ARAI® Progress through Research Update

Towards Safer, Cleaner & Quieter World ...

Design, Development and Testing Services at ARAI

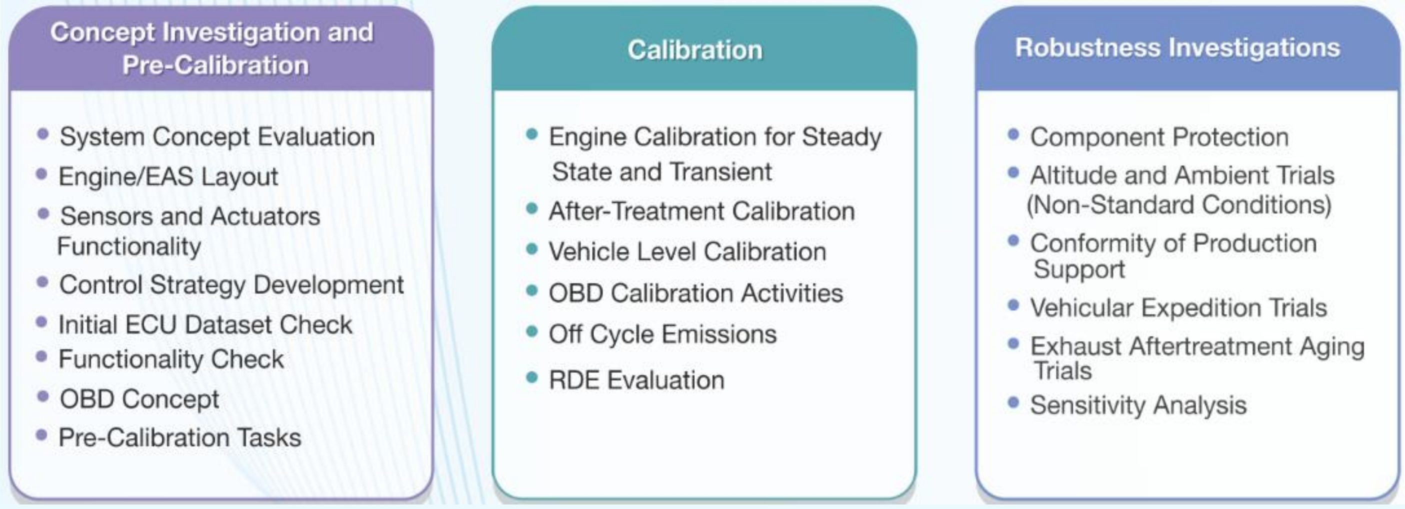
October - December 2017

Virtual Calibration Facility at Virtual Calibration Centre (VCC)

Developments for BS VI and TREM IV / TREM V require significantly higher calibration efforts as well as development time due to complex engine and after-treatment controls. Development has to pass through concept definition, detailing, prototype development and calibrations for engine-out basis steady-state and transient emissions, after-treatment, OBD, Vehicle level performance, Off-cycle emissions, including RDE, etc. This calls for long duration occupancies on high end Engine and Chassis Dynamometers followed by extensive Field Trials.

Virtual Test Bed facility at ARAI Virtual Calibration Centre (VCC) is aimed at significant reduction in development time and resource requirement for BS VI and beyond developments. In Virtual Test Bed based calibration, physical engine, after-treatment and vehicle are replaced by advanced real time models. Calibrations can be done for engine and vehicle level emissions. The system can be used for complete development, i.e. from concept investigation, emissions calibration, OBD calibration, vehicular performance to field trials, including ambient, altitude, Real Drive Emission evaluation, etc.

ARAI Virtual Calibration Facility



Virtual Calibration Portfolio

ECU, with certain maturity achieved with virtual calibration, can be directly taken up for real testing on engine dynamometer, chassis dynamometer and in the field, gives significant advantage with reduction in requirement of real testing. In addition to reduction in real testing time and prototype component development efforts, this provides advantage of improved calibration quality because of high reproducibility and good extrapolation capability. The facility can configure engine and after-treatment devices. It can be used for all category / application engine and vehicle calibration. Besides Diesel and Petrol engines / vehicles, it can be used for engines with alternate fuels and hybrid vehicles.

Advantages of virtual calibration -

- Improved calibration quality with high repeatability and excellent extrapolation quality
- Calibration independent of weather condition, location and prototype availability
- Minimized usage of expensive test facilities
- Faster time to market
- Reduced fuel consumption leading to reduction in CO_2 emission

Services are offered for development of products for stringent emission level compliance demanded by BS VI, TREM IV / TREM V, etc. and aiming at reduced number of prototypes. The virtual calibration facility is integration of ARAI's expertise in Simulation and Hardware-in-Loop (HiL) testing, and experience in Calibration with following unique advantages of ARAI as a Development Partner -

- Strong competency and thorough experience in building predictive plant models
- Calibration expertise for wide range of engines, after-treatment and vehicles with different fuels
- Expertise in hardware-in-Loop integration and calibration
- NABL certified engine test cell facilities for acquiring accurate input data
- One stop solution from concept investigation to real world emission calibrations

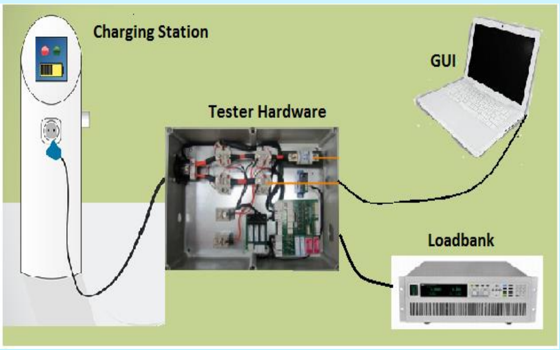
❑ Evaluation of Electric Vehicle Conductive Chargers (AC/DC)

In line with National Electric Mobility Mission and thrust of Government of India on Electric Mobility, rapid growth in Electric Vehicle development is envisaged in India. ARAI has set up Centre of Excellence (CoE) for Electric Mobility to support automotive industry for development, evaluation and certification of Electric Vehicles. It is essential to have convenient and safe infrastructure for charging electric vehicles. Availability of infrastructure is a major factor in consumer acceptance.

ARAI is ready with all requisite facilities and competency for providing complete support for development, validation and certification of these chargers as per various National / International standards, like AIS 138, IEC 61851, Bharat EV AC-001, Bharat EV CD-001, etc. Apart from physical verification, following important activities are involved in compliance to Bharat EV AC-001 and Bharat EV CD-001.

1.0 EV to EVSE Communication and Interoperability for Bharat EV Charger- DC001

ARAI has developed a simulator for simulation of Electric Vehicle environment for offline testing of Charging Station. With the help of this simulator, validation of protocol can be done with multiple use cases to ensure interoperability of DC charger.



2.0 Characteristics and operating condition for AC/DC chargers

Environment Requirements

a) Ambient Temperature Range: 0°C to 55°C as per 11.11.1.2 of AIS 138 Part 1
b) Ambient Humidity: 5% to 95% as defined in Section 11.2 of AIS 138 Part 1
c) Storage temperature: 0 to 60°C

Mechanical Requirement

a) Ingress Protection: Minimum IP degrees for ingress of objects is IP 54

b) Mechanical Impact: As per IEC 61851-1 Section 11.11.2

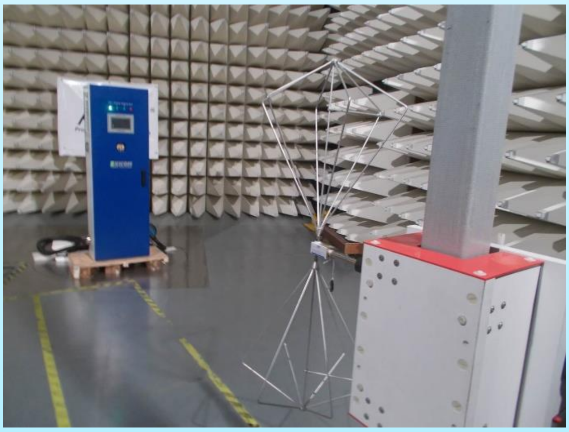
c) Mechanical Stability: As per section 11.11.2.2. of AIS 138 Part 1

Electrical Protection Requirements

a) Earth Presence Detection (Socket-EVSE)
b) Earth Continuity Check (EVSE-EV)
c) Over Current and Short-Circuit Protection
d) Leakage Current Protection (RCD)
e) Dielectric Withstand Voltage

EMI / EMC Testing

a) Immunity to electrostatic discharge
b) Supply voltage dips and interruptions
c) Fast transient bursts
d) Voltage surges
e) Radiated Emission (only for DC charger)



3.0 EVSE – CMS Communication for AC/DC charger

EVSE should be able to communicate with CMS using Open Charge Point Protocol (OCPP) 1.5 or higher versions compatible to OCCP1.5.

a) Communication interface: Reliable Internet connectivity.

b) It should authorize the operation, before electric vehicle start or stop charging. EVSE should respond to CMS for the queried parameters. Reservation, cancellation addition and deletion of EVSE should be possible from CMS.

c) Metering: Grid responsive metering as per consumption of units of the vehicle.

Manufacturing Process Parameter Design by Dilatometry Technique

Introduction

Today Forging and Heat treatment process has become a science, which was earlier considered as an art. To manufacture high strength component with optimal cost, heat treatment process optimization is vital. Component heat treatment cycle is normally decided by standard thumb rule. Quantification of effect of time, temperature and its rate (i.e. cooling and heating) is seldom analyzed for heat treatment optimization. In this article transformation, temperatures are quantified for different thermal cycle using dilatometry technique and ideal hardening temperature is identified for 40Cr4 material.

One of the major areas to reduce cost of the vehicle is to reduce component production costs and this can be achieved if significant energy is saved during manufacturing process. There is huge potential in developing cost effective production technologies in India without compromising technical requirements. Forging and heat treatment of steel components are major energy intensive processes in production cycle. In today's scenario heat treatment cycle in forging industry is designed through trial and error / thumb rule / experience / literature. Introduction of new materials and also chemistry modified materials is common. Saving of few kW in the process can translate into larger increase in energy efficiency because of 'mass-production effects' and this leads to huge cost saving. This will be useful for Indian manufacturing industry, which is undergoing major paradigm shift in terms of its production capacity and also implementing new technologies.

Quenching Dilatometer

Dilatometry technique is used for study of phase transitions in material by measuring its linear strain. Strain occurring because of microstructural changes is one of the important parameters used in studying phase transformation. This technique is aimed at establishing direct link between discrete values of strain and specific microstructure constituents in materials. Continuous Cooling Transformation (CCT) and Time Temperature Transformation (TTT) curves are obtained as output.

Test specimens are held between the two push rods of the dilatometer. The sample is heated by induction principle. Cooling is achieved by combination of controlled reduction in heating current and injection of helium gas onto the sample. Dimensional change is measured along the longitudinal axis of the sample and temperature change is measured by means of thermocouple welded to the surface of the sample midway along its length. Refer Fig. 1 for typical sample. ASTM Standard A1033-10 gives procedure for quantitative measurement and reporting of hypo eutectoid carbon and low-alloy steel phase transformations. 40Cr4 is used as a typical material for studying effect of hold temperatures and different cooling rates and also for the determination of critical temperatures, i.e. austenite start and finish temperatures. **Quenching dilatometer facility is available at ARAI**

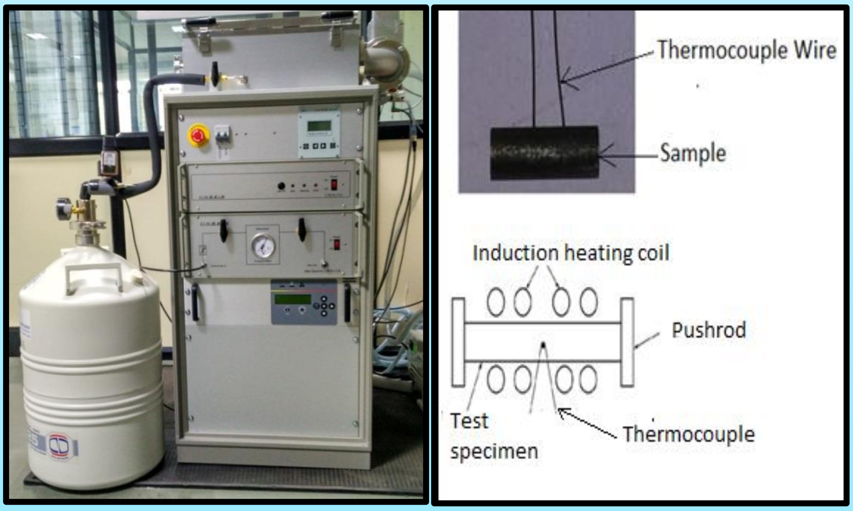


Fig 1: RITA L78 Quenching Dilatometer, Make: - Linseis GmBH, Germany

❑ International Transportation Electrification Conference (ITEC) India 2017

Future of Transportation Sector is poised for transformation, primarily driven by regulations and demand for more efficient vehicles. Globally, automotive industry is gradually shifting towards Hybrid and Electric Vehicles (EVs) due to environmental challenges and energy concerns. In line with the global developments, the need for electrification of automotive industry in India is also well recognized. Significant step in this direction has been Government of India's 2030 Electrification Vision. Combination of regulatory support from the Government in promoting EVs and efforts by the industry to meet the challenge and use the opportunity so created will go a long way in implementing this vision.

ITEC INDIA 2017 organized from 13th to 15th December 2017 by ARAI in association with SAEINDIA and IEEE Industry Applications Society at Pune; was a step in this direction to deliberate on issues which will facilitate smooth transition from conventional vehicles to advanced electrified vehicles. With deliberations focusing on components, systems, standards, grid interface technologies, efficient power conversion for all types of electrified transportation; ITEC INDIA 2017 has added momentum to our journey of resetting the future of mobility through an efficient and appropriate Electric Vehicle Ecosystem.

ABOUT ITEC INDIA 2017

ITEC India is a biennial event focused on e-mobility and electric vehicle technology. ITEC India 2017 was jointly organized by SAE India, IEEE IAS and ARAI. The event was supported by Ministry of Heavy Industries and Public Enterprises, Govt. of India and Bureau of Energy Efficiency. ITEC India 2017 was the second edition of ITEC in India, after ITEC India 2015 organized in Chennai in August 2015. In its second edition itself, ITEC India 2017 set new benchmark in all aspects.

Key highlights of ITEC India 2017 are 120 technical papers presented by experts from industry, research organizations and academia alike; with representation from 14 countries. Over 30 keynotes were presented by eminent speakers from across the globe. The three day event also featured a panel discussion with eminent people representing different sectors such as vehicle manufacturers, research organizations, testing organizations, academia, etc. Theme of the panel discussion was ***"Electric Vehicle Ecosystem – Resetting the Future of Mobility"***.

Concurrent exposition featured over 35 stalls displaying different products, technologies, services, etc., with participation from Indian and international organizations alike, in the field of e-mobility. Prominent exhibitors in the exposition were AVL, Horiba, Honda Cars, Siemens, ABB, Asia Electric, A Raymond, Tata Consultancy Services, Greenfuel Energy, Sun Lectra, Dynafusion, etc. representing different products & service areas such as electric/hybrid electric vehicle manufacturers, battery swapping solution providers, simulation tool providers, traction motor manufacturers and suppliers, chargers, etc. The key highlight of the exposition was participation of numerous Indian organizations working in and providing indigenous products and solutions.

Another highlight of the event was display of lectric vehicles, with the participants getting chance to interact with and get feel of the vehicles.

The conference was inaugurated at the hands of Dr. Abhay Firodia, President SIAM & Chairman Force Motors, in the presence of Mr. Doug Patton, President SAE International, Dr. Tomy Sebastian, President IEEE IAS, Dr. R K Malhotra, President SAE India and Mrs. Rashmi Urdhwareshe, Chair Steering Committee ITEC India 2017, Director ARAI and Vice President SAE India.

Inauguration By Dr. Abhay Firodia, President SIAM & Chairman Force Motors

Shri Anant Geete, Hon'ble Minister, Ministry of Heavy Industries and Public Enterprises, Govt. of India, was the Chief Guest at the Valedictory Function. ARAI's E-Mobility Center of Excellence was also launched at the hands of Shri Anant Geete during the Valedictory Function.

Dignitaries at the Valedictory Function

Inauguration of ARAI E-Mobility COE

Visit of Dignitaries to Exposition

Visit of Dignitaries to Vehicle Display

Significance of ITEC India 2017 lies in the fact that three different organizations, representing three different domains viz.; IEEE from the electrical domain which dominates electric powertrain, SAE from the mobility engineering domain and ARAI from the automotive engineering, involving different domains, regulations, testing and validation and technology application area;, coming together to deliberate and discuss different aspects, challenges, opportunities and solutions for affordable and effective electrification of road vehicles in India taking into consideration different aspects of the complete eco-system involved.

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