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REVIEW ARTICLE

Evaluating the combustion characteristics of methanol-gasoline blends in IC engines

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Abstract

This study expresses the core elements associated with the various types of fuels used in vehicles functional in the present day. The exploration of chemicals such as methanol and others have also been conducted in an accurate manner to gain objective insights and outlooks in the study. The social and economic impacts of methanol-gasoline blends in engines can be complex in nature that depend on various factors such as the concentration levels of methanol in the blend, the availability of fuel, and public perception, among others. Further research and analysis as conducted in the study have been useful in understanding the potential impacts of methanol-gasoline blends across global spheres.

Keywords: Social and economic impacts, Combustion, Methanol-gasoline, Inflammable fuels.

Introduction

This study aims to address the wide range of combustion engines that are retail on fossil fuels and similar other sources of energy for common vehicular innovations. The wide range of inflammable fuels such as methanol and gasoline that have developed since the advent of industrialization has been assessed to revolutionize the concept of engines and their pertaining combustion capacity. The innovations of vehicles that derive energy from the combustion of fuels have been elaborated to have developed a plethora of socioeconomic impacts on a global range.

Aims and Objectives

Aim

The study's main aim is to focus on the combustion factors pertaining to methanol, gasoline and similar blends commonly found in internal combustion based engines.

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Objectives

- To explore the factors affecting methanol and gasoline fuel blends.
- To understand the impacts of different fuels on the IC engine industry.

Literature

Methanol-gasoline blends can be expressed as the amalgam of methanol and gasoline in specific quantities that are used as alternative fuels in internal combustion engines (ICEs). Here are some core characteristics about methanol-gasoline blends: Methanol can be implemented in its crude form or as a blend component in a vast array of ICEs that are currently functional across global populaces (Obulesu *et al*., 2021). Owing to its vast implementation range, it maintains an ever-increasing nature of demand. Methanol-gasoline blends can have several merits, such as being a more conscious and ethical choice for the environmental preservation of resources. It can also be crucial in keeping the energy consumption pattern of the engine clean and renewable, leading to a higher heat generation necessary for movement. Blending methanol with equally volatile fluids like gasoline can increase the octane rating, a common metric for measuring power output in internal combustion engines. The percentage of methanol in the blend can vary in terms of applications. However, it has been noted to commonly range from 5 to 85% depending on socioeconomic factors (Singh *et al.,* 2022). Explorations by earlier academic sources have demonstrated that the performance of gasoline engines can be impacted by the percentage of methanol added to the chemical blend. Pertinent factors for motion such as

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engine torque and power may undergo decline, but vital elements such as brake thermal efficiency and others can improve after undergoing greater methanol percentages.

Subsequently, methanol-gasoline blends offer a potential substitute to fuel choices currently functional within internal combustion engines, with both risks and opportunities for improving engine performance and emissions. As further explored in the study, a vast range of merits and demerits can also be devoted to be associated with methanol and gasoline blends for fuels. While on the one hand, methanol keeps the engine clean, however, on the other, it has lower energy density than gasoline. Methanol, concurrently, has a higher flashpoint in case of fire that can lead to an incline in the octane rating, resulting in higher power output (Verhelst *et al.*,2019). Currently, the exhaust emission rates and engine performance of various blends of methanol and ethanol in gasoline engines require a more exploratory and investigative approach for better socioeconomic practicality.

Methodology

A vast range of academic journals and insights have been crucial in understanding the effects of methanol-gasoline blends on IC engine durability and performance. In concurrence, scholastic studies that have explored the effects of the blends on engine performance and emissions have resulted in crucial insights. Here are some key findings from the researches that have been explored in the study:

A comparative analysis conducted in 2021 had examined the results of a 10% methanol blend used in a 90% unleaded gasoline composition to measure the output performance of a spark ignition engine (Sarikoç, *et al.,* 2020). The study understood that a 13% decline in hydrocarbon emissions can be perceived from the emission rates signifying major output capacities. However, another academic investigation had unearthed that the merits and demerits of methanol-gasoline blends are prominently capable of reducing pollutant emissions as compared to neat gasoline consumption by IC engines.

A study in 2018 analyzed a gasoline engine with different composition rates of methanol blends (from 10 – 30%) in gasoline to be less impactful in improving transportation. The results exhibited that the engine torque and power had declined. Subsequently, the brake thermal efficiency had improved reasonably with an incline in methanol proportion in the fuel blend.

The addition of methanol to gasoline increases the octane number which is a core element in its combustion capacity, which permits the engine to be fueled more efficiently (Ilkeretal *et al.*, 2020). The methanol-gasoline blends have also been significant in operating at higher compression ratios across a variety of engines.

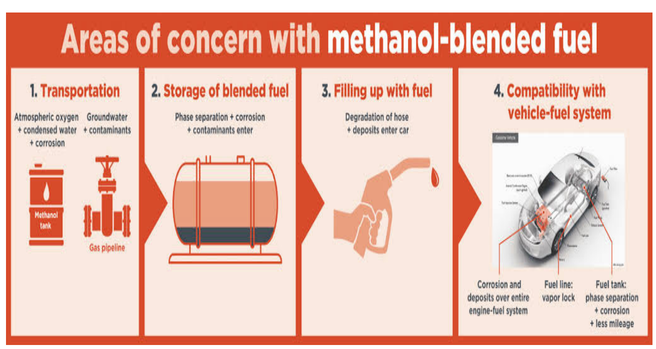
There are some rising issues that have been registered about the effects of methanol-gasoline blends on engine durability that can have an impact over longer periods of time. Degrading factors such as corrosion and decay issues can occur in the vehicle fuel system owing to methanol and gasoline mixtures coming in contact with corrosive elements such as lead, magnesium, aluminum, and others.

It can be denoted that a diverse range of research has been conducted on the effects of methanol-gasoline blends on IC engines and their pertinent factors such as durability and others. Studies have also indicated that chemically volatile blends can lower pollutant emission scales leading to an improvement in brake thermal efficiency (Nuthan Prasad B. S. and Kumar G. N. 2019). However, the studies have also been clear on issues that may arise such as corrosion and others within the vehicle fuel injection system.

Results

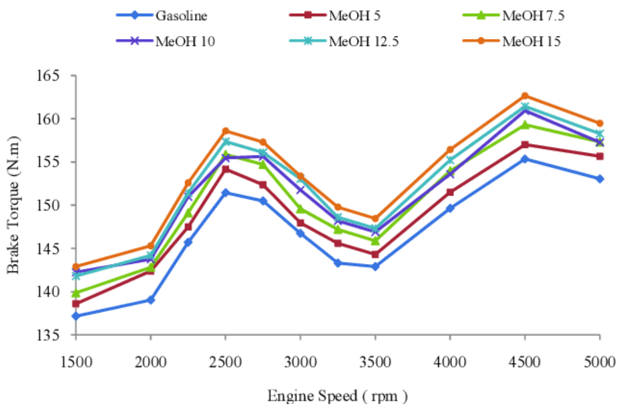
The application of methanol-gasoline blends can have many outcomes on an engine's fuel system that are found across global environments. Here are some key points regarding their impacts; Setbacks such as corrosion and degradation in the fuel interface, after it interacts with certain materials such as lead, magnesium, aluminum, and some plastics, can lead to leaks and other issues in the fuel system. The aforementioned issue can lead to hindrance in vehicular performance over a course of time. Furthermore, the compatibility of the fuels elaborated in the study such as methanol-gasoline blends can range in compatibility with all materials that have been employed within the fuel system (Abdellatief *et al.*, 2022). Certain plastics and rubber components that are below the permissible limit may not be capable of withstanding the corrosive impacts of methanol, which can result in deterioration and potential failure in the vehicular production industry.

Research indicates that fuel system modifications may be vital to accommodate methanol-gasoline blends across global IC engines that are developing across metallurgical conglomerates. The aforementioned agenda can include directives such as upgrading the fuel lines, seals, and other parts to ensure prominent performances and prevent leakages or damage (Figures 1-3).



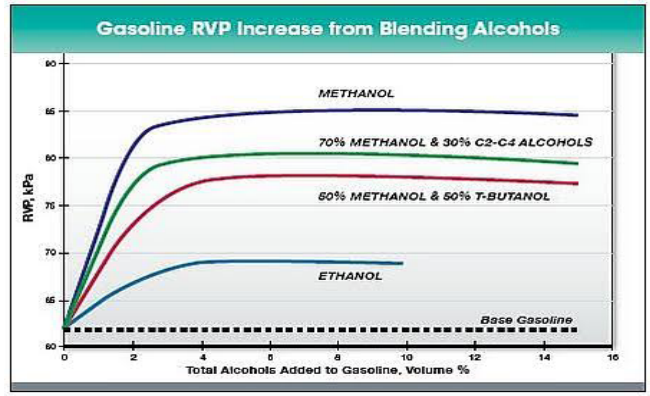
(Source: Abdellatief *et al.*,2022)

Figure 1: Aspects of methanol fuel blends



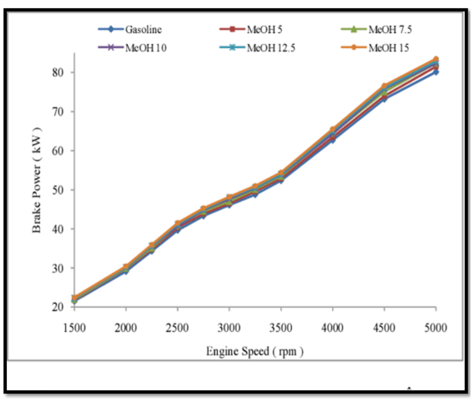
(Source: Chaudhary & Subramanian, 2022)

Figure 2: Engine performance based on fuel blends



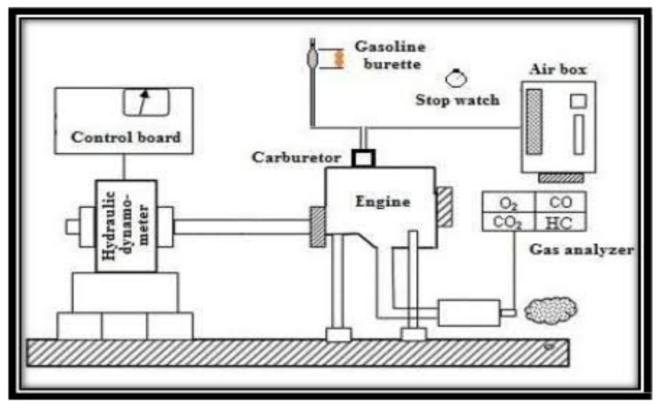
(Source: Chen *et al.*, 2019)

Figure 4: Methanol rates in blends



(Source: Nuthan Prasad & B. S., Kumar G. N. 2019)

Figure 3: Impact of methanol fuels on brake performance



(Source: Abdellatief *et al.*,2022

Figure 5: IC engine structures

Discussion

Core Factors of Internal Combustion Engines

It is necessary to understand that internal combustion engines (ICEs) currently functional in markets are capable of burning a range of fuels that have been further explored in the following sections. Gasoline is one of the most common forms of fuel used in ICEs in the present day. Gasoline engines can be defined as spark-ignition engines that ignite using plugs to trigger the combustion reaction between the fuel and air (Chaudhary & Subramanian, 2022). Gasoline is commonly employed to fuel cars, trucks, vans, and a plethora of other automobiles that are currently a staple mode of transportation for global communities (Figure 4).

Diesel is another common type of vehicle fuel that uses compression to ignite the fuel and air mixture that has been employed in automobile transmissions on a global scale. Diesel is composed of hydrocarbon chains with 15 to 18 carbon atoms capable of harnessing immense energy outputs upon combustion. One of the most common and household forms of energy produced by natural gasses also include hydrocarbon gas mixtures that are primarily composed of methane particles. It can be implemented in ICEs with some modifications to the fuel system to ensure leakage does not occur since it can lead to disastrous repercussions (Figure 5).

Gasses that are capable of undergoing production at lower cost structures such as biogas and landfill gas can be used as fuels in ICEs. However, engines relying on such interfaces require some modifications to the fuel system to ensure no leakage occurs that can lower operational capabilities.

One of the most vital forms of crude energy, methanol can be used in its raw form or as a blend component in a variety of ICEs. Methanol-gasoline blends can have several merits, such as being a safer choice for environmental wellbeing, prolonging the engine's performance range by keeping them reliant on clean energy, and having a higher product life (Abdellatief *et al.*, 2022). However, there are also a prominent range of demerits to acknowledge, such as lower energy densities and potential lowering of engine torque and power output when there is a higher percentage of methanols in the blend.

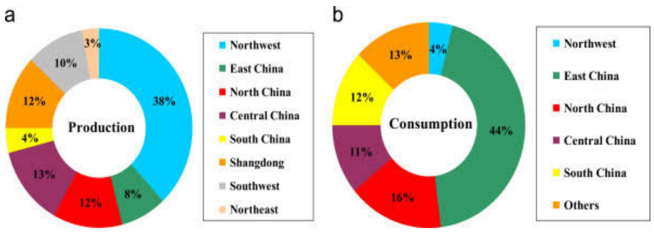
Overall, ICEs can rely on a range of fuels, each with their own advantages and disadvantages (Chen *et al.*, 2019). The type of fuel used in an ICE is reliant on factors such as the form of engine, the application, and the availability of fuel resources.

Socioeconomic Impact of Methanol-Gasoline Blends as Energy Sources for Engines

The use of methanol-gasoline blends in engines can lead to a diverse array of social and economic impacts. Here are some potential impacts as further explored in the study (Figures 6-9 and Table 1).

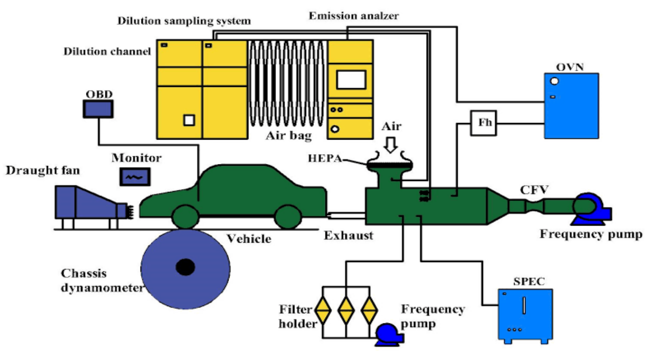
Social Impacts

Methanol and its blends are toxic and flammable, which can pose safety risks if not handled efficiently. Hence, global



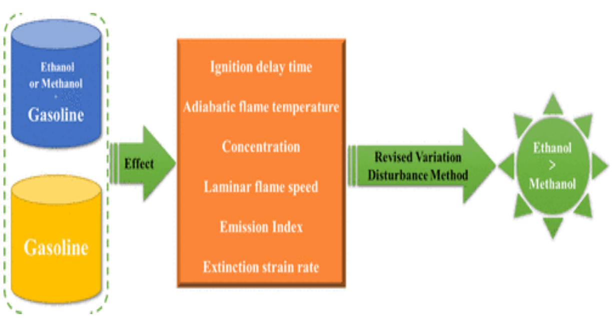
(Source: Chen *et al.*, 2019)

Figure 6: Global energy production and consumption rates



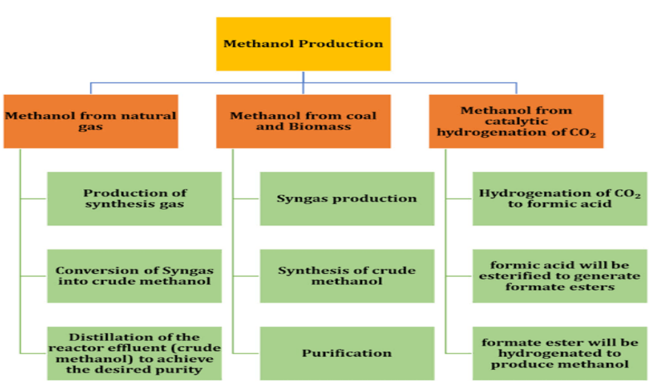
(Source: Chen *et al.*, 2019

Figure 7: Combustible engine structures



(Source: Abdellatief *et al.*, 2022)

Figure 8: Energy conversion process



(Source: Li *et al.*, 2022)

Figure 9: Methanol production strategies

Table 1: Energy fuel compositions

Property	*Euro diesel*	*Biodiesel*	*Methanol*
Cetane number	52	51	<5
Lower heating value 9MJ/Kg)	42.5	37.5	19.7
Density (kg/m^3)@20^0 C	840	871	792
Viscosity (mPa-s) @40^0 C	2.4	4.6	0.59
Heat of evaporation (Kj/kg)	250–290	300	1178
Carbon content (%mass)	86.6	77.1	37.5
Hydrogen content (%mass)	13.4	12.1	12.5
Oxygen content (%mass)	0	10.8	50
Sulfur content (mg/kg)	<10	<10	0

(Source: Li *et al.*, 2022)

petrochemical corporations and organizations have been observed to employ science teams to ensure that the quality of their services is stable.

Public Outlook

Using alternative fuels such as methanol-gasoline blends can encourage a considerable awareness of environmental safety among communities. The public perception of the automotive industry and its commitment to goals of sustainability and reducing emissions across distributaries.

Environmental Benefits

Methanol-gasoline blends can reduce pollutant emissions that are emitted in the air during the construction of metallic structures. Compared to neat gasoline, it can positively impact air quality and public health, which has been globally acknowledged as a pressing concern.

Economic Impacts

One of the most contributing factors behind the adoption of methanol is its less expensive nature which has been useful in producing sustainable compositions of ethanol fuel (Li *et al.*, 2022). It can also result in cost savings for consumers and the automotive industry, resulting in better demand and supply balance performance.

Fuel Infrastructure costs: The use of methanol-gasoline blends may require modifications to the fuel system and infrastructure. Subsequently, it can result in additional costs for consumers and the automotive industry, such as employment opportunities and others.

Conclusion

This study has acknowledged the various elements that are associated with the chemical blends used in global engines present within vehicles. This study also addresses the different array of risks and setbacks related to the field and are crucial for developing energy-efficient approaches for global communities. In addition, the chemical composition of the various fuels and their range of applicability to the mass production of engines has also been analyzed in an introspective manner to provide better insights.

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