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A literature review on potential alternative fuels for IC engines

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Abstract
The using of fossil fuels causes several environmental problems and affects the human life. Indeed, it is emitted huge quantities of carbon dioxide and other greenhouse gases in the environment that contributed in global worming phenomenon. Furthermore, these fossil fuels are obtained from limited resources. These limited resources are highly concentrated in certain region of the world. Hence, it is necessary to look for alternative fuels which can be produced from resources available locally with in the country such as alcohol, biodiesel, vegetable oil etc. This paper presents the development and genesis of the use of alternative fuels in internal combustion ignition engines. Based on the analysis of the various literature review, this paper shows various alternative fuels used in all over the world. Furthermore, this article describes the research directions for alternative fuels use in road t powered by IC engines.

Keywords: IC engines, alternative fuel, fossil fuel, renewable energy

Introduction
Alternative fuels, known as non-conventional and advanced fuels, are any materials or substances that can be used as fuels, other than conventional fuels like; fossil fuels (petroleum coal, and natural gas), as well as nuclear materials such as uranium and thorium, as well as artificial radioisotope fuels that are made in nuclear reactors. Some well-known alternative fuels include biodiesel, bio alcohol (methanol, ethanol, butanol), chemically stored electricity (batteries and fuel cells), hydrogen, non-fossil methane, non-fossil natural gas, vegetable oil, propane and other biomass sources. As a result, gases from fossil fuel emissions have caused and are continuing to cause great damage to the atmosphere (such as the greenhouse effect and acid rain). The use of alternative fuels to power our cars, buses, and trucks would significantly reduce our dependence on foreign oil.

Literature Review
Srinivasnaik M *et al.* has suggested that, biodiesel made through a chemical process called transesterification whereby the glycerin is separated from the fat or vegetable oil. The process leaves behind two products-methyl esters (the chemical name for biodiesel) and glycerin (a valuable product usually sold to be used in soap and other product) Biodiesel can be process from any type of vegetable oils and animal fat. Food grade vegetable oils such as soya been, canola, palm oil, sunflower oil and peanut can be used to produce biodiesel. Biodiesel can also be processed from animal fats such as lard, tallow, chicken fat, fish oils and used cooking oils from restaurants. The direct use of vegetable oils in fuel engine is problematic due to high viscosity and low volatility; they do not burn completely and form deposits in the fuel injectors of diesel engines. So, biodiesels produced from vegetable oils appear to be a potential alternative source to petro-diesel. Biodiesel reduces nearly all form of air pollutions. Most importantly, biodiesel reduces air toxics and cancer-causing compounds. Biodiesel is made from cooking oil and alcohol, so if spill it on the ground, it will quickly degrade into natural organic residues. Biodiesel is very new and it is catching slowly, because it is expensive. Make sure that the biodiesel used meets ASTM Standard there are no water, sediment or thick viscous layers on the bottom. Biodiesel can be store about the same length of time as diesel fuel. However, storage longer than six months is not recommended [1].
Caban Jacek *et al.* has concluded that in his article that, modern pro-ecological attitude associated with environmental protection against increased toxic exhaust emissions and over-exploitation of natural resources have forced to look for innovative liquid fuels. For efficient use of different fuels in existing engines, fuel or power systems of internal combustion engines modifications are applied. As demonstrated in the paper, the problem is to produce fuel similar to a classic one, whose properties can be used as best as possible, withdrawing from the available raw material. Experience from the test stand and the operation show that the power of internal combustion engines with alternative fuels is a complex and long-term process and possible use of renewable natural resources are among the most environmentally friendly. It is stated that you cannot clearly determine which fuel is the best. In case of small motors, it can be quite different fuels than for tractors' engines or trucks and buses. Climatic conditions of exploited vehicles are of great importance when using biofuel. Advantageous effects of RME on exhaust emissions from older diesel engines have been confirmed in many previous studies. However, in case of modern diesel engines, the influence of RME seems to be less recognized.
The main scientific problems relating to alternative fuels include: accurate knowledge of physical, chemical, thermodynamic, supplies and logistics processes. Issues mentioned in the article, the problems associated with the use

and production of alternative fuels show that research on the development of alternative fuels is a complex and constantly current research field [2].

Taha *et al.* has describes that in his article that, it is well known that gasoline and diesel engines are the major sources of Greenhouse Gases (GHG) emission. One of the main advantages of using biofuels instead of fossil fuel in the transportation sector is the ability to minimize the GHG emissions from vehicles. The combustion of biofuels itself can be regarded as CO2 neutral. Nonetheless, the biofuel production life cycle has be assessed to reach a conclusion about the overall greenhouse gas balance. Hydrogen has clean burning characteristics and better performance. It has a wide range of flammability and high diffusivity compared to all other fuels. On the other hand, it is difficult to quench a hydrogen flame than a flame of most other fuels. Also, it has a low density, which implies a reduction in the power output of the engine. Currently ethanol is the most widely used renewable fuel in the United States with up to 10% by volume blended into gasoline for regular spark ignition engines or up to 85% for use in Flex-Fuel vehicles designed to run with higher concentrations of ethanol. Biodiesel is similarly used with 5-20% by volume blended into petroleum based diesel for compression ignition engines. Biodiesel fuel is methyl or ethyl esters derived from a broad variety of renewable sources such as vegetable oils, animal fats and cooking oil. One of the drawbacks of pure biodiesel is the reduction of power and maximum torque which may be due to the increase of the flame speed [3].

Talupula *et al.* has stated that, our dependence on energy is key to our economy and approach of life. Economically, new and renewable types of fuels are to be utilized, as our supplies of many current fuels are very limited. Environmentally, burning fossil fuels has been greatly affecting and damaging our planet. Thus, it is necessary to compare all types of fuels, in order to determine the best ones, economically and environmentally, short term and long term in all aspects. And hence, alternative fuels are to be developed [4].

Elishav *et al*. has stated that conversion of hydrogen into transportable and environmentally-friendly chemical fuels can facilitate the implementation of renewables into the energy grid. Both carbon and nitrogen can potentially serve as hydrogen carriers leading to carbon- or nitrogen-based fuels. The present paper shows the feasibility of the nitrogen economy where nitrogen-based fuels act as renewable hydrogen carriers, expanding both energy and fertilizer sectors. An energy analysis comparing the two tracks showed that using nitrogen-based fuels as hydrogen carriers for stationary applications is energetically feasible. The energy analysis was conducted by defining a power-to-fuel-to-power (PFP) metric that allows a critical comparison between the suggested fuels. The economic feasibility of using nitrogen-based fuels as hydrogen carriers was investigated for the energy sector. A levelized cost of energy storage (LCOES) analysis was used to compare suggested storage technologies. The analysis showed that even today a model nitrogen-based fuel could be competitive with other suggested alternatives such as batteries and methanol. In the future, when a cost-effective technology for producing hydrogen will be available, nitrogen-based fuels will be competitive with current mature technologies such as PSH, CAES and peaking power plants. The safe utilization of a model nitrogen-based fuel was demonstrated. The auto ignition process of a model fuel (aqueous UAN) was investigated for safe storage and effective combustion purposes. Results demonstrated that this fuel ignites thermally under certain conditions and can be safe to store in ambient well-ventilated vessels. The present work shows for the first time the feasibility of effective catalytic pollutant reduction during combustion of a nitrogen-based fuel at elevated pressures using noble metal catalysts in a batch reactor. Five commercial catalysts (V2O5⁄WO3, Ru, Rh, Pd, and Pt) were tested, using a cordierite honeycomb substrate, coated with γ-Al2O3 and impregnated with the catalysts above. The metal oxide catalyst showed poor performance and was found to be ineffective for the catalytic reduction of pollutants from the UAN combustion process. However, all noble metals tested demonstrated a dramatic reduction of the N2O and NH3 pollutants by 80% and 95%, respectively. In addition, continuous catalytic combustion demonstrated that UAN combustion could be environmentally clean and comply with strict regulations standards. The nitrogen economy, where renewable hydrogen is chemically stored in the form of safe and environmentally he nitrogen economy to energy and fertilizer sectors, providing economical flexibility in the future [5].

Kuimov and Plotnikov have concluded that on their article that evaluation of the efficacy of various alternative and mixed fuels is possible to carry out largest decline of economic damage to the national economy of the country's pollution of the environment. The use of methanol-fuel emulsions and mixtures of rape seed oil with diesel fuel can significantly reduce consumption and reduce environmental concerns by reducing, environmental damage caused by exhaust gases. The use of the proposed design solutions allows to achieve the identity to law of heat supply in diesel cylinders with its alternative fuels and mixed operating on pure diesel fuel [6].

Bharadwaj *et al*. has concluded that, algae have long been recognized as potentially good sources for biofuel production because of their relatively high oil content and rapid biomass production. Algae generally grow very quickly compared to terrestrial crops; the practice of algal mass culture can be performed on non-arable lands using non-potable saline water and waste water. Algae are an ideal biodiesel feedstock, which eventually could replace petroleum-based fuel due to several advantages, such as high oil content, high rates of production, less land, etc. There is also the ever-present climate change and global warming problems and the tendency to reduce greenhouse gas emissions on global level as well as national and regional levels, so it is the right time for a fresh look at algae as a potential energy source.

Thus, use of algae for production of as an alternative biodiesel biofuel is proving to be an economical choice because of its low cost and easy availability. Although, the present research is essentially a primary work and needs to be further investigated to arrive at specified conclusion with respect to other implications [7].

Saud *et al*. From the result of these studies it can be concluded that there is feasibility of using LPG as fuel either by complete replacement of gasoline or in combination with gasoline in SI engine and in dual fuel mode with diesel in CI engine. The use

of LPG in I C engine reduces the major pollutants like NOx, CO2 and smoke [8].

Kothari *et al*. has stated that, biodiesel is intended to be used as a replacement for petroleum diesel fuel, or could be blended with petroleum diesel fuel in any proportion. Biodiesel does not require modifications to a diesel engine to be used. Biodiesel has reduced exhaust emissions compared to petroleum diesel fuel. Biodiesel has lower toxicity compared to petroleum diesel fuel. Biodiesel is safer to handle compared to petroleum diesel fuel. Biodiesel quality is governed by ASTM D 6751 quality parameters. Biodiesel is biodegradable. Biodiesel must be produced from naturally occurring fats and oils using transesterification. It has been observed the excellent transesterification if we use pure and virgin oils. Biodiesel is a cleaner burning replacement fuel made from renewable sources like new and used vegetable oils and animal fats. Low-level blends (≤20% biodiesel) can be used in almost any existing diesel engine. High-level blends (>20% can be used in most new diesel engines [9].

Abdulrahman *et al*. has concluded that in his article that, biodiesel has many advantages over traditional petroleum diesel. This work is attempted to produce reliable biodiesel from corn oil. It can be argued that it is possible to produce biodiesel from corn oil by adopting transesterification method. The process optimization is also achieved the optimal alcohol: oil ratio. It can be argued that adopting methanol/ oil ratio about 7:1 could achieved productive friendly nitrogen-based fuels, offers a storage solution that can provide energetically and economically feasible power generation on demand. This in turn, can fertilize our energy portfolio and expand biodiesel yield about 96%. However, it is also quite recommended that to achieve more studies and process optimization before installing biodiesel plant for commercial production [10].

Conclusions

In conclusion, Alternative fuel has many advantages over traditional fossil fuel. Alternative fuel such as biodiesel, methanol, ethanol etc contains higher cetane number compared to fossil fuel indicates potential for higher engine performance. Other alternative fuel such as alcohols have higher octane number than gasoline. Furthermore, by using alternative fuel, safety in storage and transport can be increased because the fuel is nontoxic and biodegradable. Alternative fuel such as biodiesels produced from vegetable oils appear to be a potential alternative source to fossil fuel (petrol, diesel). The most important advantage of alternative fuel is that alternative fuels reduces nearly all form of air pollutions. Most importantly, biodiesel reduces air toxics and cancer-causing compounds.

The main scientific problems relating to alternative fuels is that there is no accurate knowledge of physical, chemical and thermodynamic properties. Furthermore, there are also problem with alternative fuel that there is no well development in supplies and logistics processes of alternative fuels. One of the other drawbacks of alternative fuel such as pure biodiesel is the reduction of power and maximum torque which may be due to the increase of the flame speed. Furthermore, in order to adopt the alternative fuel in IC engine, engine has to be modified slightly like replace rubber fuel hoses and gaskets with synthetics because of biodiesel's tendency to deteriorate rubber and other seals.

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