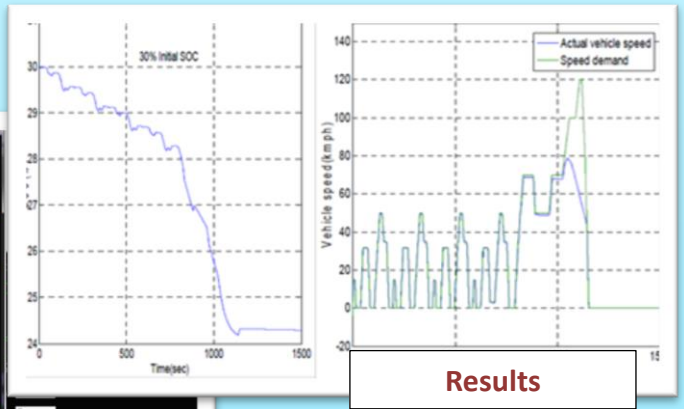
Simulation Package - Technical Details

- Modeling of the plants done in MATLAB Simulink platform.
- Wide range of deliverable component library elements required for simulation of all possible EV / HEV configurations.
- Pool of types of components / sub-systems.
- Standardization and interchanging capability of different sub-systems.

Real Time Simulator



Vehicle Plant Model



Seminar on Tyres – Technology and Regulations 2016

Seminar on Tyres – Technology and Regulations, the second in the series, was conducted on 8th and 9th August 2016 in the Golden Jubilee year of ARAI. It was greeted with enthusiastic response and participation from practicing engineers, scholars and students in engineering discipline.

Mr. Anilesh M. David, Head – Bureau of Indian Standards, Pune inaugurated the Seminar, in the presence of Mr. Rajiv Budhraja, Director General, ATMA and Mr. Tom K. Thomas, Executive Director – Technology and Projects, CEAT Tyres as a Guest of Honour. The seminar witnessed presentation of papers by renowned speakers from Tyre, Automotive and Allied industry.

Dignitaries at the Inauguration: From Left: Mr. Tom. K. Thomas, Mr. Rajiv Budhraja, Mr. A. M. David, Mrs. Rashmi Urdhwareshe and Mr. A. V. Mannikar

Speakers at the event:

- Prof. R. Krishnakumar, IIT Madras
- Dr. T. Sundararajan, Wheels India Limited
- Mr. Sunil Bhatambrekar, Maxion Wheels
- Mr. Hemant Desai, TUV Rheinland India
- Mr. Mandip Singh Tack, IDIADA
- Mr. Joan Puig, IDIADA
- Mr. S.S. Gusain, Bridgestone, India
- Mr. P. Sankar Ganesh, Apollo Tyres India
- Dr. Rajesh Babu Ramanujam, Apollo Tyres India
- Mr. Kumaraswamy Shivashankaraiah, Siemens
- Mr. Karthikeyan Varadarajan, EDS Technologies
- Dr. Abhirami Srikanth, Momentive
- Mr. Animesh Tripathi, Michelin India
- Mr. Vivek Bhandari, Lanxess India

Technical sessions started with the keynote presentation on “Tyre technology R&D Roadmap for India”, by Prof. Dr. R. Krishnakumar – IIT Madras. His talk focused on R&D roadmap for tyre technology in India. Dr. T. Sundararajan-Wheels India, in his keynote, took review of “New Trends and Testing of Wheel Rims”, focusing on the current and future technologies and testing methods in Wheel Rim testing.

Mr. Mandip Singh Tack, IDIADA talked about the role of IDIADA in the international market and tyre development services. He also shared the current market growth scenario in the tyre industry.

Audience

Mr. S.S. Gusain, Bridgestone India educated the audience on “Inflation Pressure: Effects on Tyre Performance”. He shared knowledge on the need of regular checks of inflation pressure of tyre from his long experience in tyre industry.

Mr. Karthikeyan Varadarajan, EDS Technologies shared knowledge on tire analysis using Simulia. He discussed Tire Simulia Timeline and various applications of Simulia. His presentation concluded with a talk on Simulation Lifecycle Management.

Mr. Sunil Bhatambrekar of Kalyani Maxion Wheels, made informative presentation on Analytical & Experimental Study of impact on Performance of Wheel Rim of Commercial Vehicles due to variation in Tyre and Wheel contact during operation. He presented two case studies, which included impact of Tire inflation pressure and tire and wheel contact.

Mr. P. Sankar Ganesh, Apollo Tyres covered in his presentation, tyre modeling challenges on growth and development in India. He explained about the global challenges faced by the tyre industry and the complexities in tyre modeling.

Mr. Joan Puig, IDIADA, made presentation on “Tyre Simulation role in the process of tyre integration on vehicle”. He elaborated subjective and objective roles of tyre integration in vehicle process and also explained Tyre simulation and various Tyre Models.

Dr. Rajesh Babu Ramanujam, Apollo Tyres presented “Tyre R&D testing facilities in India: demand vs availability” and shared the current research and test facilities in India and different tyre characteristics such as wet grip, rolling resistance, friction and tyre labeling.

Mr. Hemant Desai – TUV Rheinland India described the process of type approval of tyres in different countries like China, Indonesia, Brazil, etc. In his presentation he also highlighted the challenges faced during type approval certification in different countries.

Mr. Kumaraswamy Shivashankaraiah, LMS Test Solutions and Engineering Services elucidated on Tire development and regulations on tire noise. He described Pass-by noise Airborne Source Quantification and showcased the LMS Test Lab Software as a single platform for Noise and Vibration testing and evaluation.

Mr. Animesh Tripathi, Michelin, presented Tubeless Technology Benefits for HDV. He helped the participants understand that tubeless tyre gives better life cycle and fuel efficiency. He also compared Fuel Consumption in the light of a test, comparing tubeless and Tube type conducted in India. He also enlightened about other such benefits of Tubeless Tyres.

Dignitaries visiting display of ARAI Tyre Test Capabilities

Panel discussion on “Roadmap: Tyre Regulations for India” was a much sought-after session of the event. The Panel constituting following members, encompassed various areas concerning tyre regulations in India:

1. Chairman - Mr. A. Akbar Badusha, Sr. Deputy Director and Head – HMR & VEL, ARAI
2. Mr. D. P. Saste, CIRT, Pune
3. Dr. P. Chattaraj, NATRAX
4. Mr. Niteesh Shukla, IRMRA - Thane
5. Mr. T. C. Kamath, MRF Tyres
6. Mr. I. A. Joy, Apollo Tyres
7. Mr. Joan Puig, IDIADA – Spain

Panel discussion in progress

Panel discussion started with the address by the Chairman, Mr. Akbar Badusha, who introduced the topic and set the tone for discussion. The discussions included current status of GTR-16 and UN R 117. The panel also discussed the Indian perspective and need and objective of UN R 117. Tyre labeling in India, co-existence of IS standards and global regulations in certification were the topics of discussion as the session progressed. Panel members then responded to the queries from the Chairman and the audience, resulting in an interactive session.

ARAI-TIFAC Golden Jubilee Transport Vision Conclave

Theme: Transport Vision for the Future

ARAI has transformed itself from a Test house to globally recognized R&D organization, through its journey of 5 decades. ARAI celebrated its 50th anniversary, the Golden Jubilee of Service to the Nation. As a part of these celebrations, Transport Vision Conclave was organised jointly with TIFAC at ARAI-Pune. TIFAC is the think tank of Department of Science and Technology and works towards developing policies for the future. The theme of the event was vision and roadmap for future transportation in all modes, i.e. land, air, sea and rail. **Transport Vision 2035** roadmap for India was unveiled on the occasion. Distinguished speakers shared their thoughts around the theme of the event, followed by panel discussion, among the panelists representing various modes of transportation. The program was presided over by the eminent scientist, Dr Anil Kakodkar, who is also the Chairman of TIFAC. Poster session was also organized, depicting ARAI’s contribution in furthering automotive technology.

In response to the major changes in economic situation, geopolitics and technology domain at global level in the last two decades, TIFAC presented fresh perspective on technology imperatives for India as Technology Vision 2035. **Transportation Vision 2035** roadmap highlights vision for sustainable, clean, safe, inclusive, smart and integrated mobility system. Mobility enhances quality of an individual's life and binds the nation together. By year 2035, technology should enable us to access public transportation within one km from our home. No place will be more than three hours away from district headquarter, five hours from the state capital and eight hours from our national capital. Inter-modal mobility should ensure that no two points in a metropolitan area would be more than an hour away. Every settlement will be connected with an all-weather road and every panchayat will have a helipad for delivery of services such as emergency healthcare. Also, from safe mobility perspective zero pedestrian fatalities should be ensured in all parts of the country. This would require mandatory, technology-assisted driver training. With growing population in urban areas and increasing influx of industrial zones to semi-rural neighborhoods that require 25-50 km of one way travel, providing last mile connectivity through multi-modal means is a huge challenge. Use of ICT to tackle traffic congestion will be essential. Development of vehicles that are twice as fuel efficient but emit half the current emissions will be required.

High quality infrastructure, road transportation technologies and traffic management systems are organically interrelated and should be treated in an integrated manner. In addition, there will be a need for intercity connections through cost-effective modes such as semi-high speed and bullet trains for faster intercity access. Multi-modal mobility for goods and services will need to be enhanced with development of dedicated, high speed freight rail corridors. Last, but not the least, will be the great challenge of developing and producing powertrain for an indigenous transport aircraft. Major need will be implementation of technologies, in such a manner that provides for very affordable, comfortable, clean and punctual transportation for all strata of our citizenry. Special focus on inland waterways and coastal waters for transportation is highlighted. The transport vision document was prepared on a consultative framework and is being placed as a referential document to inspire all the stakeholders and articulates vision for all Indians in 2035.

Test Facility Management / Upgradation / Integration / Automation Services

Central Maintenance Cell (*CMC*) of ARAI has been working in the areas of maintenance, upgradation, automation, integration and overall facility management of Engine / Chassis Test Cells, Environmental Chamber Systems, Vehicle Data Acquisition Systems, etc. **ARAI is now ready to serve the industry in these critical areas of test facility management including process improvement to reduce down time and defects in the service / plants.**

CMC possesses high technical knowledge and multi-skilled Electro-Mechanical team and can bridge the gap of long distance services by OE and criticality of equipment functioning, by providing component level innovation and sort out root causes. CMC also develops calibration method and / or provides calibration verification support for variety of equipment.

System Integration

Special Test Facility Upgradation

Training on Maintenance Management

Automation Consultancy Services

Key features:

- Consultancy services for automotive test and measuring equipment.
- Elimination of system problem with substitute and JUGAD innovation to make existing equipment work.
- Creative solutions for assured equipment productivity with cost and time saving, to improve machine down time, setup time and operational efficiency.
- Development of calibration method and / or calibration verification.
- Process improvement to reduce defects in service / plants, critical areas of test and manufacturing equipment.
- Training on maintenance management system.
- Highly knowledgeable, experienced and multi-skilled Mechanical-Electronic support team.

Based on the strong foundations of trust and loyalty, ARAI strives for harmony with customers. We make every effort to provide quality and timely services to the customers. Customer feedback is considered for improvement that bridge the gaps between our service and customer expectations.

As we continue to build stronger partnership with customers, ARAI organized **"CUSTOMER MEET 2016"** on 25th November 2016 to meet and celebrate success with customers. The aim of this meet was also to commit to customers best of our services regularly.

This programme was organized jointly by ARAI and ACMA, with focus on western zone component manufacturers to know each other and understand the requirements to serve better and faster. This programme provided a platform to the customers to exchange views with ARAI and ACMA. This will help ARAI to create better infrastructure, facilities, competency, etc. and serve better.

Facilities and services offered by ARAI were also showcased on this occasion. We intended to gather feedback from our business partners, to align our services with their expectations. It was greeted with enthusiastic response and participation of more than 100 personnel from different component manufacturers, viz. lighting, wheel rim, tyre, brake hose, fuel tank, hinges and latches, safety glass, etc. from different parts of western zone.

The meet was presided over by Mrs. Rashmi Urdhwareshe, Director – ARAI and inaugurated by Mr. V Madhavan, President - Group Business Development, Anand Automotive (P) Ltd. in the presence of Mr. Piyush Munot, Co-Chairman – ACMA Western Region & Director KCTR Varsha Automotive Pvt. Ltd. Mr. A. V. Mannikar, Sr. Deputy Director and Head of Automotive Safety Lab and Mr. Nitin B. Dhande, Senior Deputy Director and Head Business Development & Corporate Planning, ARAI.

Dignitaries at the Inauguration
Mrs. Rashmi Urdhwareshe, Mr. V Madhavan, Mr. Piyush Munot, Mr. A. V. Mannikar and Mr. N. B. Dhande

ARAI Experts made following presentations in the Meet, sharing information about ARAI facilities, capabilities and services, new and forthcoming Govt. notifications, updation of Type approval & COP procedures, applicability of EMI and EMC on components, etc.

Topics	Speakers
ARAI Corporate Presentation	Nitin B. Dhande, Senior Dy. Director & Head - BDCP
Active Safety Component testing and AIS:037	B. V. Shamsundara, General Manager, SHL
Passive Safety Component testing	P. P. Chitnis, General Manager, PSL
New and expected CMVR Notifications	Vikram Tandon, Dy. General Manager, HMR
EMI & EMC testing	A. B. Mulay, Dy. General Manager, AED
Customer Feedback Session	• Nitin B. Dhande, Senior Dy. Director & Head BDCP • U. A. Kulkarni, Deputy Director, SHL

Customer feedback was much sought-after technical session of the event. Many customers shared their experience and expressed further expectations from ARAI with respect to new facilities, better service, readiness of forthcoming regulations, etc.

Discussion on customer feedback started with address by Mr. Nitin B. Dhande and Mr. U. A. Kulkarni, Deputy Director.


Customer feedback session

Participants at the Meet

Simulation-Based Development of SCR System for Automotive Application

1. Introduction

The upcoming BS VI emission legislation demands combination of advanced combustion technologies and highly effective after-treatment system. Requirement of reduction in NOx emission by 90% in BS VI compared to BS IV arises difficulty in selection and matching of compact, but efficient SCR system. Therefore, well adapted designs are essential to fulfil system targets concerning emissions, durability and cost effectiveness.

Powertrain Engineering (PTE) has established competency for selection of efficient SCR system by evaluating appropriate catalyst material, coating and brick size using virtual simulation tools. Packaging layout of SCR system can also be optimized for different urea doser-mixer integration in reactor tube and its interaction with engine performance. This approach helps to achieve highest SCR conversion efficiency under the set of constraints, which significantly reduces time and efforts required during experimentations.

2. Challenges and Complexities in Design Selection of SCR System

Selection and matching of SCR system involves challenges and complexity due to

- Space constraints on vehicle
- Additional weight of after-treatment system on vehicle
- Increase in system backpressure on engine and its adverse impact on fuel economy
- Cost of ownership of after-treatment systems
- Ammonia slip due to space velocity, ANR, higher temperature, etc.
- Complete conversion of urea to ammonia in achieving required uniformity index of NH_3 and velocity
- Avoidance of urea deposition, urea crystallization, low temperature deposit
- Good conversion efficiencies only at narrow temperature window

Simulation can help to develop thorough understanding of complete process in identifying root causes and helps in design selection of highest efficiency SCR system.

3. SCR System Design Selection by Simulation Technique

PTE has developed cost effective approach for complete replacement of experimentation for design and selection of SCR system in concept and layout phase. In first stage, designing packaging layout, which includes decomposition tube length, mixer-doser integration and mixer-doser orientation using 3-D CFD tools, can be optimized for prediction of uniformity index (NH_3 + HNCO and velocity) at upstream of catalyst. In second stage, results obtained from 3-D CFD tools are used as input data for 1-D thermodynamic simulation to calibrate storage modelling, reaction rate parameter, impact of variation in NO_2, space velocity, coating and catalyst type on NOx conversion efficiency to satisfy comprehensive set of performance criteria. In third stage, characteristic parameters of second stage are used for 3-D CFD simulation to evaluate overall performance, including fine tuning of after-treatment system.

PTE has performed case-study for BS-VI development with an objective to simulate, calibrate and optimize after-treatment system for BS-IV compliant commercial vehicle. The after-treatment system includes DOC, DPF and SCR system. This case study was performed to achieve required NOx conversion efficiency of SCR system for BS-VI emission norms.

State-of-the-art approach for selection and matching of SCR system begins with optimizing packaging layout of SCR sub-system by 3-D CFD simulation. In this task, design of packaging layout from 3-D CFD simulations is performed considering interaction of following parameters:

- Flow conditions (velocities, temperatures, pressure drop)
- Spray preparation (NH_3 distribution, wall film formation, risk of deposits, effect of mixing devices)
- Substrate flow conditions (flow uniformity, pressure gradients)
- Appropriate NOx sensor location

3-D CFD tool is used to meet above design criteria by implementing all relevant physical and chemical phenomena such as -

- Momentum interaction between gas phase and droplets
- Evaporation and Thermolysis of droplets
- Hydrolysis of isocyanic acid in gas phase
- Heat transfer between wall and droplets
- Spray / wall interaction
- Two-component wall film, including interaction with gas phase and reactor tube.

NOx conversion in SCR system is simulated for two selected operating points, i.e. high flow high temperature and low flow low temperature of an emission test cycle, with after-treatment module of CFD tool. Urea injection is considered in a transient manner with 1Hz pulse frequency.

3.1. CFD Analysis

CFD model used for case study is a sub-system of an after-treatment system, consisting of decomposition tube with an injector housing, static mixer and SCR catalyst. CFD fluid volume of this system is shown in Fig.1. Outlet assembly of SCR is not included in this study for simplification. Mesh is created in 3-D CFD with a mesh count of about 2 million elements, including two prism layer around wall zones to resolve near wall conditions. Fig.2 shows computational mesh created for this model.

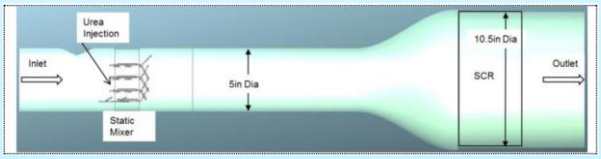


Fig 1: CFD Model

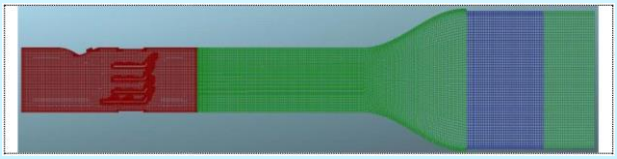


Fig 2: CFD Mesh

3.2. CFD Results

The aim of the case study was to optimize position of two-stage mixer for maximizing UI (NH_3+HNCO, Velocity) for more than 95% NOx conversion efficiency. Prior to optimization of packaging layout, urea injection on mixer is evaluated for effectiveness of collision. Fig. 3 and 4 shows that spray plum is hitting on right blade to enhance mixing performance by fast evaporation.

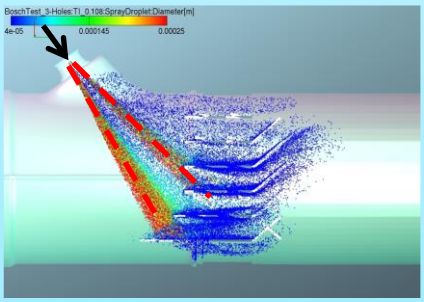


Fig 3: Spray hitting on mixer

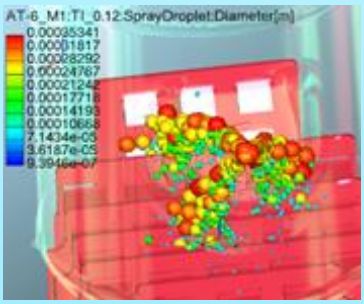


Fig 4: Droplet collision

In next step, cone mixer and two-stage mixer, along with orientation of two-stage mixer, were evaluated in the same reactor tube to achieve more than 95% conversion efficiency within acceptable pressure drop.

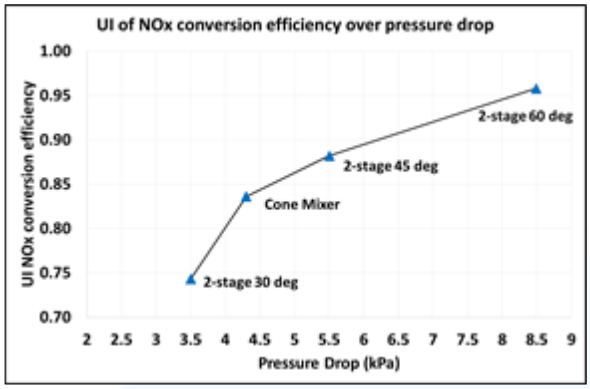


Fig 5: UI of NOx conversion efficiency

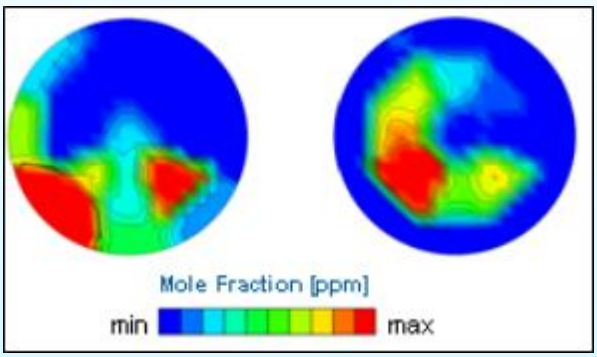


Fig 6: NH_3+HNCO distribution upstream of SCR

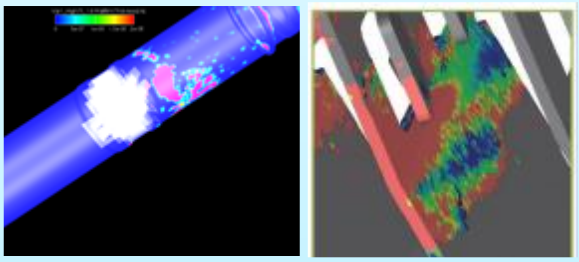


Fig 7: Urea deposition on reactor & mixer

Given the trade-off between back pressure and mixing performance, mixers with good performance often have high back pressure to the system. Especially attack angle of urea spray interacts with exhaust gas velocity, resulting in spectrum of performance, as shown in Fig.5. Mixing performance of two-stage mixer increases with higher pressure drop and higher degree of orientation of mixer with respective to axial because of active evaporation and thermal decomposition caused by wide response area of urea sprayed into exhaust gas.

Fig. 6 shows distribution of NOx reduction efficiency of two-stage mixers with 60 deg orientation at high flow high temperature and low flow low temperature operating condition. This allows fastest SCR reaction and is reflected in high NOx reduction efficiency. The uniformity indices reflect very good distribution of reductant over whole area of SCR catalyst with medium pressure drop.

Wall film formation and propagation within the SCR system were simulated for low flow and low temperature operating condition. As shown in Fig. 7, temperature decrease of mixer due to spray impingement was observed. Also some regions of reactor tube with low temperature were seen as deposits for first 3 pulse of urea injection. However, these deposits might not appear after few cycles, which is computationally expensive to predict in CFD.

3.3. 1-D Simulation Analysis

Although detailed chemistry is available within 3-D CFD software package to compute NOx conversion efficiency, it requires relatively longer period of computation. PTE has developed competency using 1-D thermodynamic simulation tool to solve adsorption / desorption reaction, SCR reaction, including surface chemistry, etc. that can be used in lieu of detailed chemistry, resulting in dramatically reduced computational time. This approach helps to predict NOx conversion efficiency of SCR catalyst and ammonia slip.

PTE has studied all relevant catalytic reactions in 1-D thermodynamic simulation tool to determine -

- Layout of exhaust after-treatment system
- Determination of necessary brick volume
- Selection of catalytic coating from available types
- Prediction of NOx conversion efficiency over entire engine operating zone
- Prediction of drive cycle emission

In this task, 1-D thermodynamic simulations are performed first to predict elementary reaction (NH_3 adsorption-desorption reaction) prior to SCR reaction. The amount of reducing agent (NH_3 in urea SCR) storage on the substrate is very important parameter for catalytic converter model calibration. Model can only predict precise catalytic conversion reactions if the catalyst storage model is well calibrated. Validity of storage modelling is confirmed as shown in Fig. 8. From this simulation at each temperature, 1 and 2 active site densities of both weak and strong NH_3-adsorption site for the reaction model were determined. After that, reaction-kinetic parameters for NH_3 adsorption / desorption reactions (i.e. frequency factor, activation energy, active site density) were identified by the transient simulation as shown in Fig. 9.

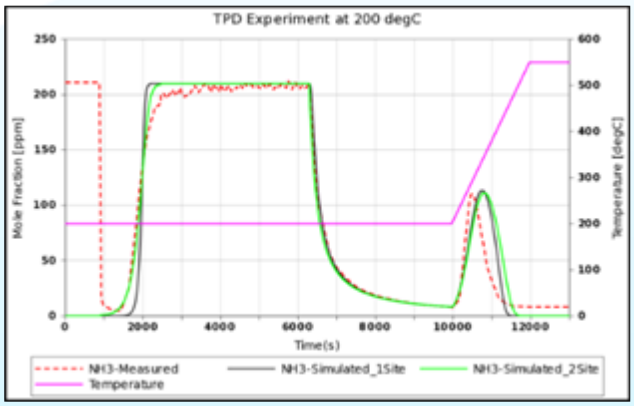


Fig 8: Storage Modelling

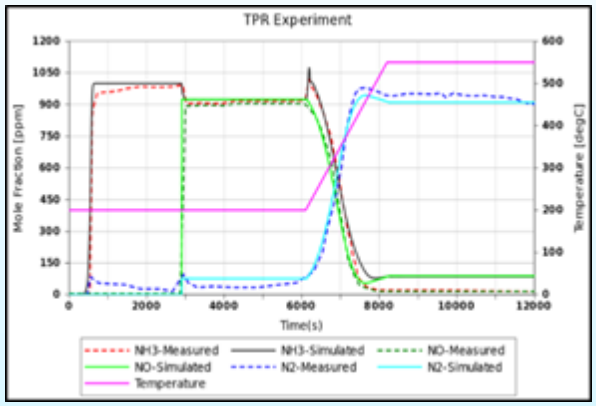


Fig 9: Catalytic Reaction Modelling

By using these calibrated parameters, catalytic reactions are simulated for Cu-Z & Fe-Z catalyst. Catalyst selection is very critical phase in catalytic converter system design. As shown in Fig. 10, copper exchanged zeolites offer better low temperature conversion whereas Iron exchanged Zeolites offer better high temperature conversion. Vanadium based catalysts offer economical solution and better Sulphur tolerance.

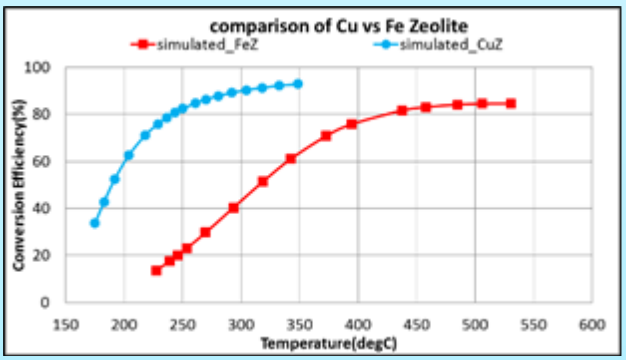


Fig 10: Simulated Results of Fe-Catalyst and Cu-Catalyst for NOx reduction

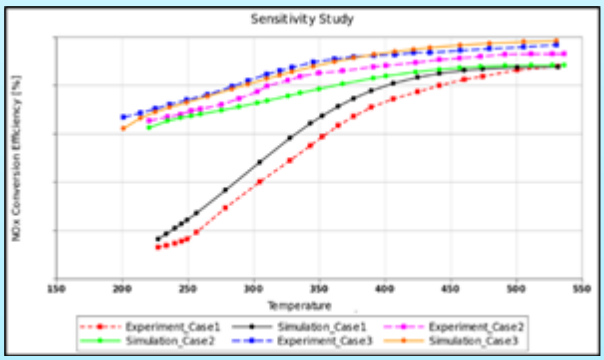


Fig 11: NOx Reduction of Fe-Catalyst for Space Velocity Variation

Once model with reaction rates is calibrated for both storage and catalytic reactions, it is further simulated with variation in parameters such as temperature, space velocity, exhaust feed composition variation to achieve 90% NOx conversion efficiency as shown in Fig. 11.

Finally, to achieve 90% NOx conversion efficiency, low temperature conversion efficiency improves with increase in the inlet feed NO_2 fraction due to slow and fast SCR reactions occurring at the same time. As shown in Fig. 12, at NO_2 fraction beyond 0.75, drop in conversion efficiency is observed due to dominant slow SCR reaction. Some catalysts show more sensitivity to inlet NO_2 feed than others and NO_2 feed of 0.5 is considered ideal for all the catalysts.

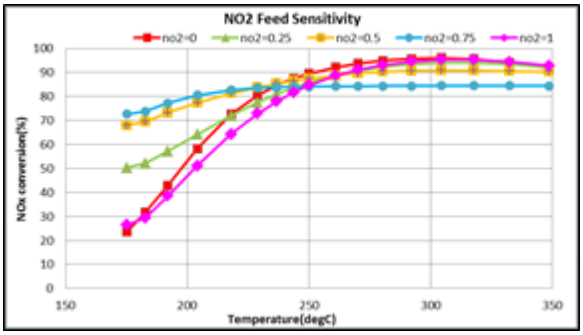
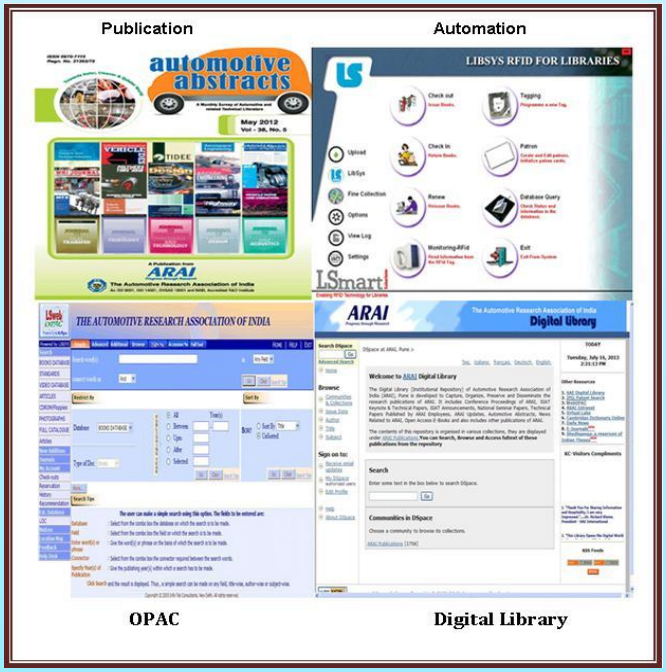


Fig 12: NOx reduction of Fe-Z catalyst for NO_2 variation

ARAI Knowledge Centre Services

ARAI's well-equipped and fully computerized Knowledge Centre provides information support to satisfy the information needs of in-house researchers, faculty members and Academy students. It also serves professionals, faculty, students and various government organizations to gather knowledge in automotive engineering domain.

Knowledge Centre has collection of around 23000 books and standards, 75000 SAE Technical papers, 500 SAE Special publications and Academy Project Reports on various topics like powertrain, electric & hybrid vehicles, emissions, NVH, brakes, fatigue, vehicle dynamics, safety, automotive electronics, automotive materials, management, soft skills, etc. and technical reports, seminar/conference proceedings such as SAE, IMechE, SIAT, FISITA, etc. Every year, more than 100 books are added to Knowledge Centre. It also has rich collection of National and International standards like IS, SAE, JASO, ISO, DIN, ASTM, BS, EEC/ECE, ADR, AIS, etc. It also has a good collection of national and international journals with back volumes. Collection of SAE Technical papers is another valuable addition to the Knowledge Centre. Library Web OPAC is available on website www.araiindia.com



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Student Project Reports	650

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Automotive Abstracts: Monthly Publication of ARAI

Automotive Abstracts (ISSN No. 0970-7115) offers most comprehensive service to the automotive industry in India. Abstracts of articles published in most of the leading Journals / Periodicals on Automotive Technology and International Symposium such as IMechE, FISITA, ISATA, SIAT, etc. are included in our publication. It includes Autonews, Technoscan, IPR scan, Forthcoming events, etc.

Annual subscription period is fixed from April to March (11 print issues, e-version+December Index issue in CD).

❑ Plastic Injection Molding Simulation – New Domain Engineering Services at ARAI

With increasing demand of **light-weighting**, **cost reduction** and **cost-effective production**, use of plastics and composites is an obvious answer for designers and manufacturers. Moreover, plastics have widespread applications in almost all industrial domains. At an early stage of development, even the most experienced fail to predict surprises awaited during the trial (first prototype) stage. These surprises include defects and issues related to quality, aesthetics, dimensions, etc. Correcting these defects becomes a 'trial and error' approach, which adds unnecessary re-tooling expenses while stretching the delivery commitments. Correcting defects at the end stage of development would compromise quality, leading to potential field failures due to unpredictable component life. Moreover, modern day designers are more creative and adventurous in their design, which increases importance for validation tool.

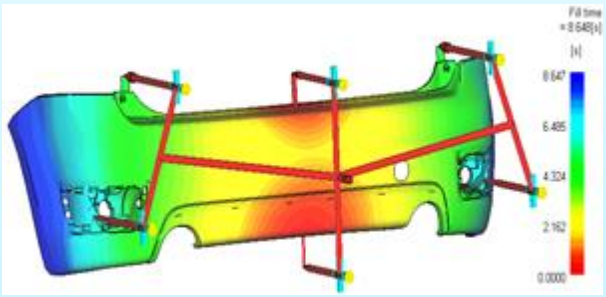
In order to stay aligned with the market trends and to adopt new technologies, ARAI has added state-of-the-art **Plastic Injection Molding Simulation** service to its portfolio.

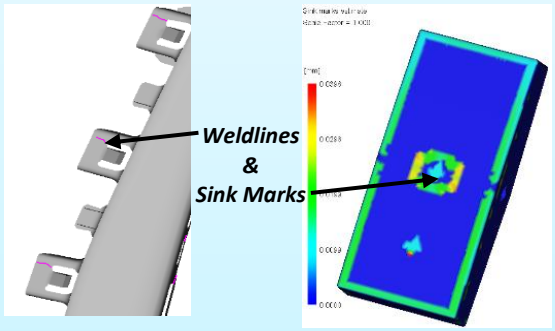
Following solutions are provided through Plastic Injection Molding Simulation in best possible way-

- Perform virtual validation of molding issues related to design and process in order to relieve customers from the risk of losses after huge investment on the mold / tool.
- Optimize design from manufacturability aspect in order to have robust product that sustains process variations.
- Pre-detect potential aesthetical defects such as weld-lines, air traps or sink marks that can fail the part at quality. This creates scope to make necessary arrangements in design and mold design to eliminate it.
- Detect dimensional issues such as ‘warpage’ which hold the key to part’s success since most of the parts designed in today’s world work in assemblies. This creates scope to understand its key contributors as well.
- Carry out ‘design of experiments’ study in very less time to understand key parameters affecting the result or design criteria.

ARAI provides Injection Molding Simulation services in the following areas:

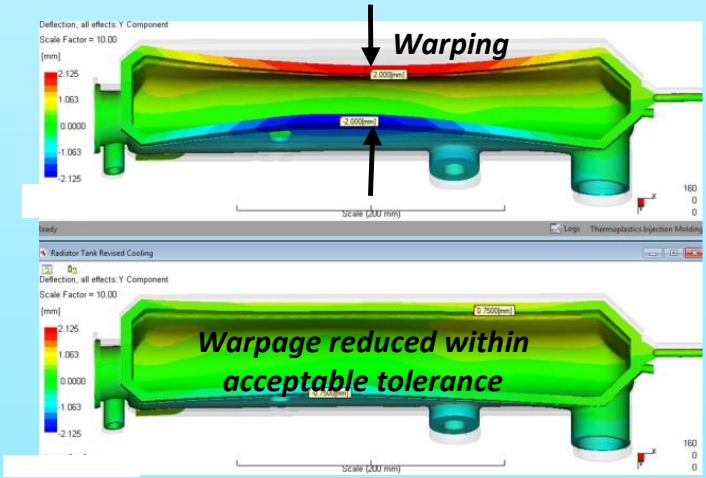
- Product Design Validation for Defect Identification



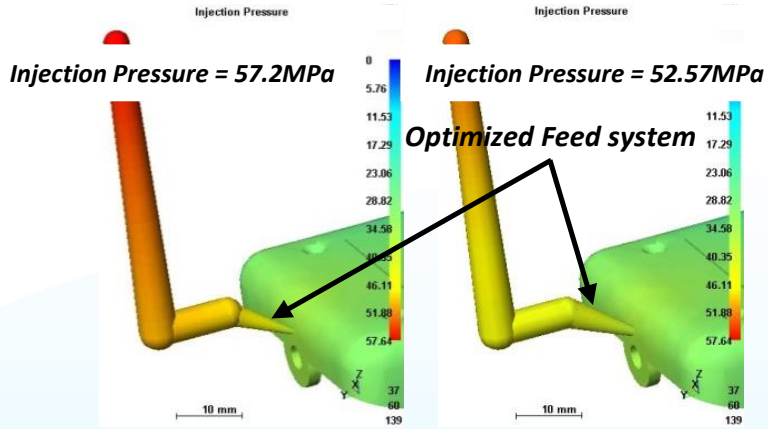


- Optimization
- Value Added Engineering
  - Thickness Reduction from Filling perspective
  - Cycle Time Reduction

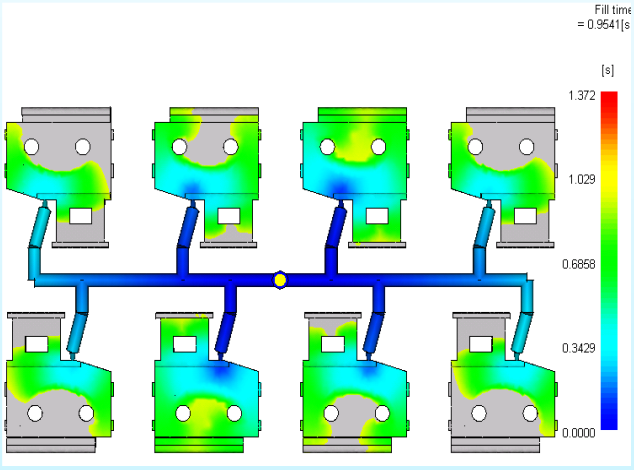
- Mold Design Validation
  - Optimizing gate location/s
  - Computing best combination of multiple gates
  - Optimizing filling, packing and warp



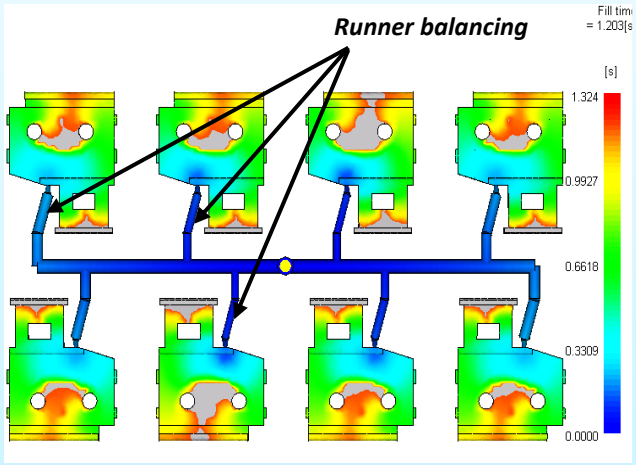
- Feed System Optimization



- Runner Balancing

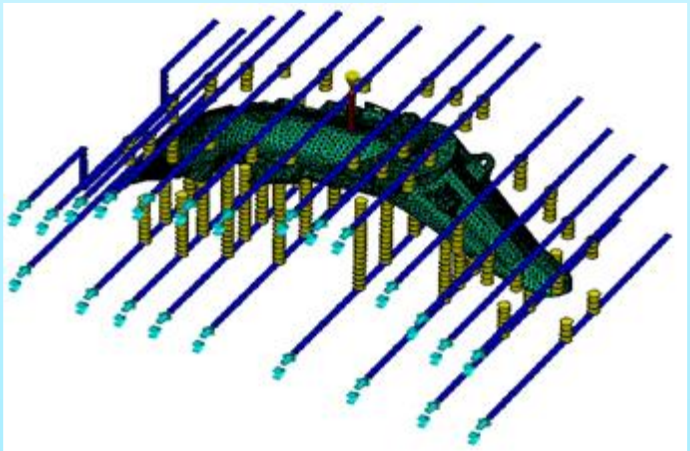


Unbalanced multi-cavity



Balanced multi-cavity

- Evaluating Channel Layout effectiveness and locating ‘hot-spots’



- Raw Material Validation
- Material Comparison
- Core Shift Analysis (mold/part insert deflections)
- Sequential Filling
- Providing Technical and Domain based Training in Molding Simulation

ARAI now supports customers to get best solutions for defect-free Injection Molding using Simulation. Our domain expertise in this field is an added advantage for providing customers with more accurate and implementable solutions.

ARAI establishes India's First Child Restraint System Test Facility

To support Government of India's drive towards facilitating safe transportation mode for Children, ARAI has established new Child Restraint System Test Facility under its Passive Safety Laboratory at Kothrud, Pune.

This is the first such facility in India. The facility is capable of testing of child restraint systems as per AIS 072 as well as UN ECE Regulation No. 44. The facility was inaugurated during SIAT 2017, at the auspicious hands of Shri Sanjay Mitra, Secretary, Ministry of Road Transport & Highways, Government of India.

ARAI's facility is equipped with

- Full family of state-of-the-art Q-Series Child dummies.
- ISOFIX Child Restraint Fixtures.
- Dynamic Test Benches with latest generation high speed cameras.
- All the static test rigs such as overturning rig, lock off device test rig, adjuster conditioning rig, energy absorption test rig, UTM Machines, Climatic Chambers and other rigs required for complete testing of child restraint systems and its child parts.
- ARAI's latest Crash Test Facility at HTC-Chakan is capable of performing full vehicle crash tests with child dummies as per proposed Bharat NCAP test protocol and as per other international NCAP protocols.

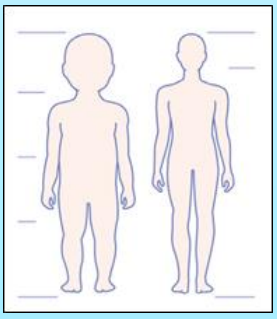



Child safety seats (sometimes referred as an infant safety seat, **a child restraint system**, a restraining car seat, or ambiguously as car seats) are the seats designed specifically to protect children from injury or death during collision.

CRS is usually hard-back child safety seat, which is used for safe transportation of children in cars and aircrafts.


Why to protect your child?

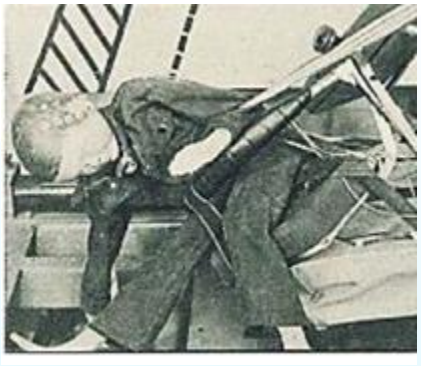
Babies and toddlers, compared to older children and adults, have weaker neck muscles carrying relatively large and heavy head in relation to their body. To reduce the risk of severe injuries in case of crashes or emergency braking, it is important that this group of children is transported against the driving direction for as long as possible.



Child Safety seats help to prevent death and injury in case of crash.

- Majority of injuries to children are the result of being thrown into windshield or dashboard, crushed by adult, or thrown from the vehicle.
- In the event of crash, unrestrained child becomes like a missile that is thrown with great force.

- Child safety seat is designed to:
    - Hold the child in the seat in the vehicle.
    - Protect child from being thrown out of the vehicle or from hitting something in the vehicle.
    - Absorb force of impact.
    - Spread force of vehicle's impact safely over whole body.



Brief History

First seats for children arrived on stage in 1930, but not for protecting children! These seats were meant to lift the child so that adult parent can see them inside the car.

Swedish Doctor, Bertil Aldman, developed concept of rearward facing CRS offering better protection to young children in 1962.

Volvo launched PV544 with first rearward facing CRS as a standard accessory in 1964.

What are the legal requirements?

- Most of national or regional legislation requires use of child restraint systems for transport of children up to certain age or height.
- US adopted FMVSS 213 – Standard for CRS in Year 1971.
- By 1985, all states in USA passed law for mandating use of CRS.
- First set of Child Dummies (p-series) developed by TNO, Netherlands in late 1970s.
- UN ECE issued CRS Test Standard UN ECE R44 in 1981.
- Europe issued regulation for CRS in 1993. Many countries in Europe enforce mandatory use of CRS.

Categories of Child Restraints

CARRY COTS

Carry Cots approved for automobiles only serve their purpose for speeds below 50 km/h. Placed transversely in vehicle rear seat, they need belts with 3 points and special harness for their attachment.

REARWARD FACING CRS

Rearward Facing CRS are placed both in the front seat (unless you have active airbag) or rear seats. Fastened with vehicle's three-point seat belt or using ISOFIX system, if vehicle's seat is ready for this adjustment device.

FORWARD FACING CRS – Integral Harness

Forward facing CRS are adapted to constitution and specified weight babies. It can be placed in rear or front seats, forward facing. If placed in rear seat, would be preferably in the Centre. Are installed with the car seat belt or using ISOFIX system (if vehicle seat got this anchoring system) and forward facing.

FORWARD FACING CRS – High Back Booster

Child restraints which use vehicles seat belts directly for restraining child as well as seat. Usually adapted to growth and its backrest can be removed, once dimensions allow child using seat belt for adults only with booster.

BOOSTER SEATS

Same weight range as Group 2 car seats, but without backrest and with height adjuster for seat belt. Until child exceeds 1.35 m. high and can use adult seat belt directly, it must use compulsory booster seat.

India's Foray into Child Restraints

- India has published and adopted AIS-072 - Approval of Restraining Devices for Child Occupants of Power-Driven Vehicles (Child Restraint System).
- Government of India, vide Notification No. GSR 291(E), mandates :
  - Provision for fitment of at least one CRS in vehicles manufactured on or after 1st Oct 2014.
  - Use of AIS-072 type approved CRS for transportation of children in passenger vehicles from 1st April 2016.
- Accordingly, it is in the interest of the passenger/consumer to start using approved Child Restraint System for transportation of children in cars.

❑ Flexi Arm Portable Coordinate, 7-Axis Measuring Machine (CMM) with Scanner Attachment

Edge Scan Arm HD is the most affordable, high performance contact / non-contact measurement system.

FARO Edge with Scan Arm ES is the latest advancement in FARO's Laser line Probe product line and features enhanced Scanning Technology (EST). EST is a combination of multiple hardware and software improvements such as high dynamic range (HDR) mode designed to boost performance by improving ability to scan challenging surfaces including high contrasting colours simultaneously.

Applications:

Dimensional Analysis

- Calculate geometric and GD & T measurements
- Compare complex geometry, surfaces and feature positions to nominal data
- Automatically generates reports.

CAD-Based Inspection

- Measuring directly against CAD data lets the operator see real-time deviations from nominal
- Allows parts to be produced with an inspection report certifying the part has been manufactured within acceptable tolerances.

On-Machine Inspection

- Quickly and easily inspect parts on the machine tool producing them
- Reduce time and cost of inspections
- Achieve tighter Tolerances with fewer errors and less production waste

Alignment

- Perform alignments faster, more accurately, and with less effort than traditional measurement methods.
- Real-time measurement confirms tolerances and validates design

Reverse Engineering

- Digitize part or object to create fully surfaced CAD model.
- Rapid prototyping allows engineer to reproduce complex shapes in fraction of time.
- Need to create hard masters and space they require is eliminated.

Non-Contact Inspection

- Allows inspection of soft, deformable, or complex shapes
- Easily align data to the nominal in order to compare Virtuality to reality
- Ideal for inspection, Point cloud-to CAD comparison, rapid prototyping reverse engineering and 3-D modelling

Technical Specifications: **Model:** FARO Edge; **Measuring Axis:** 7; **Measuring Range:** 1.8 metre; **Single Point Repeatability:** 0.024 mm; **Volumetric Accuracy:** ± 0.034 mm

FARO Laser Line Probe Specification: **Accuracy:** ± 35 µm; **Repeatability:** 35 µm; **Stand-off:** 80 mm; **Depth of field:** 85 mm; **Effective Scan Width:** Near field 53 mm, for field 90mm; **Points per line:** 752 points /line; **Scan rate:** 60 frames/second x 752 points /line=45120 points /second

❑ Celebration of 1st Anniversary of HTC, Chakan

First anniversary of ARAI - Homologation and Technology Centre at Chakan was celebrated on 4th January 2017. Shri Rajendra Petkar, Head of Power Systems Engine, ERC, Tata Motors Limited, graced the occasion as a Chief Guest, in the presence of Shri Kamlakar Takawale – HR Head – Volkswagen India Pvt. Ltd. ARAI employees and many industry stalwarts, including the members of the Governing Council for ARAI, attended the function. On this occasion, ex-employees of ARAI felicitated and were given a tour to the state-of-the-art development and testing facilities at ARAI-HTC.

Mrs. Rashmi Urdhwareshe, Director – ARAI, in her opening address, welcomed the guests and presented the overview of facilities and capabilities of ARAI-HTC, progress made by the Centre since inception and the way ahead, facilities going to be added in near future. In her speech, she acknowledged the support of the automotive and allied industry and appealed to put across service feedback, their requirements and expectations from ARAI.

Shri Petkar expressed satisfaction over the progress made by the Centre in a short span and congratulated ARAI employees for the same. His informative and visionary speech inspired the audience. Shri Takawale acknowledged the efforts made by ARAI in establishing the Centre in Chakan industrial hub and the service rendered to the industry.

Symposium on International Automotive Technology (SIAT) 2017 – Brief Overview

ARAI, in association with SAE India and NATRIP and with the support of SAE International (USA), had organized Symposium on International Automotive Technology (SIAT) at ARAI, Pune from 18 – 21 January 2017. The event featured presentation of technical papers and keynote speeches, with participation of automobile experts and professionals world over. Theme of SIAT 2017 was "Smart, Safe and Sustainable Mobility", keeping in tune with latest trends and challenges ahead of the automotive community.

The focus of Indian Government on reducing pollution, encouraging electric mobility, coupled with thrust on reducing road accidents and fatalities through smart and intelligent solutions, has driven industry to advance their R&D efforts. SIAT 2017 was the ideal platform for the researchers around the globe to put forth and deliberate their ideas to address India specific and global challenges faced by the automotive sector.

In addition to 170 technical papers, 40 keynotes, were presented in 5 parallel sessions during the 4-day Conference. The main attraction of the conference was plenary sessions on "Smart, Safe, Sustainable & Future Mobility" by eminent speakers, who set the tone for conference deliberations and provided direction to automotive fraternity.

SIAT 2017 witnessed participation of 1400 delegates from India and abroad and presentation of 205 technical papers and 40 keynotes by the automotive experts worldwide. In the concurrent SIAT Expo 2017, global auto and allied industry displayed their products, technologies services through ~ 200 stalls and received overwhelming response in terms of participation and turnover.

SIAT 2017 activities were planned according to the vision and guidelines of Digital India initiative. Entire conference process, right from technical paper submission to delegate registration, was set up online. 7" Android Tablet, with pre-installed Mobile App and other data to provide complete information about the conference, was provided to each delegate.

SIAT 2017 was a remarkable event in the history of ARAI. In true sense it was a grand finale of ARAI's year-long Golden Jubilee celebrations.

Global Engine Manufacturers' meet at ARAI

On 7th February 2017, Indian Diesel Engine Manufacturers Association (IDEMA) had organized engine manufacturers' meet at ARAI, wherein 30 senior representatives of global engine manufacturers participated. The alliance is named as International Internal Combustion Engine Manufacturers Association (IICEMA). Following alliance members attend the Meet :

European Association of Internal Combustion Engine Manufacturers (EUROMOT)
Engine Manufacturers Association, USA (EMA)
Indian Diesel Engine Manufacturers Association (IDEMA)
Japan Land Engine Manufactures Association (LEMA)
Japan Internal Combustion Engine Federation (JICEF)
Japan Ship Machinery & Equipment Association (JSMEA)
China Internal Combustion Engine Industry Association (CICEIA)

Besides focus on the current scenario, the deliberations encompassed worldwide regulations, future challenges and course of action.

The members were addressed by Mrs. Rashmi Urdhwareshe (Director, ARAI), Mr. Georg Diderich (President, EUROMOT), Mr. Vijay Varma (Chairman, IDEMA) and senior executives of ARAI. Question and Answer Session followed following the meet, which gave lot foresight on Indian Regulations. Mr. Robert Jorgensen (Vice President, EMA) proposed vote of thanks.

ARAI's capabilities, knowledge and dedication of employees, and facilities were highly appreciated by the delegates. The meet as well as visit to ARAI facilities will strengthen business association of ARAI and IICEMA Members.

Mrs. Rashmi Urdhwareshe, Director, ARAI
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