Design, Development and Testing Services offered by
Automotive Research Association of India,Pune

ARAI Update

July 2011

1) Development of Dual Fuel Engine

2) Loaded Mode Emission Test Methodology for in-use Two-Wheeled Vehicles – A Patented Technology

❑ Development of Dual Fuel Engine

A duel fuel diesel engine is a diesel engine fitted with fuel conversion kit to enable use of clean burning alternative fuel like compressed natural gas. Dual fuel engines have number of potential advantages like fuel flexibility, lower emissions, retaining diesel compression ratio, better efficiency and easy conversion of existing diesel engines without major hardware modifications. In view of energy depletion and environmental pollution, dual fuel technology has caught attention of researchers. It is ecologically-friendly and efficient combustion technology. This technology has been used worldwide for multiple applications such as genset, marine, locomotives and automotive. In India the technology of dual fuel was not explored for automotive applications. In this context, ARAI took the lead in developing a dual fuel automotive engine in India using its pioneering experience and strength in development of CNG and Diesel engines.

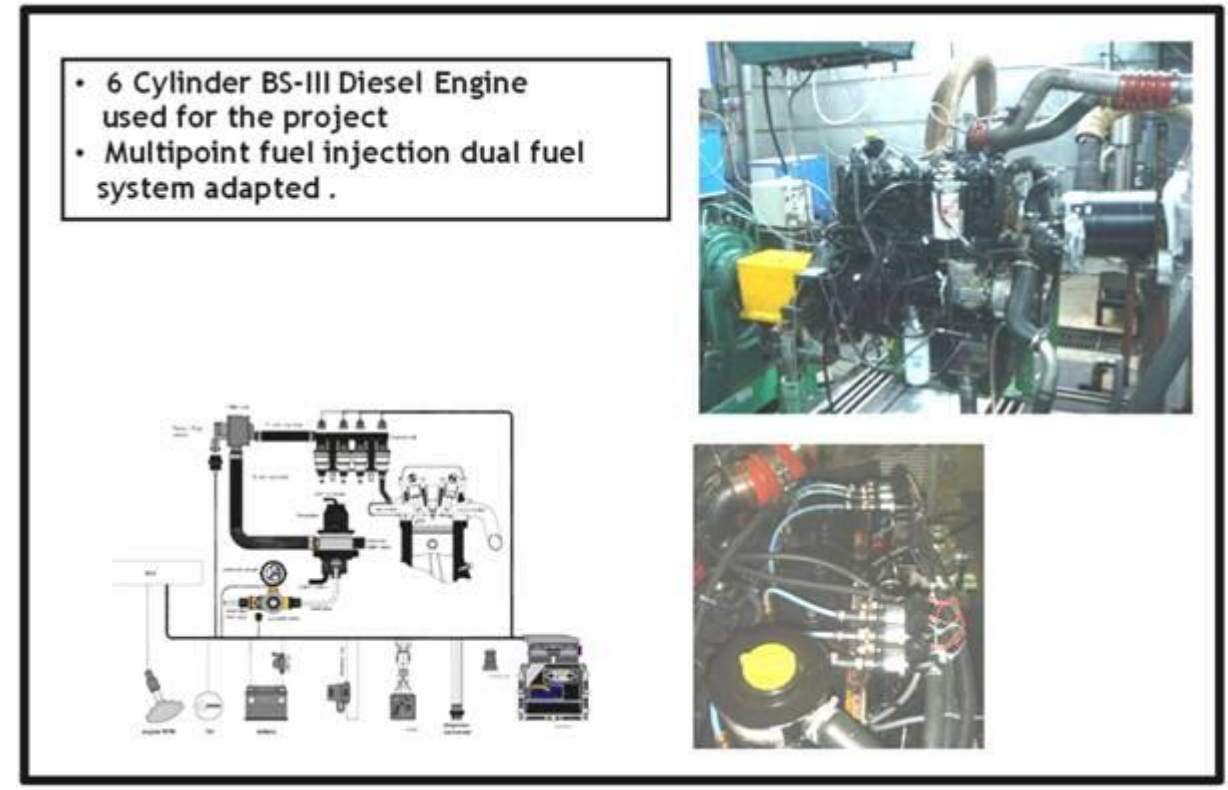
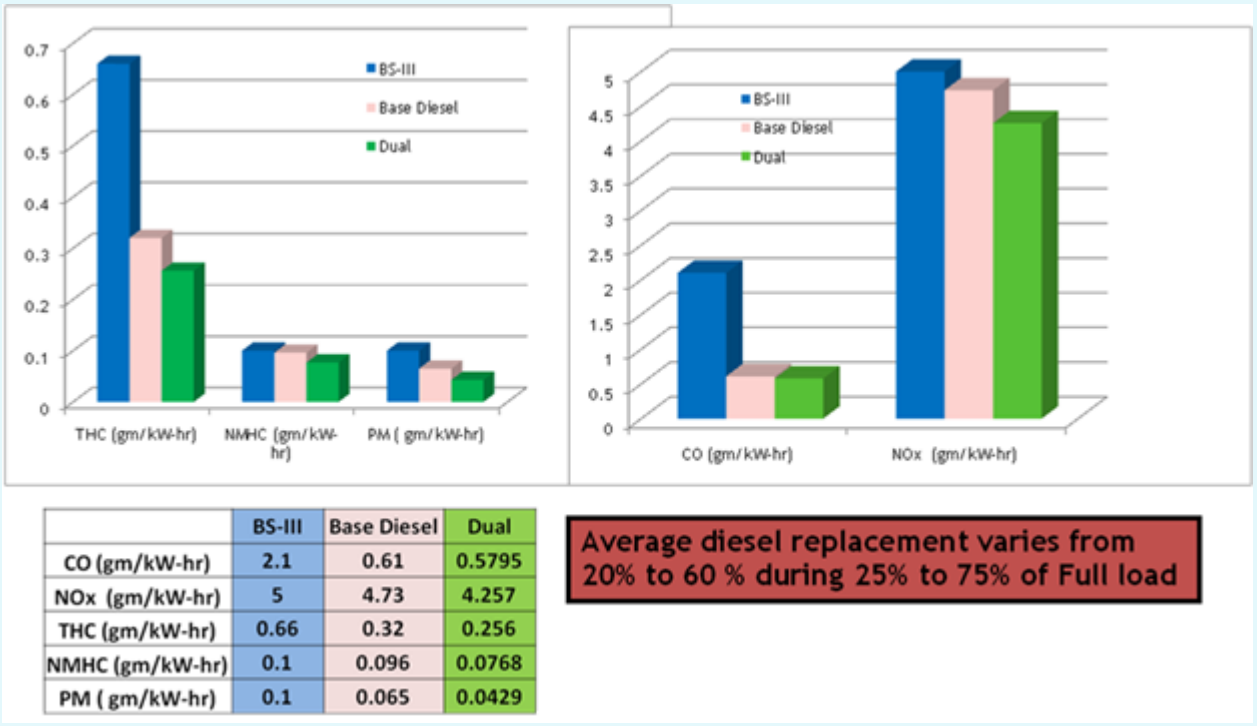


Fig. 1: Dual Fuel Engine at ARAI

ARAI has developed a 6-Cylinder Diesel-Natural gas dual fuel engine using injection technology (Refer Fig.1). Six cylinder engine was chosen due to its importance for intercity bus and truck applications. Major advantage of this system is that no modifications are required in baseline diesel engine, except addition of dual fuel kit. Dual fuel vehicle has flexibility of operation by way running on diesel and natural gas in cities where CNG is available and on pure Diesel in remote regions

where CNG is not available.

The dual fuel combustion technology demonstrated by ARAI uses dual fuel CNG injection kit, which facilitates CNG single point and multi-point injection with diesel replacement up to 60% for part load conditions. At idling and full load conditions the engine operates solely on diesel fuel. This ensures that there is no power drop as compared to neat diesel operation. This also prevents thermal overloading of engine. It is observed that dual fuel operation reduces smoke and PM emissions by approx. 35-40%, CO is marginally reduced and NOx and HC are comparable with diesel operation. The dual fuel engine developed by ARAI has successfully met BS-III norms with sufficient margin using suitable low loading oxidation catalyst. (Refer Fig. 2).



	BS-III	Base Diesel	Dual
CO (gm/kW-hr)	2.1	0.61	0.5795
NOx (gm/kW-hr)	5	4.73	4.257
THC (gm/kW-hr)	0.66	0.32	0.256
NMHC (gm/kW-hr)	0.1	0.096	0.0768
PM (gm/kW-hr)	0.1	0.065	0.0429

Average diesel replacement varies from 20% to 60 % during 25% to 75% of Full load

Fig. 2: Dual Fuel Experimental Results

With increase in number of control variables for the engine (gas supplement ratio), it becomes more difficult to evaluate all possible operating points experimentally, and this necessitates simulation of such combustion cycle. CFD and chemical kinetic simulation has been performed. Thereafter, combustion in the engine under consideration at ARAI has been simulated using this mechanism.

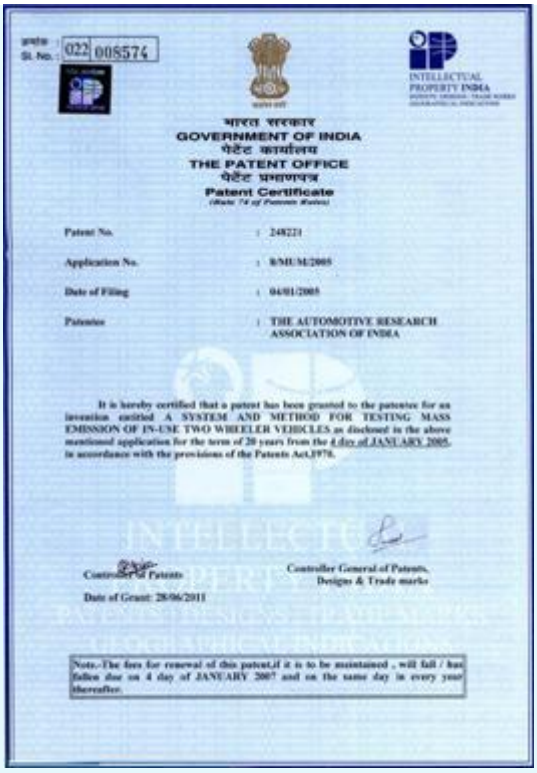
The dual fuel technology has been evaluated in detail, with respect to its effect on engine performance, emissions, ease of commercialization and importance and scope in the Indian context. The following can be concluded about the application of dual fuel diesel natural gas technology in India. During the past decade, appreciable CNG distribution and dispensing infrastructure has been set up across India, hence in Indian context, diesel natural gas dual fuel engine concept can be implemented and commercialized easily. This technology can be used for all generation of diesel engine technologies such as mechanical in line pump, mechanical rotary pump, Electronic Diesel Control (EDC) and Common Rail Direct Injection (CRDI).

ARAI is fully equipped and has the expertise to undertake development projects for all types of Dual fuel Diesel – CNG engines for the automotive industry.

❑ Loaded Mode Emission Test Methodology for In-use Two Wheeled Vehicles – A Patented Technology

On 28th June 2011 Controller General of Patents

Designs and Trademarks, Mumbai has awarded Patent No. 248221 dated 28th June 2011 to ARAI for "Loaded Mode Emission Test Methodology for In-Use Two Wheeled Vehicles". The methodology can be looked upon as a potential in-use vehicle test and certification methodology in Indian scenario.



भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
पेटेंट प्रमाणपत्र
Patent Certificate

Patent No. : 248221
Application No. : 8/MUM/2005
Date of Filing : 04/01/2005
Patentee : THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA

It is hereby certified that a patent has been granted to the patentee for an invention entitled A SYSTEM AND METHOD FOR TESTING MASS EMISSION OF IN-USE TWO WHEELER VEHICLES as disclosed in the above mentioned application for the term of 20 years from the 4 day of JANUARY 2005, in accordance with the provisions of the Patents Act,1970.

Controller of Patents
Controller General of Patents, Designs & Trade marks
Date of Grant: 28/06/2011

Note:-The fees for renewal of this patent,if it is to be maintained , will fall / has fallen due on 4 day of JANUARY 2007 and on the same day in every year thereafter.

Vehicular pollution is a major cause of concern today due to continuously deteriorating urban air quality. New vehicles are tested for compliance with ever stringent emission norms. But it is equally necessary to monitor its running life effectively. In India, in-use vehicles are tested for idle CO and HC to ensure that the vehicles emit fewer amount of pollutants. But the present PUC methodology has quite a few lacunae and does not realistically represent emission performance of a vehicle. A complete emission test set up is very expensive and hence is not a viable solution for testing in-use vehicles.

In India two-wheeled vehicles are largely used as a convenient and cost effective personal transportation medium, to elaborate two-wheeled vehicle population makes for more than 70% of total vehicle population in India. The vehicle kilometer travelled (VKT) of a 2-wheeler in a major city is also very high due to very large population. And hence performance deterioration of in-use 2-wheeled vehicles needs to be effectively verified.

ARAI has developed a loaded mode emission test methodology for in-use two-wheelers. The system consists of a fixed inertia, single roller chassis dynamometer and eliminates use of expensive motor / power absorber, portable 4/5 gas analyser similar to the one used for PUC testing and a PC based software for data logging, drive trace simulation and emission estimation. The system gives estimated mass emission results based on the vehicle model dependent predefined signature. The instantaneous predefined constant, proportional to exhaust flow of the vehicle model is called ‘Signature’ of the vehicle model.

The ‘Signature’ of various vehicle models are stored in the software. The short test uses Indian Driving Cycle as driving pattern. During the short test, instantaneous raw CO, HC, CO_2, NOx (NOx if measured) are measured and logged throughout the driving pattern. The ARAI developed software calculates mass emission in g/km for CO, HC, depending upon the model based predefined signature.

The test methodology has distinct advantages like simple, cost effective and estimation direct mass emissions, which are realistic representation of vehicle emission performance. The '*Auto Fuel Policy*' Committee has also appreciated and cited in its report, that ARAI developed loaded mode emission test methodology as possible and cost effective solution for in-use two-wheeler testing.

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