



**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI  
SHORT ABSTRACT OF THESIS**

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Thesis Title: Role of Global Fuel-Air Equivalence Ratio and Intake Charge Preheating in Dual Fuel Diesel Engines Run on Biogas and Blended Oxygenated Pilot Fuels

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**SHORT ABSTRACT**

The diesel engines mainly generate a tremendous quantity of carcinogenic oxides of nitrogen ( $\text{NO}_x$ ) and soot. The recently reported works reveal that the conversion of pure diesel mode (PDM) to dual fuel mode (DFM) of engine operation has a great ability to curtail the  $\text{NO}_x$  and soot. Moreover, in DFM both renewable liquid and gaseous fuels can simultaneously be used. In this context, during the last two decades, biodiesels, alcohols, and ethers in various forms as pilot and biogas as the attractive inducted gaseous renewable fuels are found. However, owing to the different ignition qualities and heating values of the fuels being chosen, there is a performance penalty in DFM as compared to PDM. Thus, the researchers have observed comparatively more deterioration in DFM engine performance at engine standard compression ratio (CR) and injection timing (IT). Nevertheless, the major benefits to run the DFM engine at standard CR and IT are easy to fall back to PDM in case of shortage of gaseous fuel. Hence, keeping this vista in mind, the present study aims to improve the biogas run DFM engine performance (at standard IT = 23 CAD bTDC and CR = 17.5) that is competitive to PDM using various liquid oxygenated fuels blended with diesel fuel. This idea is mainly to generate the power in the rural areas of the developing countries like India.

In order to achieve a competitive performance with DFM at standard CR and IT, the crucial parameter global fuel-air equivalence ratio ( $\Phi_{global}$ ) has been optimized at each of the applied engine loads. The  $\Phi_{global}$  is considered as the function of inducted air, pilot fuels and inducted biogas quantities. The  $\Phi_{global}$  is also constrained to improve the engine performance from part to higher loads. The pilot fuels considered in the present investigation are: (a) diesel, (b) binary blends of 5% ethanol blended with 95% diesel (E-5), (c) ternary blends (TB) of diesel-biodiesel-ethanol (D-B-E), (d) ternary blend of D-B-butanol (TB-BT) and (e) ternary blend of D-B-diethyl ether (TB-DEE). As there is an improvement of engine performance with preheating, all the experiments with the blended fuels are carried out with preheating of the intake charge. The preheating temperature is controlled at  $55 \pm 2$  °C depending upon the appearance of knocking sound, controlling of  $\Phi_{global}$  and depending upon the engine volumetric efficiency. In the performance analysis, the parameters such as brake specific energy consumption (BSEC), brake thermal efficiency (BTE), volumetric efficiency (VE), liquid fuel replacements (LFR), actual diesel replacements (ADR), fuels energy shares,  $\Phi_{global}$ , premixed fuel-air equivalence ratio ( $\Phi_{premixed}$ ) have been considered. In the combustion analysis, the cylinder pressure history, net heat release rate (NHRR), ignition delay (ID), combustion duration (CD), cylinder mean gas temperature (CMGT), and cycle-by-cycle variations of the cylinder peak pressure (CPP) are considered. Further, for the emission analysis, carbon dioxide ( $\text{CO}_2$ ), carbon monoxide (CO), hydrocarbon (HC), and oxides of nitrogen ( $\text{NO}_x$ ) are chosen. In order to accomplish this benchmark research work, a thermodynamic study is also carried out. The thermodynamic analysis includes energetic and exergetic studies based on first and second law of thermodynamics, respectively.