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PERFORMANCE ANALYSIS OF DUAL FUEL IC ENGINE WITH BIOGAS AS PRIMARY FUEL FOR DIFFERENT COMPRESSION RATIO AND INJECTION TIMINGS: A REVIEW

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ABSTRACT

Energy demand is increasing day – by – day. It is very difficult to meet this high energy demand with coal and petroleum based fuels. In such conditions, environment-friendly alternatives must be worked out. Biogas stands for best alternative. It is produced by anaerobic fermentation of biological waste material. These materials are readily available at rural and remote areas as by-products of agro-based business. Biogas can be used in spark ignition engines. This needs major modifications in SI engines, secondly it can be used in CI engines. It is not possible to ignite the biogas is CI engine with conventional procedure. Additional fuel is required to serve this purpose. This mode of operation is called as *"dual fuel mode"*. To study the behavior of engine while operating on biogas, the engine was first tested with neat diesel fuel in conventional mode. Later engine was modified to operate in dual fuel mode. A simple T-joint mixer is used to introduce biogas into induction manifold. The engine will be tested in both operating conditions for parameters like brake power, energy conversion efficiency, and emissions. The effect of diesel replacement on emissions was also studied.

INTRODUCTION

India is an agriculture country with more than 75% of its population engagedin agriculture related activities. This population is living in rural, some at very remote areas. The centralised power generation systems are inadequate to meet the energy needs of the decentralised communities of rural India. Over past few decades there has been phenomenal increase in the use of diesel engines in rural areas. As more and more diesel engines are being used for a variety of rural applications, viz. tractors, irrigation pumps, generate sets chaff-cutters, crushers, mills etc., the demand for conventional fuel- diesel is increasing even at rural areas.On the other hand, the world wide awareness of environmental pollution and global warming caused by burning fossil fuels has driven researchers as well as industrialists and governments to look for the other energy sources. This made essential that the electricity be introduced to rural areas in sustainable and environmentally sound way. Local production of fuel and generation of electricity is a sustainable option for rural electrification, which only can contribute to economic development and poverty reduction of rural areas. Thus there is a growing need to adopt/modify such diesel engines for efficient and trouble free operation with biomass based gaseous fuels. Since biomass is available in huge amount in rural areas, it could be helpful to generate these fuels at the local sites; and using them to operate diesel engines. These fuels are also environment friendly, and thus their increased use will also help to alleviate the growing menace of pollution.There could be two approaches to use these fuels. The first could be that the fuel can be directly used in the diesel engine without any change in the existing engine and other could be to use these fuels with minimal changes in engine. In the Present scenario, diesel engines are being extensively used for variety of applications in villages, while petrol engines or petrol operated generator sets are almost nil.

LITERATURE REVIEW

Yungjin Kim et al .[1] has studied by the effects of CO_2 contained in biogas on the fuel consumption and NO_x emissions ,here we compare results obtained with a 40% CO_2 content with those from 100% methane. Thermal efficiency improves and NO_x reduces with using a lean burn strategy. He conclude that a significant reduction in NOX emissions is expected using biogases containing CO_2; however, an increase in fuel consumption appears unavoidable. A lean burn strategy is effective for reducing both fuel consumption and NO_x emissions; however, the use of biogas with the stoichiometric air–fuel ratio (which can better handle transient operating conditions) appears effective in reducing NOX emissions and can improve the fuel economy at higher loads.

Guven Gonca et al.[2] has studied the experiment and theoretical results of effective power and effective efficiency with respect to change of engine load for different engine models. The effective power increases with increasing engine load and reaches to maximum value at 100% load.The results showed that there are different optimum values of compression ratio for different engine loads and optimum compression ratios which provide maximum performance increase with increasing engine load.

Bhasker Bora et al.[3] compared the performance analysis- At 26° BTDC, the EGT increases by 10.9%,16.43%, 19.24% and 22.7% for CRs of 18, 17.5, 17 and 16, respectively, as compared to diesel mode. The burning velocity of the biogas air mixture increases with the increase of CR. Therefore, the time required for complete combustion reduces and this produces lower EGT. Combustion analysis- At 26° BTDC with BMEP of 4.24 bar, the maximum NHRR under DFM reduces by 43.20%, 44.13%, 52.09% and 52.19% for CRs of 18, 17.5, 17 and 16, respectively in comparison to diesel mode as indicated. Emission analysis-On average, there is an increase of 13.64% in CO_2 emission on advancing IT from 26° to 32° BTDC for CR of 18. For the same range of IT, on average, there is an increase of 8.89%, 7.76% and 4.7% in CO_2 emission for CR of 17.5, 17 and 16, respectively. It can be concluded that the high CR results in better performance, combustion and emission for a RBB-biogas run dual fuel diesel engine.

J.Li, W.M.Yang,H.An,D.Zhao et al.[4] has studied the Combustion characteristics- The effect of gasoline ratio behaves different with different SOI timings, namely C-SOI (_7_ CA ATDC) and A-SOI (_35CA ATDC). Combustion characteristics of C-SOI are less sensitive to that of A-SOI with varied gasoline ratios. Therefore, more precise controllability could be offered with A-SOI by varying gasoline ratio. NO_x emissions- It could be implied that generally increases in gasoline ratio could reduce NO_x emissions. As temperature is the major factor to the formation of NO_x emissions, it could be inferred that increases in gasoline would reduce the highest temperature attained.

Cenk Sayin etal.[5] performed Nitrogen oxides (NO_x) emissions -tends to increase the NO_x concentration. The change in NO_x emissions for different biodiesel-blended diesel fuel at different CRs. increased CR increased the NO_x emissions by 15.56% and reduced CR decreased NO_x emissions by 12.45% compared to results of ORG CR for B50. Reduced CR is to reduce the in-cylinder temperatures, and thus flame temperatures during the combustion to suppress NO_x emissions. Hydrocarbon (HC) emissions-increased CR reduced the HC emissions by 4.39% andreduced CR increased them by 35.50% for B20 when compared withORG CR. At lower CR, insufficient heat of compression delays ignitionand so HC emissions increase. Carbon monoxide (CO) emissions-Increased IT can also cause a higher cylinder temperature and an increase in oxidation process between carbon and oxygen molecules, which will lead to a decrease in CO emissions . Brake thermal efficiency (BTE)- the BTE usually increased with the increase in biodiesel percentage in the fuel blend. Thus, the primary reason for the decrease in the BTE of biodiesels is the higher BSFC in spite of lower LHV of biodiesels. the change in BTE with respect to diesel fuel is 1.99%, 3.69%, 5.99% and 9.06%, respectively, at reduced CR.

Bhaskar J.Bora et al.[6]conducted an experimental investigation to evaluate performance analysis- At 100% load, the BSEC under DFM is found to be 4.82 kJ/s/kW, 5 kJ/s/kW and 5.44 kJ/s/kW respectively as compared to 3.6 kJ/s/kW for diesel mode. On an average, the BSEC reduces by 12.85% as CR increased from 17 to18. The VE is found to decrease with the increase of load for both diesel and DFM as observed.Combustion analysis- At 100% load, the maximum NHRR under DFM is found to be 38.4 J/deg.CA, 36.42 J/deg.CA and 29.26 J/deg.CA for CRs of 18, 17.5 and 17, respectively in comparison to 82.02 J/deg.CA in diesel mode. Thus, it can be observed that the maximum NHRR under DFM increases with the increase in CR.

Kyunghyun Ryu et al.[7] studied the effect of combustion characteristics- Injection timing of pilot fuel in dual fuel combustion affects the engine power and exhaust emissions. BSEC of DFC improves with advanced pilot injection timing at low load and with delayed pilot injection timing at high loads. The ignition delay in DFC is 1.6–4.4 CAD longer than that of the diesel single fuel combustion. Smoke is decreased and NO_x is increased with advanced pilot injection timing in the biodiesel–CNG dual fuel combustion.

Mohammed EL-Kassaby et al.[8] studied the effect of the brake thermal efficiency of diesel engines tested was reduced when substituting diesel by biodiesel in its blended form. The change of compression ratio from 14 to 18 resulted in, 18.39%, 27.48%, 18.5%, and 19.82% increase in brake thermal efficiency in case of B10, B20,

B30, and B50 respectively. On an average, the CO_2 emission increased by 14.28%, the HC emission reduced by 52%, CO emission reduced by 37.5% and NO_x emission increased by 36.84% when compression ratio was increased from 14 to 18.

Senthil Ramalingam et al.[9] studied the injection timing of 30 b TDC, along with compression ratio of 19.5 gives better performance ,combustion and lower emissions when compared with standard Injection timing of 27 b TDC and compression ratio of 17.5. For all tested values,A20 provides best results in terms of BTE, higher heat release rate, and lower emissions of HC, CO and NO_x. Hence A20 can be effectively used as an alternative biodiesel with Injection timing of 30_bTDC along with compression ratio of 19.5 in tested engine. Even though only 20% of Annona methyl ester is added with 80% pure diesel, will meet to a certain extent the shortage of availability of pure diesel. Annona is available with lower cost when compared to diesel in present scenario.

Datta Bharadwaz et al.[10] found that the optimum operating conditions of the engine to get high performance and least emissions from methanol blends are found to be at 9.03 kg of load, 18 compression ratio and methanol blend of 5%. Responses such as Bth, Bsfc, CO, HC, NOx and smoke at optimized parameters are found to be 31.95%, 0.375 kg/kW h, 0.036%, 5 ppm, 531.23 ppm and 15.35% respectively. Brake thermal efficiency and brake specific fuel consumption are found to be increasing with increase of methanol content in the blend. It is also noted that with use of methanol blends CO and HC emissions are increasing whereas NO and Smoke are reducing.

CONCLUSION

The objective of this work is to study the performance of single cylinder diesel engine when operated in biogas diesel dual fuel mode. It is study by observing different parameters of diesel engine. In this study it concludes that, the load on IC engine increases when diesel is used as fuel compared to biodiesel used as fuel. Brake power, mechanical efficiency, volumetric efficiency, thermal efficiency, brake specific diesel consumption are increases by using biodiesel as fuel in IC engine. The OP, HC, and CO emission decreased and NOx emissions increased with the increase in IP for the all fuel blends.

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REFERENCES

1. *Youngjin kim , Nobuyuki Kawahara, Kazuya Tsuboi, Eiji Tomit, "Combustion characteristics and NOX emissions of biogas fuels with various CO2 contents in a micro co-generation spark-ignition engine"applied energy 182(2016)539-547*
2. *Guven Gonca , Erinc Dobrucali , "Theoretical and experimental study on the performance of a diesel engine fueled with diesel biodiesel blends.",renewable energy 93(2016)658-666*
3. *Bhaskor J. Bora, Ujjwal K. Saha, "Experimental evaluation of a rice bran biodiesel ebiogas run dual fueldiesel engine at varying compression ratios.", renewable energy 87(2016)782-790*
4. *J. Li, W.M. Yang,H.An, D. Zhao,"Effects of fuel ratio and injection timing on gasoline/biodiesel fueled RCCI engine: A modeling study." applied energy155(2015)59-67*

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5. *Cenk Sayin, Metin Gumus , "Impact of compression ratio and injection parameters on the performance and emissions of a DI diesel engine fueled with biodiesel-blended diesel fuel.", applied energy 31(2011)382-3188*
6. *Bhaskor J. Bora,Ujjwal K. Saha, "Optimisation of injection timing and compression ratio of a raw biogas powered dual fuel diesel engine." applied energy 92(2016)111-121*
7. *Kyunghyun Ryu , "Effects of pilot injection timing on the combustion and emissions characteristics in a diesel engine using biodiesel–CNG dual fuel." applied energy 111(2013)721-730*
8. *Mohammed EL_Kassaby, Medhat A.Nemit_allah,"Studying the effect of compression ratio on an engine fueled with waste oil produced biodiesel/diesel fuel ."Alexandria engineering journal (2013)52,1-11.*
9. *Senthil Ramalingam,Silambarasan Rajendran, Ravichandiran Nattan "Influence of injection timing and compression ratio on performance, emission and combustion characteristics of Annona methyl ester operated diesel engine". Alexandria engineering journal(2015)54,295-302*
10. *Datta Bharadwaz , Govinda Rao, Dharma Rao, Anusha "Improvement of biodiesel methanol blends performance in a variable compression ratio engine using response surface methodology".Alexandria engineering journal (2016) 55, 1201–1209*