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Experimental Study on Performance and Emission Parameters of An IC Engine Using Alternative Fuels

Sohail Khan[1] and Deepesh Singh Gehlot[2]
Department of Thermal Engineering[1,2]
LNCT Indore, Madhya Pradesh, India
snawab007khan@gmail.com, deepesh.gehlot.84@gmail.com

Abstract: *The increasing depletion of the fossil fuel reserves as well as the growing concern over the vehicular emissions have well intensified the search for the sustainable as well as the cleaner fuel alternatives for the context of internal combustion engines.. This paper presents an experimental project on the use of compression ignition engine on various alternative fuels of choice, its performance as well as emission properties. This was done by taking such parameters as the brake thermal efficiency, the brake specific fuel consumption, the exit emissions in form of carbon monoxide, hydrocarbon as well as the nitrogen oxides emissions and carbon dioxide. All the experiments were done under different conditions of load in the normal test processes. It can be seen that alternative power sources can provide the competitive engine power besides significantly cutting down to high level of harmful emissions. Some shortcomings were however experienced with regards to nature of fuel and the combustion behaviour. The research results could be used to supplement the developing literature that embraces a pro-adoption of alternative fuels as a viable alternative to the conventional petroleum-based fuel in the internal combustion engines*

Keywords: Internal combustion

I. INTRODUCTION

Internal combustion (IC) engines have well remained one of the dominant power source for transportation a agricultural applications for more than a century. Diesel and petrol engines still have continued to contribute largely to transportation and productivity of industries in the world. The excess consumption of the fossil fuels has had numerous significant environmental issues including air pollution, green house gases and climate change. Besides, depletion of petroleum reserves has also been a subject of concern to the security of the long-run energy security (1).

Examples of automobile emissions that have been cited as being critical air pervaders of the urban centers include emissions of carbon monoxide (CO), un-burnt hydro carbons (HC), specifically nitrogen oxide (NO[?]) emissions, and the particulate matter. Not only these emissions affect the environment negatively but they are extremely hazardous to the health of the human beings. With the demands on emission controls steadily increasing in the majority of the world, scientists and policymakers should find cleaner and renewable energy to be used in the IC engines (2).

Part of the alternative fuels that have created immense interest are bio-diesel, ethanol, methanol, biogas and hydrogen in that the alternative fuels are renewable sources and they can potentially lead to a reduction in the emissions of exhausts. Such similarity as manifested in the combustion properties and the fact that such similar fuel can be used with the existing engines has also seen music particularly the bio-diesel be proposed as an option to the diesel fuel (3). Alcohol fuels too have done commendable emission profiles only that there are deficiencies of low calorific value and cold-start.

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The given research will also attempt to experimentally identify the operation and emission characteristics of an IC engine that will utilize the proposed alternatives fuels. The systematic comparison of the fuels with the conventional diesel will be utilized so as to find out how such fuels will be utilized in the feasibility of the practical engine systems and help in the provision of the sustainable energy solutions.

II. CLASSIFICATION OF ALTERNATIVE FUELS

Alternative fuels used in the IC engines can be broadly classified based on their actual origin, physical state, and chemical composition.

2.1 Bio-based Fuels

The vegetable oils, animal fats and agricultural residues are used as the biological feeds of biofuels. Transesterification process of vegetable oils results in the production of biodiesel and makes this oil undergo research because it is biodegradable and low in sulfur (4).

2.2 Alcohol Fuels

Ethanol and alcohols methanol are oxygenated and it provokes total combustion process. These fuels are prone to decreasing the emission of CO and HC yet can manifest the emission of aldehydes and fuel consumption because they contain lower energy density (5).

2.3 Gaseous Fuels

These include compressed natural gas (CNG), liquefied petroleum gas (LPG) and biogas. Nevertheless, the fuels have a cleaner burn without making a lot of modifications to the engine and special storage capabilities are needed (6).

2.4 Hydrogen and Synthetic Fuels

Hydrogen is a zero-carbon fuel at the point of use, however, there is an issue of storage, safety and cost of production impairs its use. There is also the development of synthetic fuels which are produced as a result of chemical processes (7).

Table 1: Experimental Results under Different Load Conditions

Load (%)	Fuel Type	Brake Thermal Efficiency (%)	BSFC (kg/kWh)	CO (%)	HC (ppm)	NO_x (ppm)
25	Diesel	28.4	0.29	0.32	65	410
25	Biodiesel Blend	26.9	0.31	0.25	52	380
50	Diesel	31.7	0.26	0.28	58	520
50	Biodiesel Blend	30.2	0.28	0.21	47	490
75	Diesel	33.5	0.24	0.24	50	610
75	Biodiesel Blend	32.1	0.26	0.19	42	570

III. TECHNOLOGY USED IN THE TESTING

The single cylinder four stroke water cooled compression ignition engine was used along with eddy current dynamometer in the experimental research. The engine was operated at the same rate and dynamometer controller was used to take different loads. The fuel consumption was quantified with a burette and a stopwatch in place and with an air intake as they were quantified; air box with the orifice meter was used (8).

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Exhausts measurements were done through a calibrated exhaust gas analyzer with the capacity of detecting the level of CO and HC, NO[?] and CO2 concentration. The values of the levels of the opacities were measured using a smoke meter. The standard quantities of thermodynamics were used to calculate engine performance. The whole measurement was done during steady state operating condition and with interest to minimise measurements error.

IV. RESEARCH AND FINDINGS

4.1 Performance Characteristics

All the load conditions indicated that the thermal efficiency of the brake when using alternate fuel on the engine was slightly less compared to that of the diesel. Among the factors that influenced this drop, there should be low calorific values and high viscosity of alternative fuels changing the atomization and the combustion efficacies of the fuels (9). The difference in the efficiency however became smaller by increase in loads which showed better combustion behaviour.

The alternative fuels were not highly powered and this implied that braking specific fuel consumption was good. This was not so much augmented but rather to the extent that made engines useless.

4.2 Emission Characteristics

It was found out that the reduction of carbon monoxide and hydrocarbons realised in the case of alternative fuels utilisation was great. These fuels already have oxygen, which has gone through a greater total combustion, and, therefore reduced incomplete products of combustion (10).

The amount of nitrogen oxides emissions during the lower loads was slightly lower than when using diesel. It is possible that this behaviour has to do with low peak combustion temperatures. Yet, the output of NO[?] was greater at high loads, and this could be discussed by the fact that the burning of the fuel was better, as well as the in-cylinder temperatures were high.

V. SCOPE AND FUTURE PROSPECTS

The results of the present research prove the fact that the alternative fuels can be considered as the possible alternative of the will be considered as the traditional diesel in the IC engines with the least unfavorable effect on the level of performance. It can be open to possibilities that optimization of fuel blend, timing of injection and design of the combustion chamber can be successfully applied in future research, in an attempt to realize improvement in performance and economy and also reduce emission level.

The highly developed technologies like exhaust gas recirculation, catalytic converters and electronic fuel injection system can allow the adoption of alternative fuels that lead to lower emissions like ethanol so as to comply to the limiting emission regulation provisions. They also need to be supported by long-term endurance tests and must carry out cost-benefit tests too to justify widespread signing.

VI. CONCLUSION

The experimental research proves that the alternative fuels are a saleable measure to the problems of recession of the fossil fuel and environmental pollution. Although the fact that minor changes in the performance parameters occurred, the amount of harmful emissions was reduced to a significant level and this is what they do good to the environment. To the extent that the right policy reinforcement and adoption of the corresponding technological interventions is taken into account, the alternative fuels occupy strong place in the ensuring of the attainability of the sustainable and cleaner transportation systems.

Abbreviations

IC – Internal Combustion
BSFC – Brake Specific Fuel Consumption
CO – Carbon Monoxide
HC – Hydrocarbons

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NO_x – Nitrogen Oxides
CNG – Compressed Natural Gas

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