Methods of Using Methanol as Internal Combustion Engine Fuel

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Abstract – Methanol is an alternate fuel that is renewable, technologically and commercially appealing and one of the most advantageous fuels over conventional fossil fuels. Methanol was recently used to satisfy certain environmental and economic issues, as an option to conventional fuels for internal combustion (IC) engines. In this study we have discussed about the methanol, methods of using methanol as an engine fuel, uses of methanol fuel in internal combustion engine, which is concluded that the Developing and applying methanol in order to substitute existing fossil fuel fuels will eliminate conventional emissions regulation requirements and economic costs.

Keywords – Methanol, IC, Engine, Fuel

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INTRODUCTION

In order to offset the non-renewable supplies, numerous substitute resources such as methanol, ethanol or hydrogen are now required, with the stocks of these fossil fuels becoming rapidly exhausted. If oil costs rise and global warming is a prevalent environmental problem, the usage of renewable fuels appears unavoidable in the future. Our current source of electricity is dependent on non-renewable fossil fuels. Given the developing world population, the climate and the demand for electricity per capita as well as global warming, there is a strong need for a long-term supply of renewable energy. Methanol is one of the safest long-term, widespread fuels for oil-based combustibles. There are a lot of advantages among renewable alternative energy sources, for example (1) mitigating national safety and the economic concerns about fuel supplies, (2) improving air emissions and (3) maintaining sustainable development of resources [3]; and (2) developing alternative fuels like alcohol instead of traditionally unrenewable oil supplies; Methanol (CH3OH) fuel has been regarded as one of the most advantageous fuels for IC engines among petrol and diesel substitute fuels.

It may be used with a high compression spark ignition (SI) engine which can replace diesels in certain professional applications; (2) it can be used with a SI engine; (3) it may be used with a SI engine with an inlet injection port; and (4), it may be used with a direct-injection stratified charge (SI) engine.

METHANOL

The country's electricity demands must be taken into account both in the long run and in the short run. Natural gas, coal, biomass and unburned waste may be generated with Methanol. While there is an associated energy loss, coal methanol output has promise for the long-term. Another inconvenience to produce methanol and coal is the fact that carbon dioxide generation is larger than that for mining and petrol use. Despite these drawbacks, the U.S. and international coal supplies are far higher than natural gas and oil; thus, they are potentially a source of resources to satisfy the nation's transport needs.

Methanol, a high-octane and sterile burner, is an ideal option for combustion engines. It is mainly used as a diesel as a combination of 85% methanol and 15% hydrocarbons (M85) or 100% methanol (1156, 169, 1681). Some OEMs can mix methanol and gasoline up to M85 in every original equipment manufacturer. Because of its outstanding efficiency as a chemical, Methanol has been used in competition for several years. Methanol provides with these comprehensive fuel engines a substantial improvement in engine performance over diesel-powered engines; figures vary from 15 and 30 percent based on changes in current gasoline engines. Emissions have also significantly increased. Another improvement in automotive energy performance can be achieved by replacing petrol motors with lighter, lightweight comparable methanol pavers. The smaller engines directly use less gasoline and reduce the weight of the car and thus make more fuel savings.

The long-term possibility to generate this fuel from bi-mass and municipal waste is one of the most significant factors for continuing the production of methanol as alternative fuel. The United States is faced with a waste disposal problem. Some claim that land-filling sites would be exhausted worldwide before the end of this century. If biomass and urban waste are treated, methanol generates substantial energy and fossil energy consumption is low or no. Production ratios of up to 2.3 can be obtained for combustion of biomass in methanol (the energy from the methanol separated by the non-renewable energy input). This relationship reaches infinity whether waste or solid waste is used as the feedstock.

The same kind of device and producer that currently are used in petrol may be used to distribute Methanol. Due to the incompatibility of Methanol with such components, fuel storage containers, pumps and dispensers of soft products and materials immune to corrosion (sheets, joints, pants, regulator diaphragm etc.) shall be manufactured of alcohol compounds.

Methanol is the primary problem with the emission of Methanol, particularly formaldehyde. Unburned Methanol is, however, a much more volatile leaf than the nuanced combination of unburned hydraulics released by gasoline and diesel-fueled engines. Methanol is often emitted by the unburned Methanol. Methanol has demonstrated the possibility of reducing peak and long-term ozone amounts in the Los Angeles Basin modeler tests. The ozone reduction in methanol-powered automobiles is sensitive to the amounts of formaldehyde; in these experiments the ozone levels were lower than in other control scenarios. The control technology for catalysts often provides great hope for aldehyde control.

The vaporization heat, which is the heat necessary to transform the gasoline from liquid to vapor, operates at low ambient temperatures to the detriment of ethanol and to the benefit of natural gas or LPG. For the combustion to be started, a liquid fuel must be vaporized. It is very difficult to vaporize methanol owing to its low steam pressure and high vaporizing temperature at low starting temperatures (less than 4.6 percent). In order to have efficient and fast start in cold weather, such methods must be put into practice for initiating Methanol combustion. Many methods were employed, including addition of the primers with higher vapor pressure, low vaporization heating and other vaporization devices, using dual combustion approaches with higher vapor pressure and less heat from the vaporizing fuel, and direct injection with low cylinder pressures in plant. None of these approaches is fully acceptable.

METHODS OF USING METHANOL AS AN ENGINE FUEL

Methanol is a solvent for the engine in many forms:

- **In SI engines:** Due to its strong resistance to autonomy and high vapor fire, methanol is mainly considered a SI engine fuel. mixture. It may also lead to improvements in operating conditions, however large numbers of gasoline/alcohol fuel flex engines have been designed and run worldwide. The condensation of the fuel is minimal.

- **In CI engines:** In diesel applications alcohols have also been used, but need major changes from the norm, again a corollary of strong resistance to autoignition. Dual-fueling, recently used in big ship engines such as Stena Ger manica, has also been implemented, where methanol is separately incorporated into gasoline, and is then used as a combustion source. This clearly involves a drastic change in the fueling scheme, but luckily, with LNG conversions to certain engines this is most popular. Methanol port fuel injection is also a possibility in these dual-fuel motors, which in particular is explored as a way of improving pollution in waterworks.

- **In SI engines, as a separate fuel stream:** As mentioned earlier, an octane-on-demand solution is applicable if alcohols are used as a booster of octane and are separately added to gasoline only when their high-octane numbers require a knock avoidance and charged cooling impact. Increased compression or downsizing of engines will then be given for a better energy efficiency for vehicles. While total intake of alcohol is ideally less than if combined with a one-size-fuel solution, the complications on engine and vehicle level are significantly enhanced since two fuel systems and a more advanced engine control device must be provided at the same time. The 'gauging impact' of usable alcohol is higher with increased petrol intake.

The following two parts would clarify why enticing options are offered with the use of binary and ternary methanol blends.

1. Binary alcohol blends

For several years alcohol has been mixed into automobile fuels, notably in Brazil, and during the Californian methanol fuel trial both of which have been mentioned, the first important application of methanol as an ingredient was perhaps. The volume of ethanol mixed into US petrol after the Californian M85 trial, motivated by energy protection issues, has steadily increased. In recent years, the Company's average fuel economy (CAFE) regulation on OEMs in the USA has led to the selling of E85/gasoline flex-fuel vehicles, as the fuel usage of ethanol in fuel is largely overlooked in terms of reportable fuel consumption. The M85 and E85, in particular, have a connection since the latter technology has been transplanted easily, the researchers discussed, who also noted that the initial Ford M85 production vehicles might run in their fuel tanks in any combination of petrol, ethanol and methanol; this will be restored at a later stage. This will be done.

The 15% volume fuel in these blends nominally helps to denature the alcohol, avoid intake, provide a more inflammable mixture (especially critical in low temperatures) and, in the event of a fire in the car, provide a more noticeable blaze.

Flexfuel Vehicle (FFV) technology used by the OEM in order to comply with the CAFE rules would often underline how inexpensive it is to be applied on a real market. In contrast to the current electric car industry, it operates in an area without government subsidies and has an unreasonably high amount of pre-adopting customers, essentially "hidden" from the public. Many E85/gasoline trucks have been marketed without telling buyers that the technology was actually zero-cost at the point of selling because those buyers thought they were purchasing only gasoline at this price point.

The alcohol blends could take the form of low-, mid- and high-level blends that are not formally defined, but are considered by the researchers to be as high as 15% by volume (low), 15% to 30% by volume and more than 30% by volume (high)[57]. Israel introduced a regular M15 recently. Small ethanol blends are now popular in Europe and the United States (generally 10%), with a 15% rise for reasons of air quality with exemptions for more advanced cars being studied by the American Environmental Protection Agency (EPA). The shifts in the petrol distillation curve up to this concentration stage, which can be mitigated by modifications of the bulk hydrocarbon components. However, the OEMs in the vehicle must do further calibration to render their goods flexible enough to accommodate fuel whose oxygenation could differ considerably, from nil to 15% and higher; it becomes clear that the more and more ethanol is mixed into the stoichiometric Aire fuels ratio (nominally reducing from 14.7 for gasoline to 13.8 for E15).

Consequently, the octane level of the gasoline is raised as the ethanol content is increased. There are considerations. Typically, the hydrocarbon portion of fuel has so far been degraded using enhanced ethanol octane characteristics, to make it easier to remove high-octane components from bulk hydrocarbon fuel as required in the interest of increased financial returns. However, as investigators have seen, large improvements in octane with relative low amounts of ethanol addition can be required, and this can be estimated satisfactorily if the components are called molar fractions.

Furthermore, it is increasingly impossible, 15% ethanol per amount, to match a conventional fuel distillation curve because alcohol tends to lower vapor pressure because it does not obey Raoult's law. Also, the abovementioned 15% waivers are considered. However, the fact that E85 automobiles can be assembled demonstrates that this problem can be solved by technology. This could be significant since, for the sake of the current engine technologies, the optimum degree of alcohol addiction (at least for ethanol) is not linear.

The mixing of alcohols with petrol helps to boost motor power which will enhance fuel octane. Vapor pressure may nevertheless increase significantly and PN emissions can decrease in certain cases. However, the drawbacks are counter measured, and overall, increases in engine output and reliability when alcohol is mixed. The method of blanket alcoholic addiction to bulk gasoline would not make full use of the amount accessible, however, and many researchers examined its use as a second fuel system octane enhancer to varying degrees when required.

2. Ternary blends

Though gasoline-alcohol blends are mostly binary, many alcohols may be used at the same time. An illustration is so-called ternary blends which can include fuel, ethanol and methanol, for example (so called GEM blends). The researcher proposed this idea, which checks the stoichiometric air-to-fuel ratio as the conventional E85 alcohol fuel. Actually, a ternary blend of gasoline, ethanol and methanol can be created from any binary mixture of Gasol's-ethanol to produce the same stoichiometry air-to-fuel ratio for a fraction of each portion. E85 will be found as a flex-fuel engine that is able to utilize ethanol by volume at concentrations of up to 85% (E85). In view of the fact that more than a million flex-fuel cars, accounting for four percent of the United States' light-duty fleet, purchases in the form of E85 constitute just one percent of US overall ethanol consumption. This is because E85 has both been affected by insufficient electricity supply and non-competitive pricing.

Researchers showed, for the motor control unit (ECU) of flex-barbarous cars, which are calibrated to operate on any ethanol-gasolines combination up to E85, that all the potential stochiometric ternary mixture from a binary blend of petrol and ethanol is virtually invisible. The absence of any risk to disrupt the engine control device on-board diagnostics opens the opportunity for these ternary blends to be used as drop-in fuels for flex-fuel automobiles. If the methanol used is renewable and oil-safe then an improved degree of renewability and energy safety is obtained when a set amount of ethanol is in the fuel pool depending on the biomass cap. The reality that there are more E85/flex-fuel cars available than the existing E85 fuel supply chain makes this ultimate scenario feasible. This is possible.

The investigator has measured the dropping potential of the gasoline-ethanol-methanol (GEM) iso-stoichiometric mixtures in two flex-fuel automobiles. A real alcohol sensor was provided on one truck and a "virtual" sensor was installed on the other truck. A physics sensor calculates the fuel alcohol concentration explicitly depending on electrical permittivity or the fuel resistance, whereas a virtual sensor uses an algorithm to quantify the alcohol concentration using knowledge provided by the other engine sensors. The benefit of a 'virtual' sensor is that hardware may not cost any extra. During testing the vehicle, the theory was verified that iso-stochiometric GEM combinations could function as drop-in alternatives to binary ethanol gasoline mixtures. When the binary gasoline-methanol fusion was operated using the 'virtual' sensor, there were just two dysfunction beams. Researchers claimed that this may be caused by the phase separation because the vehicle has not experienced road shocks or accelerations on its test stand and that some kind of cosolvent could be required when methanol and gasoline, which were not included in their splash mixtures6, are combined. The average performance gain in the alcohol use compared to the fuel checks on the same cars was about 5 percent. Cold start testing was also carried out by the researcher. The standard E85 mix was the only combustion that failed the cold start inspection. This could be anticipated as ethanol is harder to start than diesel or methanol, so it can only be expected to boost the condition if the proportion of this part was reduced and replaced by greater quantities of the others.

As a result, GEM fuels will increase the efficient displacement of petrol during winter months when established commercial E85 carburants reduce the ethanol content to nearly 70 percent so that the cold starting capacity can be retained. A set mixing ratio is therefore possible all year round. It is necessary to remember that these measurements took place on a car without understanding what the ECU was really doing and the pollutants were calculated at the end of the tailpipe. Apart from the theory, the future economic gain is another advantage of the GEM blends. Researcher found that market rates (i.e., no taxes) of 3.11 dollars (2.30 dollars and 1.11 dollars) respectively per gallon of petrol, ethanol and methanol may be considerably lower in energy prices than gasoil (as was the situation when the paper was published, e.g., around 2011). At such values, the lowering of motoring costs can be only achieved by growing the relative price of diesel versus petrol with ternary fusion comprising more than 25 percent of the amount of methanol. Because automobiles are supposed to become more effective when used with high mixture alcohol fuels, another decrease in user running costs is expected.

Another plus is that there is no need for a distance anxiety for flex-fuel vehicles which is a huge barrier to electric vehicles, as they are also capable of running on petrol. The customer will drive on a highly alcoholic GEM mix, which is much easier to work but which has a smaller range when the alcohol fuel's lower volumetric energy content or the petrol is loaded because he or she wants to go longer distances before fueling.

UESES OF METHANOL FUEL IN INTERNAL COMBUSTION ENGINE

Table 1 shows the characteristics of methanol, petrol and diesel fuels. Methanol is a colorless, neutral and flammable substance. Methanol is alcohol. Air, gasoline, esters and certain other chemical solvents are miscible. Only in fats and oils is very soluble. Methanol has better ratings of octane and higher heat than petrol, making it an adequate candidate for high compression engines of higher efficiency. This is because a higher-octane rate enables the compression ratio to rise significantly and a higher value of thermal vaporization will reduce fuel/air charge, improve the volumetric performance and promote energy efficiency. In addition to the auto-allusion temperatures of alcohols, the distribution and handling of them are greater than petrol.

Although it has half the volumetrically density of gasoline or diesel, Methanol is a fuel that is outstanding by itself or can be combined with gasoline (85% methanol and 15% gasoline), or total methanol (100% methanol). Methanol is a fuel of transport that has many considerable advantages relative to hydrogen and petrol and improved fuel efficiencies than gasoline due to the greater vaporizing heat and a far greater knock resistance making it the ideal choice for lightweight, turbocharged, high strength stochiometric engines. directly injection.

Table 1: The properties of methanol, gasoline and diesel

Fuel property	Methanol	Gasoline	Diesel
Formula	CH_3OH	C_{5-12}	C_{10-26}
Molecular weight	32	95–120	180–200
Oxygen content	50%	0	0
Stoichiometric air/fuel ratio	6.45	14.6	14.5
Low calorific value (MJ/kg)	19.66	44.5	42.5
High calorific value (MJ/kg)	22.3	46.6	45.8
Freezing point (°C)	−98	−57	−1 to −4
Boiling point (°C)	64.8	30–220	175–360
Flash point (°C)	11	−45	55
Auto-ignition temperature (°C)	465	228–470	220–260
Research octane number	108.7	80–98	
Motor octane number	88.6	81–84	
Cetane number	3	0–10	40–55
inflammability limit	6.7–36	1.47–7.6	1.85–8.2
specific heat (20 °C) (kJ/kg K)	2.55	2.3	1.9
latent heat (kJ/kg)	1109	310	270
Viscosity (20 °C) (CP)	0.6	0.29	3.9

Engine using pure methanol (M100) as fuel

Methanol is a perfect substitute, renewable, environmental and cost attractive fuel from an engineering viewpoint. In the 1990s, a high compression SI methanol engine programmed was introduced by the Southwestern Research Institute, providing a new concept for the production of high strength and highly-effective methanol engines. Investigators converted a diesel engine to a methanol engine and examined the efficiency and pollution properties. The experiments showed that the methanol engine could operate stably without crashing at 1400 rpm motor speed and maximum load, with the ignition times 18, 15 and 12 CA in the first half to the dead center (BTDC). Researchers also examined the pollution consequences of lightweight and heavy-duty automobiles with alternative fuels. The findings indicate that the M100 used in heavy-duty vehicles created variable emission patterns in terms of THC and CO compared remodulated gasoline, compressed natural gas (CNG), liquefied petroleum gas (LPG), methanol-85 and methanol-100 to conventional gasoline and diesel. However, M100 provided significant pollution gains, which are the most serious problems with baseline diesel engines, with the use of nitrogen oxides (NOx) and particulate matter (PMs). Researchers investigated the results of engine speed and charge, injector ratio and layout of injection and ignition timings in direct injection SI engine driven with methanol on the cycle-by-cycle variations of the combustion. These conditions greatly influenced the cycle-by-cycle variance in combustion and the coefficient of variation at least achieved the optimum injection and ignition times. Researchers investigated the impact of injection and combustion on the efficiency and pollution of methanol-fueled SI engines. The results showed that the SI methanol motor in which a non-uniform mixture with stratified distribution can be formed has optimal injection and ignition timings for good results and low exhaust emissions; the optimization of injection times and inflammation timing for methanol motors could result in an increase of over 10 percent in BSFC over non-oil compared to the non-oil.

Engine using methanol/gasoline blends as fuel

Methanol fuel should be mixed with gasoline in the car, it can be mixed with fuel (85% methanol and 15% petrol). A comprehensive oxidation mechanism for the forecasting of methanol–gasoline emissions from SI engines was developed by the researcher, and the mechanism considered the effect of radical species CH, CH2(S), and CH2(T) and NO. The findings demonstrated that the mechanism for the methanol-gasoline was confirmed by the experimental data for the reactor, the mechanism suggested being consistent with experimental data. The researcher studied the characteristics and conversion efficiencies of formaldehyde, acetaldehyde and methanol emissions on a 3-way converter, a SI motor, when fuel and M85 (petrol/methanol1⁄41:85) were running. The findings revealed that emissions of aldehydes have been the highest importance at the crucial point and HCHO is more critical than CH_3CHO.

Engine using methanol/diesel blends as fuel

Alcohol, in particular for methanol, is increasingly taken into account for diesel engines because they are oxygenated and renewable fuels. Methanol can be combined with gasoline in motor; it can be mixed with diesel or other ratios (85% methanol and 15% diesel).

On the basis of the cylinder stress study in a compression allergy engine, the researcher researched the simple combustion activity of the methanol/diesel blends. The findings demonstrate that the increased methanol weight fraction in the methanol/diesel blends resulted in an improvement in heat release in the premixed combustion process and a shortening of the diffuse combustion phase. In a single-cylinder, normal, four-strokes, direct injection (DI) diesel engine with diesel-methanol blends, the researcher examined the impact of the injector timing on the expulsion emission. The findings show that emissions from methanol combined diesel fuel decreased by 5–22% by a factor of 33–52% and 26–50% by a factor of smoke opacity, CO and UHC, while emissions of 14–68% and 22–66% by CO2 and NOx increased respectively, depending on the working conditions of the vehicle. Researcher analyzed the emission of carbonyl compounds produced from the diesel engine in the effects of methanol-containing additives (MCA). The findings indicate that the emission factors of carbonyl compounds (CBCs) acrolein and valeraldehyde have risen by a minimum of 91% where either 10% or 15% MCA are used.

Engine using methanol/hydrogen blends as fuel

The efficiency of SI methanol drives is effectively improved by using hydrogen. In generator, for instance, methanol fuel may be mixed with hydrogen (85% methanol and 15% hydrogen) or other percentages. Table 3 illustrates the methanol and hydrogen physical and chemical characteristics. Since hydrogen has high thermal and mass diffusivity, hydrogen enrichment will enhance the creation of fuel and air mixtures in the motor intake collectors. The enhancement of hydrogen will also contribute to turbulent combustion in conventional fuel-powered engines because of the highly flammable speed and wide flammable hydrogen limits. Investigator suggested to use computational fluid dynamics (CFD) simulation to develop a laminar flame speed association of hydrogen-methanol blends. The findings showed that the current correlation proposed was optimal for motor simulation according to the experimental results. Researchers examine the effects of adding hydrogen in component loading and leaning conditions on enhancing methanol engine efficiency. The test results showed that the variance in the motor combustion cycle is simple, BTE is improved, HC and CO emissions have generally been reduced following hydrogen mixing.

Engine using methanol/ethanol/gasoline blends as fuel

In IC engine Methanol fuel can be mixed with diesel / petrol and mixed with ethanol/petrol. SI engines are a promising way to transport and safe domestic energy supply using liquid alcohols, such as methanol and ethanol. The established fuel and storage infrastructure compliant with Methanol and ethanol and is easy to store in a car. They can only be applied in IC engines with small changes which have the ability to improve performance and reduce harmful pollution in comparison with petrol engines. Researchers investigated, by ethanol and methanol-mixed petrol, the impact of second injection on the fuel combustion and emission characteristics of an HCCI direct injection engine. The findings demonstrated that higher combustion qualities, lower NOx, UHC and CO emissions and IMEP values were gained by utilizing optimum second fuel injection times for fuel blends of methanol–ethanol–gasoline compared with low-equivalency cases of gasoline. Researchers investigated the impact on the efficiency, emission and combustion characteristics of gasoline engines of different alcoholic (methanol and ethanol) fuels. The findings indicated a higher engine torques, BSFC, thermal performance and combustion efficiency when using alcohol fuels. Furthermore, the gas cylinder pressure and heat release rate were earlier in existence; CO2 emissions increased while emissions of HC, CO and NOx decreased.

Engine using methanol/ethanol/diesel blends as fuel

In order to reduce NOx and particulate emissions alcohols have been studied, particularly methanol and ethanol, in combination with diesel fuel. Ethanol's solubility in diesel fuel is influenced by the fuel's water content and temperature. Because of several factors such as the low can count, the high vaporizing heat latent and the high ignition temperature, Methanol fuel is of low self-ignition. The gasoline of Methanol may be mixed with vehicle ethanol/diesel and mixed with ethanol/diesel. In a naturally aspirated, direct diesel injection vehicle, researchers researched the impact of combinations of alternative fuels and diesel fuels on efficiency and emissions. The experimental findings revealed that ethanol and methanol mixtures resulted in lower braking strength, although the fuel consumption and CO emission were lower.

CONCLUSION

This paper extensively examines the usage of methanol fuel as a substitute in internal fuel combustion engines. In addition, the present paper describes the applications approaches for the internal combustion engine, such as methanol/gasoline, methanol/diesel mixes. Results have shown that coal, gas, coke-oven gas, hydrogen and biomass, etc. will contain methanol. The methanol processing capability will satisfy the demand in full. The production and implementation of methanol to substitute the existing fossil fuels will reduce the expense of conventional emissions restrictions and their economic needs. The methanol is capable of reducing automotive pollution compared with fossil fuels, thereby enhancing the atmosphere and reducing legislative burden on development and energy demand.

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