INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: STANDARDIZING THE SPECIFICATION OF A BIOGAS RUN DUAL FUEL DIESEL ENGINE FOR STATIONARY APPLICATIONS

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SHORT ABSTRACT

Diesel engines have played an important role in the progress of humankind. They are the most reliable and efficient means of producing power. However, these engines are plagued by high emissions of oxides of nitrogen and soot that possess a serious threat to human health. In this context, dual fuel technology has been recognized as one of the panaceas to the above mentioned problem. Dual fuelling in diesel engines is a mode of combustion where a small pilot injection of high cetane fuel ignites a premixed high octane gaseous fuel and air mixture. The liquid fuel is called the pilot fuel and the gaseous fuel is called the primary fuel. Among the different types of primary fuel tested in dual fuel engines, biogas has emerged as a low cost renewable fuel. For conserving energy and protecting the global environment, biogas is a promising alternative fuel demonstrating high hydrogen to carbon ratio. The chief constituents of biogas are methane and carbon dioxide, which is produced by anaerobic digestion of biomass. Biogas has a higher octane number giving higher resistance to knock which allows it to be utilized in high compression ratio engines. Thus, biogas presents a promising prospect of utilizing dual fuel combustion in diesel engines which can significantly lower the oxides of nitrogen (NOX) and soot emissions compared to that of tradition diesel engine. However, running biogas along with any liquid fuel at standard diesel setting will not offer the best performance. This is because the combination of biogas along with any liquid fuel does not have the same properties to that of diesel. Therefore, it becomes important to study and optimize the performance and emission characteristics of a biogas run dual fuel diesel engine at varied operating conditions, namely, load, compression ratio (CR) and injection timing (IT). The motivation behind this research work is to use dual fuel diesel engines for power generation in rural areas particularly for developing countries like India. First of all, a comparative study of performance of three types of pilot fuel, namely palm biodiesel (PBD), Pongamia biodiesel (POBD) and rice bran biodiesel (RBB) is carried out to evaluate the best combination of pilot fuel with biogas. The selection of pilot fuel is based on the availability criteria related to the present geographical location. For experimentation, a 3.5 kW single cylinder, four-stroke, direct injection, naturally aspirated, water-cooled, variable compression ratio diesel engine diesel engine is converted into a biogas run dual fuel diesel engine by connecting a venturi gas mixer at its inlet manifold and installing a fuel control mechanism. The performance analyses evaluated are brake thermal efficiency, brake specific energy consumption, volumetric efficiency, exhaust gas temperature, liquid fuel replacement and biogas flow rate. The combustion analyses include the cylinder pressure variation, ignition delay, net heat release rate and peak cylinder

pressure. Finally, emission analysis is performed by measuring carbon dioxide, carbon monoxide, hydrocarbon and NOx. The results indicated the combination of RBB-biogas is found to be superior in comparison to that of PBD biogas and POBD-biogas at standard diesel setting. This is followed by an investigation to standardize the operating parameters of the biogas run dual fuel diesel using diesel, RBB and emulsified RBB as pilot fuel. Initially, a two-phase stable water emulsion of RBB has been prepared by optimizing the factors such as water content (5%and 10%), surfactants (3%), and hydrophilic lipophilic balance values (4.3, 5, and 6). For engine test, a set of combinations comprising CR of 18, 17.5, and 17, and IT of 23°, 26°, 29°, and 32° BTDC at different loading conditions are considered. The optimum combinations for a biogas run dual fuel diesel engine using diesel, RBB and emulsified RBB as pilot fuel are found to be CR=18, IT=29° BTDC; CR=18, IT=32° BTDC and CR=18, IT=29° BTDC, respectively. Lastly, a thermodynamic analysis for the aforementioned tests is carried out to unravel the effect of operating parameters on the energy and exergy distributions of the biogas run dual fuel diesel engine. It includes the first and second law analysis of the biogas run dual fuel diesel engine at different combinations CR and IT for the load where maximum brake thermal efficiency take place. The energy and exergy analyses reveal that the use of high CR along with advancement of IT of pilot fuel is a must for effectual utilization of fuel in a biogas run dual fuel diesel engine irrespective of the pilot fuel.