Review on Comprehensive Analysis of Vegetable and Microalga Oil-Based Biodiesel

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Abstract **- With impending economic concerns and fuel crisis, biodiesel produced from microalgae and vegetable oils have been proposed as a potential substitute for petroleum fuel. But experimental characterization of combustion, performance and emission behaviour of biofuel operating under different operating conditions would be resource consuming. In this study numerical modelling using computational fluid mechanics methods is considered.**

The aim of present review paper, to determine the use of low percentages of biodiesel blends from different feedstocks on the basis of previous study. It leads to little level performance decrease, with biodiesel advantages on reducing pollutant emissions according to ULSD when used in diesel engines only with a small amount of carbon residue in the combustion chamber.

Index Terms **- Biofuel, modelling, vegetable oil, diesel engine etc.**

I.INTRODUCTION

This definition emphasizes the intrinsic importance of chemical reactions to combustion. It also emphasizes why combustion is so very important: combustion transforms energy stored in chemical bonds to heat that can be utilized in a variety of ways. Throughout this book, we illustrate the many practical applications of combustion.

Environmental pollution and the energy crisis are affecting life at a global level. Limited reservoirs of fossil fuel and emission due to the combustion of these fossil fuels are affecting the balance of our mother nature. Phenomena like global warming, climate change, and increase in Greenhouse Gases (GHG's) are among such unbalances. The automobile sector is among those sectors which heavily rely on these fossil fuels for energy requirement.

While pollution from these automobiles is among the primary reason behind the rapid increase in air pollution. The by-product of combustion from automobiles engine exhaust consists of unburnt hydrocarbons, smoke, particulate matter, CO_2, CO, NOx, which are affecting human being in particular and our environment in general sense. With rapid economic growth and urbanization, this problem is becoming more severe in countries like India. The study from the various institution in India shows that air pollution is at an alarming level due to vehicular automobile pollutants.

Biodiesel Production

The transport sector currently accounts for over 30% of the total primary energy consumption in the European Union (EU) and is 98% dependent on fossil fuels. The EU is a net crude oil importer, with an increasing oil dependency ratio (over 80% in 2007, Eurostat). One of the most important energy targets for the EU is thus the reduction of oil use and dependency. A recent EU Directive (2009/28/EC) establishes a 20% target share of renewable energy in primary energy consumption by 2020, with a 10% share of energy from renewable sources for transport. In turn, another EU Directive (2003/96/EC) allows the Member States to have exemptions from or reductions in excise duties so as to promote biofuels and, consequently, there is a growing interest in biofuels in Europe. In this context, biodiesel constitutes a renewable fuel that is almost compatible with commercial diesel engines and has clear environmental benefits relative to diesel fuel.

Biodiesel consists of a mixture of fatty acid methyl esters (FAMEs) obtained from renewable resources, such as vegetable oils and animal fats, by transesterification with methanol in the presence of an acid or basic catalyst. It can be synthesised from a variety of feedstocks, but refined vegetable oils (such as soybean, rapeseed, palm and others) are currently

the primary industrial feedstock (first generation biodiesel).

New feedstocks for second generation biodiesel production

A major economic challenge for the biodiesel industry is the high cost of refi ned vegetable oils which constitutes between 70 and 85% of the overall production cost. Likewise, the competition of these edible oils with the food market is also an important concern. Thus, in order to reduce the cost of biodiesel and the social impact, alternative feedstocks that are readily available in large quantities and at low cost must be considered.

- Non-edible vegetable oils
- Waste oils and fats
- Algae-based biodiesel
- Biodiesel from other microbial oils

Characteristics of Biodiesel

Biodiesel is one of the best alternatives to diesel and can be used as alternative fuel in compression ignition (CI) engines. The engine injection, combustion, performance, and emission characteristics are influenced by biodiesel properties, which depend on the FA compositions and types of feed stocks. In many countries, biodiesel has been successfully introduced and commercialized. Hence, some biodiesel standards, like ASTM D6751 and the European standard EN 14214, have been developed to certify high product quality and to improve user confidence. The biodiesel is characterized by determining its different physicochemical properties like density, viscosity, FP, cloud point (CP), pure point, CV, volatility, etc.

- Density
- Kinematic Viscosity
- Cetane Number
- Calorific Value
- Cloud Point and Pour Point
- Flash Point
- Elemental Analysis
- Surface Tension

II-LITERATURE REVIEW

V. Karthickeyan presents work on, non-edible oils namely pumpkin seed oil and Moringa oleifera oil were converted into methyl ester of Pumpkin seed oil (B1) and Moringa oleifera oil (B2) using transesterification process.

High swirl and squish behaviour of TCC engine helps in better air-fuel mixing and leads to complete combustion. Biodiesel samples contain oxygen molecules in its structure, reduced engine exhaust emissions except NOx were observed.

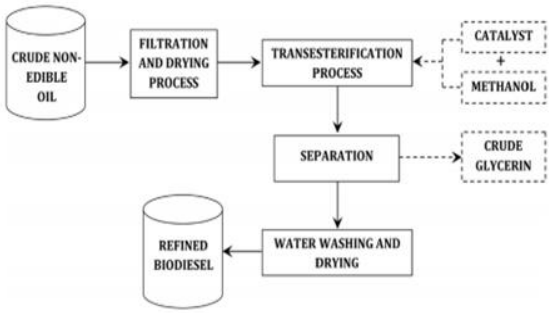

Figure2.1 Process diagram of biodiesel production

The aim of study given by Upendra Rajak et. al. (2018) to investigate emulsion fuel characteristics with B20 blend level of microalgae spirulina biodiesel (MSB) concentration and their effects on performance, combustion and exhaust emissions of a direct injection diesel engine. The engine was operated at three different engine speeds.

This has been analyzed by Diesel-RK commercial software and engine parameters such as specific fuel consumption, thermal efficiency, exhaust gas temperature, ignition delay, the rate of heat release, emissions particulate matter, carbon dioxide, oxides of nitrogen and smoke emission were obtained.

G. Sakthivel et. al. (2017) presents, a novel hybrid Multi Criteria Decision Making (MCDM) technique was proposed to evaluate and select the optimum fuel biodiesel blend for the IC engine with conflicting criteria to enhance the energy efficiency.

Exploratory analysis were carried out on a single cylinder four stroke, air cooled, constant speed, direct injection diesel engine with a rated output of 4.4 kW at 1500 rpm at different loads. Two hybrid MCDM models, namely Fuzzy TOPSIS and Fuzzy VIKOR were proposed. Fuzzy was applied to determine the relative weights of the evaluation criteria whereas TOPSIS and VIKOR were applied to obtain the final ranking of alternatives.

Jose Antonio et. al. (2017) describes the elaboration of a predictive tool consisting on a phenomenological multi-zone model, applicable to the simulation of HCCI combustion of both diesel and biodiesel fuels.

The mentioned predictive tool is created with the aim to be applied in the future to perform engine characterization during both pre-design and post-design stages.

The methodology applied to obtain the proposed predictive model is based on the generation of an analytical mechanism that, given a set of regression variables representing the engine operative conditions, provides the user with the optimal figures for the scaling coefficients needed to particularize both the ignition delay and the heat release rate functional laws, which rule the combustion development in the proposed multi-zone model for HCCI engines.

Bari et al (2013) has presented a Guide Vane Swirl and Tumble Device (GVSTD) to be installed in front of the intake port to develop an organized turbulence to assist in the breakup of fuel molecules for improved mixing with air. To investigate the effect of GVSTD to generate better in-cylinder air flow, ANSYS-CFX was used to run a 3D cold flow IC engine simulation.

The model was validated with the experimental results of in-cylinder pressure from 0°CA to 540°CA and the results of in-cylinder airflow characteristics from simulations were compared with other related research works.

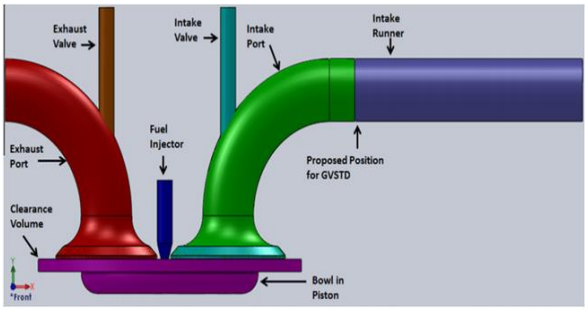

Figure 2.2 The drawing of the simulation model (Reported at S. Bari, 2013)

III- CONCLUSION

The following observations can be made after the study. For further analysis:

- Combustion modelling is an important field of research due to its distinct advantages. Firstly, it is an important phenomenon for conservation of energy. Secondly, it gives in-depth knowledge about combustion processes for limiting harmful emissions. Thus, it is required for further work.
- The combustion of biodiesels and its blends are not same as fossil diesel combustion in CI engines. For these reasons, different methods and techniques have been developed by different research groups to limit harmful emissions, but more study is required.
- There are some key limitations of kinetic modelling for combustion in CI engine such as (a) need for high-pressure kinetic methodology, (b) need for continuous improvement of kinetic mechanisms with theoretical modelling validated by experimental results. Thus, for further research these aspects should also be considered.
- Research groups have studied on particulate matter emission, injection timing, engine performance, emission and combustion characteristics of biodiesel under LTC using external air-fuel mixture, but it is not sufficient. More research needed for this.

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