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A Review on Performance and emission characteristics of a diesel engine using isobutanol–diesel fuel blends

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ABSTRACT

It is found from the literature survey that very few comprehensive reviews exist on the Performance and emission characteristics of a diesel engine using isobutanol–diesel fuel blends. Some of the important reviews on fish oil with Isobutonal as an additive, diesel with different percentages blend with Isobutonal, butonal- gasoline blends effects on the combustion process in a SI engine have been reviewed. Different Isobutonal blends with base fuels experimental performances including both diesel engine and gasoline engines have been reviewed. An attempt is being made to identify best performing methods from the literature reviewed; this will be a reference for further research. This paper deals with updated review of the literature on performance and emission analysis with Isobutonal blends with diesel and biodiesel under the resource constrained.

Introduction

In developing countries, access to electricity is very scarce, especially in rural areas. Rural electrification increases energy demand, which might contribute to global warming and depletion of fossil fuels, and could negatively affect local environmental conditions. Therefore it is essential that electricity is introduced in a sustainable and environmentally sound way. Local production of fuel and generation of electricity is a sustainable option for rural electrification, contributing to economic development and poverty reduction. Researchers have used different additives to petrol and diesel fuels for efficiency and emission improvement. The addition of alcohol based fuels to petroleum fuels has been increasing due to advantages like better combustion and lower exhaust emissions. Gasoline with additives like ethanol and isobutanol increased the brake power volumetric and brake thermal efficiency and fuel consumption. Some researchers have used cetane improvers and some others have used additives in coated engines. Up to now Additives with coated engines improved efficiency, in addition to the increase in cylinder pressure

In most developing countries, many people do not have access to modern energy sources Energy use in these countries is characterized by a high use of traditional resources like fuel wood and charcoal; access to electricity is very scarce especially in rural areas. These areas are usually very remote and very poor, making it highly unlikely that they will ever be connected to the national grid due to financial constraints. Access to electricity does not give a guarantee for economic development and poverty reduction, but providing people with electricity is associated with economic development and improvement in living conditions for the rural poor. The other way around, when a region develops economically, the demand for modern energy carriers like electricity will increase. Rural electrification increases local and eventually global energy demand which contributes to global warming, depletion of fossil fuels and can have a negative effect on the local environment. Therefore it is very important that when electricity is introduced it is done in a sustainable and environmentally sound way and it should be economically viable. Making sustainable energy available in rural areas in developing countries could lead to improved living conditions and improvement of the local environment. Therefore, an option of sustainable electricity generation that is appropriate for rural areas in low income countries is investigated

Lierature review

S. Kiran Kumar [1] has done the work on “Performance and Emission Analysis of Diesel Engine Using Fish Oil And Biodiesel Blends With Isobutanol As An Additive” he has presented that the Brake thermal efficiency is observed as the BP increases there is considerable increase in the BTE. The BTE of diesel at full load is 32.82% while the blends of F30 is 34.08%, F30D69.5I5 is 35.14%, F30D69I10 is 34.01%, among the three the maximum BTE is 35.14% which is obtained for F30D69.5I5. The BTE of fish oil is increases up to 0.364% and 0.823% as compared with to fuels of optimum blend and diesel at full load condition. Brake specific fuel consumption is observed that as the load increases the fuel consumption decreases, the minimum fuel consumption is for F30D69.5I5is 0.25 kg/kW-hr as to that of F30 is 0.258 kg/kW-hr at full load condition. Smoke density is observed that smoke is higher for optimum blend at full load conditions compared to ignition improver blends. At full load condition the smoke density obtained are 79.6 HSU, 61.34 HSU, 86.92 HSU and 86.69HSU HSU for the fuels of diesel, F30, F30D69.5I5 and F30D69I10. It is observed that smoke is increases for fish oil blends at full load conditions as compared to optimum blend. Carbon monoxide is observed that is interesting to note that the engine emits more CO for diesel as compared to fish oil blends under all loading conditions. The CO concentration is increases for the blends of F30D69.I5 and same as the diesel for F30D69I10. At full load condition the CO emission obtained are 0.05%, 0.09%, 0.06% and 0.05% for the fuels of diesel, F30, F30D69.5I5 and F30D69I10 respectively. Unburned hydrocarbons are observed that the HC emission variation for different blends is indicated. At full load condition the unburned hydrocarbons are obtained 58ppm, 8ppm, 15ppm and 24ppm for the fuels of

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diesel, F30, F30D69.I5 and F30D69I10 respectively. The unburned hydrocarbons of after adding ignition improver of Fish oil decreases up to 24.44% as compared to diesel at full load condition.

Nitin Goyal , Ashish Nayyar , Chandan Kumar [2] have done the work on "Experimental investigation of the performance of vcr diesel engine fuelled by n-butanol diesel blend" they have presented that the performance parameters of combustion ignition engine with the use of different blends of n-butanol and diesel fuel (B5, B10, B15, B20, B25, and B30). From this research work they concluded the following results. • Brake Specific Fuel Consumption increases with increasing concentration of n-butanol which slightly reduces with increasing concentration of butanol. • Brake thermal efficiency decreases with increasing ratio of n-butanol in the diesel blend. At maximum load BTE is maximum 24% which reduces to 22% with B30. • Exhaust gas temperature decreases with increasing butanol ratio. • Mechanical Efficiency increases with increasing butanol. Maximum increase noticed at full load.

Simona Silvia Merola*, Cinzia Tornatore, Luca Marchitto, Gerardo Valentino and Felice Esposito Corcione [3] have done the work on "Experimental investigations of butanol-gasoline blends effects on the combustion process in a SI engine" they have presented that the effect on the spark-ignition combustion process of n-butanol blended in volume with pure gasoline was investigated through cycle-resolved visualization applied in a single-cylinder PFI SI engine working at low speed, medium boosting and wide-open throttle. Two injection timings were fixed in order to inject the fuel at closed intake valve and open intake valve, respectively. The spark timing was changed to identify the maximum brake torque and the knocking limit. Blends of butanol up to 40% allowed working in more advanced spark timing without negative effects on performance. To work with a stoichiometric mixture for both fuels, the duration of injection was slightly increased for the blend. DOI in CV resulted longer than in OV for both fuels because, in CV injection, part of the injected spray is deposited on the intake manifold surfaces, forming a layer of liquid film. If these fuel layers are not well atomized, they enter the cylinder as drops and ligaments. During the normal combustion process, only part of the fuel deposits was completely burned. Thus, more fuel should be injected to reach the selected air-fuel ratio measured at the exhaust. When the normal flame front reached the fuel deposits, abnormal combustion was incepted. This was characterized by intense diffusion-controlled flames. Their contribution to the combustion pressure was negligible. The different levels of intensity were related to different carbonaceous structures and soot precursor concentrations. CV condition was characterized by higher fuel deposition amount and thus more intense diffusion-controlled flames than OV. Gasoline in CV condition showed the highest luminosity, and BU40 in OV condition, the lowest one. This demonstrated that BU40_OV allowed the reduction of emission of ultrafine carbonaceous particles at the exhaust and the optimization of fuel consumption at fixed performance. Moreover, medium-low percentage of butanol in the gasoline allowed the reduction of NOx and unburned hydrocarbon emission. Finally, even if an increase in the injected fuel amount should be considered to obtain the same air-fuel ratio for butanol-gasoline blend, if compared to pure gasoline, the better efficiency of fuel deposit burning allowed the reduction of that amount.

Mahdi Shahbakhti, Ahmad Ghazimirsaied , Adrian Audet, Charles Robert Koch[4] have done the work on "Combustion characteristics of Butanol/n-Heptane blend fuels in an HCCI engine" they have presented An experimental study of an HCCI engine using a blend of Butanol and n-heptane is performed at one engine speed. The volume percent of Butanol and the equivalence ratio (ϕ) are varied while holding all other engine inputs constant and 57 HCCI operating conditions (between misfire and knock) are obtained. HCCI operation is possible with Butanol blends up to 48.5% for the engine and conditions studied. The thermal efficiency ranges from 28% to 37% with higher thermal efficiency occurs at higher BVP. Location of ignition timing affects the engine thermal efficiency and a 5-degree window of CA50 (5-10 CAD aTDC) is found to provide the highest thermal efficiency. Varying BVP is an effective means to adjust HCCI ignition timing since ignition timing is delayed by increasing BVP. A higher sensitivity of HCCI ignition to variation of ϕ is observed at higher BVP values. The HCCI combustion of Butanol and n-Heptane blends exhibits a two-stage heat release where the heat release from Low Temperature Reactions (LTR) is more substantial at a lower BVP with a same fuel injection energy. It is found that LTR is almost insensitive to ϕ variations but High Temperature Reactions (HTR) are very sensitive to variations of ϕ. The location of ignition timing (CA50) significantly influences engine-out emissions. Higher Texh and higher CO and THC emissions but lower NOx emission are observed when shifting the combustion from early ignitions to late ignitions after TDC.

Murat Karabektas [5]] has done the work on " Performance and emission characteristics of a diesel engine using isobutanol–diesel fuel blends" " he has presented that the suitability of isobutanol–diesel fuel blends as an alternative fuel for the diesel engine, and experimentally determine their effects on the engine performance and exhaust emissions, namely break power, break specific fuel consumption (BSFC), break thermal efficiency (BTE) and emissions of CO, HC and NOx. For this purpose, four different isobutanol–diesel fuel blends containing 5, 10, 15 and 20% isobutanol were prepared in volume basis and tested in a naturally aspirated four stroke direct injection diesel engine at full -load conditions at the speeds between 1200 and 2800 rpm with intervals of 200 rpm. The results obtained with the blends were compared to those with the diesel fuel as baseline. The test results indicate that the break power slightly decreases with the blends containing up to 10% isobutanol, whereas it significantly decreases with the blends containing 15 and 20% isobutanol. There is an increase in the BSFC in proportional to the isobutanol content in the blends. Although diesel fuel yields the highest BTE, the blend containing 10% isobutanol results in a slight improvement in BTE at high engine speeds. The results also reveal that, compared to diesel fuel, CO and NOxemissions decrease with the use of the blends, while HC emissions increase considerably

Lennox Siwale , Lukács Kristóf , Torok Adam , Akos Bereczky , Antal Penninger , Makame Mbarawa , Kolesnikov Andrei [6] have done the work on "Performance Characteristics of n-Butanol-Diesel Fuel Blend Fired in a Turbo-Charged Compression Ignition Engine" they presented that the performance characteristics of small fractions (v/v) of n-butanol-diesel blends fired in a turbo-charged, direct injection diesel engine with a similar study by other authors using ethanol-and methanol-diesel blends. • The BSFC was lower and BTE was higher in our study than in the other study. • The reduction of exhaust gas temperature (EGT) improves the volumetric efficiency, which in turn reduces the compression work during the compression stroke. • Applying small-shared volumes of n-butanol to diesel fuel improves the BTE and BSFC requiring no engine modification compared with that of ethanol-or methanol-diesel blends. The boost pressure improves brake thermal efficiency (BTE) whereas the start of injection is retarded at low speed.

R.Senthil, E.Sivakumar, R.Silambarasan[7] have done the work on "Effect of butanol addition on Performance and Emission Characteristics of a DI diesel engine fueled with Pongamia Ethanol blend" they presented that the effects of butanol addition on performance and emissionalong with Pongamia-Ethanol blend (50- 50) have been studied at different fuel condition in this present work. The main conclusions of the present study are given below. 1. It was observed that addition of butanol is an effective method for controlling the NOx emissions. For the P40-E40Bu20 blend, theNOxemission is reduced by 23.38% at full conditions than diesel but aHC, CO emissions and BSFC is increased by at all load conditions when compared to the neat diesel fuel. 2. The EGT is reduced by 9.67% for the P40-E40Bu20 blend at full load conditions when compared to the neat diesel fuel. 3. It is concluded that NOx emission and Exhaust Gas Temperature can be reduced considerably by using butanol addition along with the Pongamia-Ethanol blend (50-50).It is simple and cost effective method without change in any engine modification. 4. The main limitation of this present work is slightly increasing the BSFC and also the engine efficiency can be slightly decreasing.

Deepali Bharti, Professor Alka Agrawal[8] have done the work on "Experimental Investigation and Performance Parameter on the Effect of N-Butanol Diesel Blends on an Single Cylinder Four Stroke Diesel Engine" they presented that the Bio-diesel from n-butanol biodiesel diesel blends resemble very much with the conventional diesel, in properties as well as in the performance on CI engines. The economical analysis suggests good scope for biodiesel in comparison to diesel. Biodiesel is an environmentally friendly fuel that can be used in any diesel engine without any modification up to 20% lean mixtures. The dependency on the diesel can be reduced by use of biodiesel instead of diesel in the applications where it is possible which will save the environment as well as our foreign exchange

Suraj Bhan Singh, Atul Dhar, Avinash Kumar Agarwal [9] have done the work on "Technical Feasibility Study of Butanol-Gasoline 2 Blends for Powering Medium-Duty 3 Transportation Spark Ignition Engine" they presented that the engine performance, emissions and combustion characteristics of butanol-gasoline blends vis-a-vis baseline gasoline were experimentally evaluated in a medium duty SI engine without any hardware modifications at 404 various engine speeds and loads. Mainresults are: Butanol-gasoline blends have slightly higher BSFC than gasoline because of 406 its slightly lower calorific value than gasoline. Combustion characteristics of 5, 10 and 20% butanol-gasoline blends are 408 similar to gasoline. Heat release for gasoline begins relatively earlier than butanol-gasoline blends. Combustion duration decreases at higher engine loads because the combustion becomes faster for richer mixtures. Combustion duration of butanol-gasoline blends is marginally higher than gasoline. BTE of the butanol-gasoline blends is lower in comparison to gasoline for all 415 speeds and this difference was statistically significantfor lower engine speeds. EGT of butanol-gasoline blends is slightly lower than gasoline. This difference was not statistically significant. Butanol-gasoline blends produced lower BSNO, BSCO emissions and smoke. BSHC emissions for butanol5 and butanol10is similar to gasoline at higherengine speeds. BSHC emissions for butanol and butanol is found to be lower compared to gasoline at all engine speeds. Overalldue to very small difference in engine performance, emissions and combustion characteristics,butanol blends can be used as a partial replacement of gasoline, without any significant hardware modifications or sacrifice in engine performance in the existing transportation engines.

Cinzia Tornatore, Luca Marchitto, Alfredo Mazzei, Gerardo Valentino, Felice E. Corcione, Simona S[10] have done the work on " Effect of butanol blend on in-cylinder combustion process "they presented that the The engine was fuelled with a commercial diesel, a blend of 80% diesel with 20% n-butanol (BU20). Combustion process was studied from the injection until the late combustion phase fixing the injection pressure at 70MPa and changing the injection timing and EGR rate. In-cylinder optical investigations, correlated with conventional measurements of engine parameters and exhaust emissions, demonstrated that the blends increased the ignition 481 C. Tornatore, L. Marchitto, A. Mazzei, G. Valentino, F. E. Corcione, S. S. Merola delay particularly at late injection timing allowing operating in PPLTC regime in which the fuel is completely injected before the start of combustion. In this regime, strong reduction of engine out emissions of smoke and NOx were obtained. On the other hand this combustion regime reduced the engine efficiency. To overcome this limitation a mixing controlled combustion (MCC) LTC regime was realized by an earlier injection. In this regime, a good compromise between low engine out emissions and a good efficiency was demonstrated. The effects of the fuel quality and injection on the flame lift-off length and soot formation were studied. The increase in lift-off length well matched to a decrease of in-cylinder soot production. The BU20 blend, at 50% of EGR and late injection timing, allowed to operate in LTC regime in which a strong decrease of soot formation joined to reduce engine out emissions were obtained.

Conclusion

From the literature reviewed we have observed that different researchers are done the work on the Performance and emission characteristics of a diesel engine using isobutanol–diesel fuel blends. some useful results there is a further scope for future research in this area to conduct experiments with duel fuel performance and emission analysis i.e biogas+Diesel blends with Isobutonal.

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