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Future Fuels "To Reduce the Dependency of Fossil Fuels"

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Abstract: ***From the last few years all over the world to reduce the dependency on the conventional fuels (which is limited to use), every automobiles company jointly working with fuel industry and trying our best by considering with each aspects which is most importantly environment friendly, cost effective, improve the mileage of vehicles to reduce running cost etc. Alternate fuels also called as the non-conventional fuels. Natural Gas (NG), LNG (Liquefied natural Gas), Electricity, Hydrogen fuel, fuel mixtures containing not less than 85% ethanol or methanol fuel like are some are the most usable Alternate fuels for automotive application.***

Natural gas, when it is pressurized at higher pressure, it is called compressed natural gas (CNG), when natural gas is condensed into a liquid form at close to atmospheric pressure by cooling it to approximately −162 °C then it is called the liquefied Natural Gas. (LNG), electricity is also the one power source to derive the automotive vehicles which is called the electric vehicle. Hydrogen gas is also one more power source for the automotive application. Mixture fuel/blending fuel which is mix with Gasoline/Diesel fuels with less than 85% of ethanol or methanol is called the blending fuels. When matter comes related to powertrains it cannot complete without the discussion of ICE (Internal Combustion Engine). ICE is most suitable for gasoline (Diesel/Petrol. Since CNG has low fuel density as compared to conventional (Diesel/Petrol) fuel, so more space required for the storage of CNG fuel on vehicle. Space constraints are bigger challenges for passenger as well as commercial vehicles for the accommodation of CNG cylinders on the vehicles. It is also highly impact dead weight in case of passenger vehicle and lowering the pay load in case of commercial vehicle, which is again add-on highly effect of customer profitability. Although using of non-conventional fuels or non-renewable having the advantages WRT conventional fuel but these fuel also having different challenges & safety related issues. Blending fuels ethanol with Petrol & Diesel, BEV (Battery Electric Vehicle), Hybrid vehicle

Keywords: Alternate fuels, CNG (Compressed Natural Gas), LNG (Liquefied Natural gas), NGV (Natural Gas Vehicles)

I. INTRODUCTION

Objective is very clear for the use of alternate fuels, since conventional fuels are in fix quantity, so to reduce the dependency on conventional fuel automotive industry are finding out or progressing with new alternate/unconventional fuel which can fulfill the fuel requirement for the futures. CNG, LNG, Electricity, Blend fuel are some are most usable alternate fuel which are using as an alternate fuel for automobiles. CNG & LNG fuels are oldest alternate fuel which are using from decades while electricity are used in the initiation of automotive vehicle in older era, but due to lower cost of convention fuels (Diesel & Gasoline) after some time electric vehicle are vanished from the market till 1930.

Now due to high cost of Gasoline/Diesel fuels, automotive industry are slowly-2 progressing with the blending of fuel which reduce the vehicle running cost as well as reduce carbon foot print for the industry. Blending fuels combined with ethanol or methanol.

II. DIFFERENT TYPES OF ALTERNATIVE FUELS

As par current scenario following are the different-different alternative fuel which are using for automobiles.

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A. CNG

Compressed Natural vehicle (CNG) powered vehicle having the numbers of cylinders for the storage of CNG fuel. These CNG Cylinders mounted either Chassis mounted or on the Roof top as per vehicle applicability. CNG cylinders are categorized four types as per their construction.

II.I.I Type-1

All metals (without wrap), this type of CNG cylinders are low in cost but having more weight as compared to other types cylinders.



Figure 1. Type-1 CNG Cylinder (All Metal)

II.I.II Type-2

This type of CNG cylinder made of metals liner & reinforced composite (glass or carbon fiber) wrap only for hoop portion of the cylinders. It is more in cost while less in weight as compared type-1 cylinders.



Figure 2. Type-2 (Metal body + Reinforced hoop wrap only)

II.I.III Type-3

This type of CNG cylinder also made of metals liner & reinforced composite (glass or carbon fiber) which wrap all around the entire tank. It is more in cost while less in weight as compared type-2 cylinders.



Figure 3. Type-3 (Metal body + Reinforced entire wrap)

II.I.IVType-4

This type of CNG cylinder made of plastic gas tight liner & reinforced composite material (glass or carbon fiber) which wrap all around the entire tank. It is most expensive in cost while lightest in weight as compared all CNG cylinders.



Figure 4. Type-4 (Plastic liner + Reinforced entire wrap)

B. CNG Fuel System

CNG fuels store at a high pressure as per vehicle requirement on chassis or roof top as per vehicle applicability. Through filtration & HPR (High Pressure regulator) its pressure reduce from 250 bar to 5~8 bar as per engine compatible for its ignition & power generation to run the vehicle.

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C. CNG System Schematic Layout

As per below CNG fuel system schematic, through Receptacle CNG fuel filled up in CNG cylinders, during the CNG fuel filling CNG fuel pressure also monitored through pressure gauge in real time. After Fuel filling receptacle closed by its cap. When engine take place for its ignition battery connection completed & Solenoid valve activated to transfer the CNG fuel through IFU (Integrated Filling Unit) to filter for the fuel filtration. After filtration of CNG fuel, it reached to HPR (High Pressure Regulator).

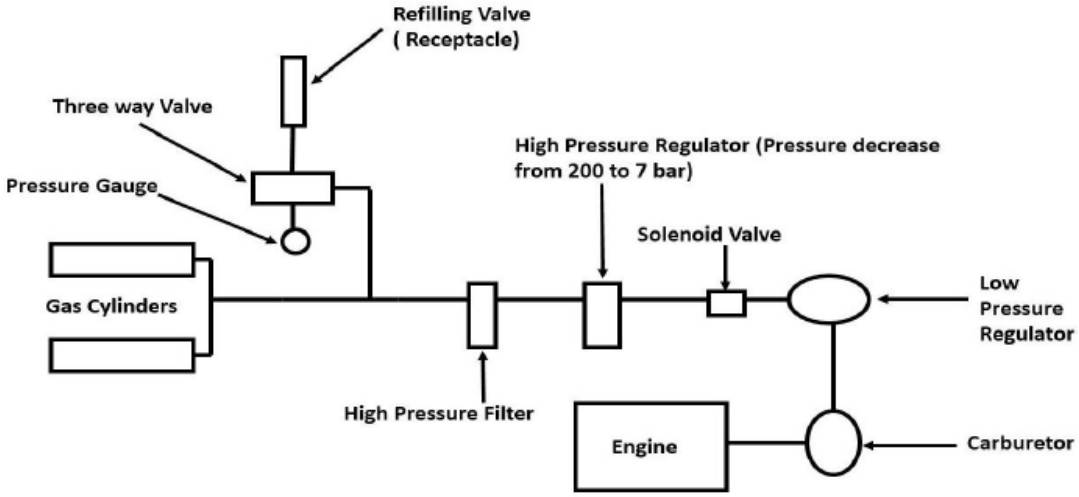


Figure 5. CNG Fuel System Schematic

High Pressure regulator regulate the pressure from 200 bar to 5~7 bar, after low pressure it is transfer through LP hose to engine where CNG fuel burn and generate the power to run the vehicle.

III. LNG

Liquefied natural gas (LNG) is natural gas that has been cooled to a liquid state, at about -260° Fahrenheit, for shipping and storage. The volume of natural gas in its liquid state is about 600 times smaller than its volume in its gaseous state. This process makes it possible to transport natural gas to places pipelines do not reach.

Liquefying natural gas is a way to move natural gas long distances when pipeline transport is not feasible. Markets that are too far away from producing regions to be connected directly to pipelines have access to natural gas because of LNG. In its compact liquid form, natural gas can be shipped in special tankers to terminals around the world. At these terminals, the LNG is returned to its gaseous state and transported by pipeline to distribution companies, industrial consumers, and power plants.

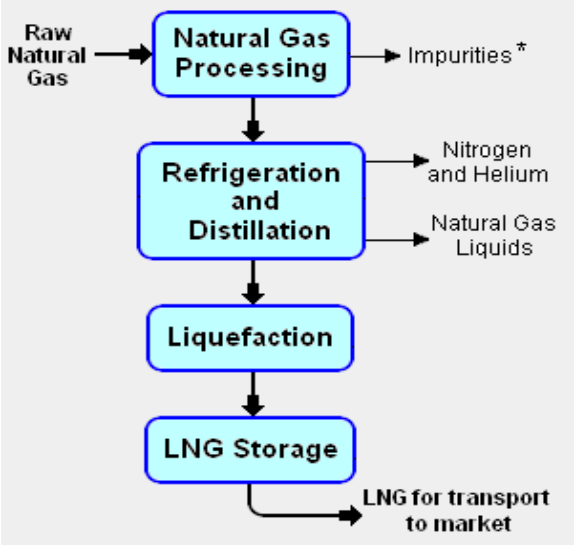


Figure 6. Natural Gas to LNG process

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A. LNG Cylinder

The LNG Cylinder is a vacuum insulated storage tank with unique vacuum insulation technology and excellent insulation performance.



Figure 7. Cryogenic LNG Cylinder

They are used for the storage and transport of cryogenic liquefied LNG, natural gas or nitrous oxide, as well as other liquids that can be used for the road transport of cryogenic liquids, mainly for LNG filling and storage of cryogenic liquids, but also for the on-site storage and supply of LNG. All models are highly standardized and the dimensions are unified, which is convenient for customers to choose and transport.

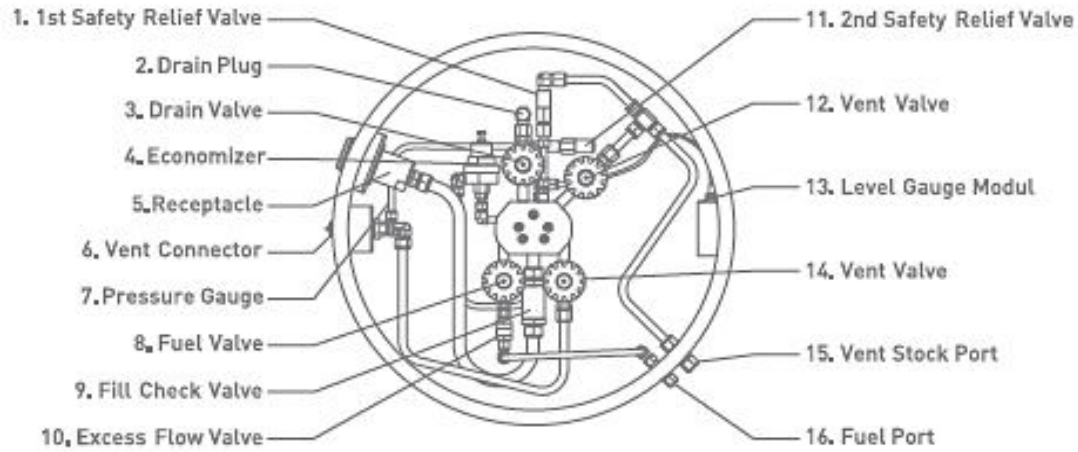


Figure 8. LNG Fuel Cylinder (Neck Side)

B. LNG Fuel System Schematic Layout

As per below LNG fuel system schematic, through Receptacle LNG fuel filled up in LNG Tank. LNG fuel filling is complex as compared to CNG fuel filling in cylinders. After fuel filling in LNG tank, firstly LNG transfer to heat exchanger, to convert the liquid form of LNG to Gaseous form like CNG.

Continuously heated coolant circulated from engine to heat exchanger, in heat exchanger, heat transfer from heated coolant to liquefied natural gas, due to heat liquefied natural gas convert in gaseous form in heat exchanger & pressure built. After heat transfer of coolant in heat exchanger, coolant again circulated to engine & this process continuously taken place for converting the LNG (In liquefied state to gaseous state).

Now this gaseous fuel transfer to filter, after filtration as per engine requirement pressure need to reduce for the proper fuel ignition so the pressure decrease as per engine requirement from 25-50 bar to 5-7 bar.

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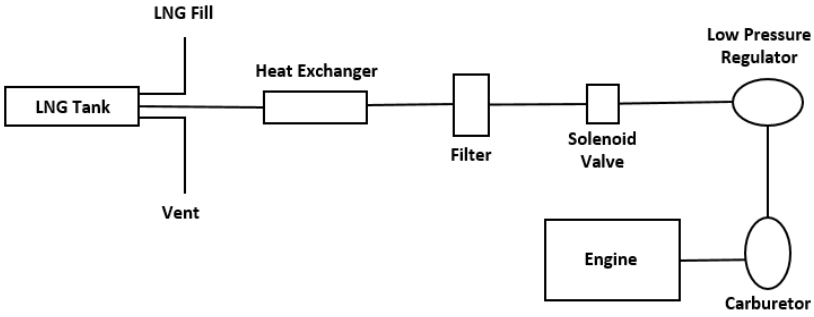


Figure 9. LNG Fuel System Schematic

IV. BLENDED FUELS

Blending fuels is the simply blending/combine of two or more fuels with specific quantity to achieve a desired blend fuel which is more cost effective and reduce carbon foot print for our next generations. Blended fuels, like ethanol-gasoline mixes, offer improved combustion, enhance engine efficiency, and reduce emissions compared to their unblended counterparts. The composition of fuel plays a critical role in determining performance and overall operational costs. Blending aims to improve fuel properties, such as octane rating or cetane number, while addressing environmental concerns and promoting sustainability.
There are two methods for blending the fuels, first is Ratio method & second one Sequential method.

A. Ratio Blending

It is also called the inline blending, so in this type of blending fuels are continuously injected in to pipe line as per their ration, means Ratio blending is the method of combining the fuels in predetermined percentage directly through its flow-stream.
Example: E10 (10% ethanol/90% gasoline), E15 (10.5% to 15% ethanol blended with gasoline), B5 (5% biodiesel/95% diesel), and B2 (2% biodiesel/98% diesel).

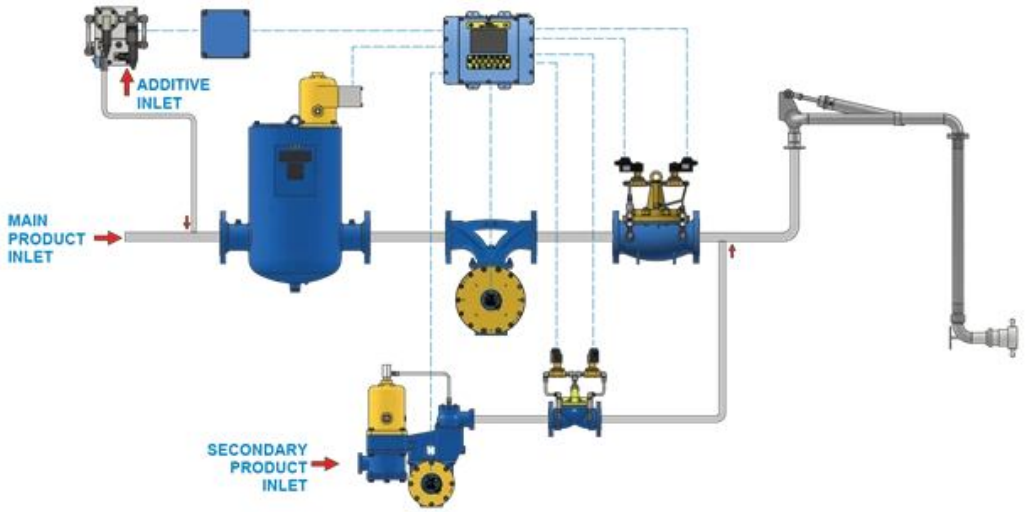


Figure 10. Ratio Fuel Blending Process

1) Sequential blending

It is also called the batch blending, in this type of blending all the chosen fuels mixed at once. So in this type of blending process fuel quantity the method of loading out the fuel in predetermined quantities that make up the percentages.
Example: 900 gallons of gasoline (90%)/100 gallons of ethanol (10%). Sequential blending is usually referred to as “splash” blending. Splash blending is not always an accepted method of blending as it lacks true control and verification.

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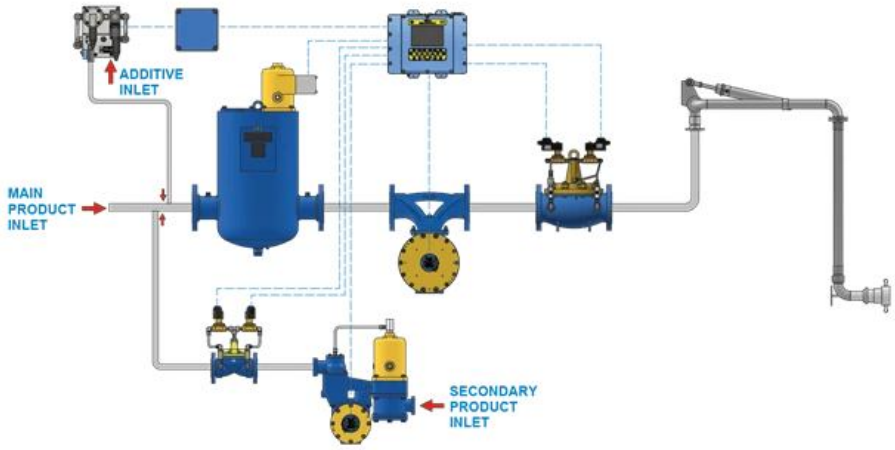


Figure 11. Sequential Fuel Blending Process

2) Fuel Blends

Blending amounts of alternative fuel with conventional fuel is one way to displace petroleum. Examples of low-level fuel blends include E10 (10% ethanol/90% gasoline), E15 (10.5% to 15% ethanol blended with gasoline), B5 (5% biodiesel/95% diesel), and B2 (2% biodiesel/98% diesel). Blends can also consist of two types of alternative fuels, such as hydrogen and compressed natural gas (HCNG), which can be a combination of 20% hydrogen/80% CNG. B20 (20% biodiesel/80% diesel) and E85 (51% to 83% ethanol blended with gasoline depending on geography and season) are not considered low level blends.

So following are the main types are Fuel blend which are used for fuel blending for next-gen.

- Ethanol Blends (E10, E15, E85)
- Biodiesel based (B2, B5, B100)

B. Gasoline/Diesel System Schematic Layout

It is the simplest fuel system for the automotive application. A fuel tank place which store the fuel as per requirement of engine, fuel transfer through its fuel lines with the filtration od fuel it reached in engine where fuel ignite & power generate to propel the vehicle.

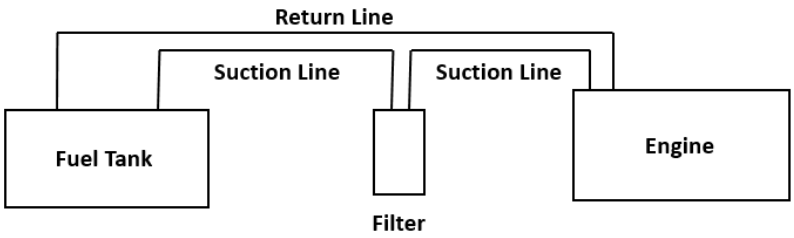


Figure 12. Gasoline/Diesel Fuel system Schematic

V. HYDROGEN FUEL

Hydrogen has the potential to be the sustainable fuel of the future, decrease the global dependence on fossil fuel resources, and lower the pollutant emissions from the transportation/Automotive industry, but it is not found in its pure form in nature. It has to be extracted from compounds such as natural gas, biomass or water, through electrolysis.

Hydrogen (H2) is an alternative fuel that can be produced from diverse domestic resources. Although the market for hydrogen as a transportation fuel is in its infancy, government and industry are working toward clean, economical, and safe hydrogen production and distribution for widespread use in fuel cell electric vehicles (FCEVs).

There are mainly following method to extract the Hydrogen (H2).

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A. Grey Hydrogen

In this method H2 is extracted from the Hydrocarbons (Fissile fuels, Natural Gas) & CO2 emitted in atmosphere. Over 99% of the current pure hydrogen produced worldwide every year is grey hydrogen.

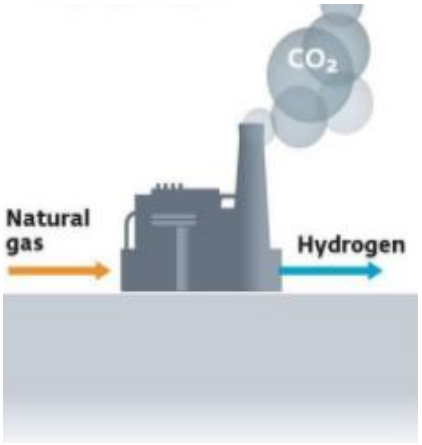


Figure 13. Grey Hydrogen

B. Blue Hydrogen

In this method H2 is extracted from the Hydrocarbons mainly from Natural Gas & CO2 store or re-used for further application.

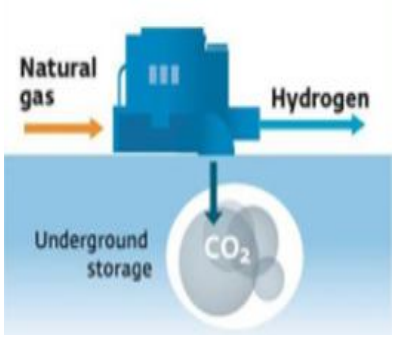


Figure 13. Blue Hydrogen

C. Green Hydrogen:

Green hydrogen is created by subjecting the water molecule to electrolysis, wherein a stream of electricity splits the molecules into a stream of pure oxygen and a stream of pure hydrogen. In this process no CO2 emitted.

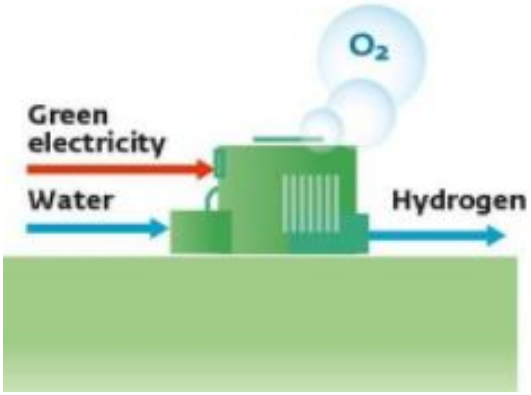


Figure 14. Green Hydrogen

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D. Fuel System Schematic Layout

There are two options to use the hydrogen fuel, first one is gas form & second one is liquid form, further gas form divided in two form one at 350 bar pressure & second one at 700 bar pressure for the application. Since Hydrogen having low fuel density so larger amount of storage space required as compared to CNG. CNG is about to 0.16~0.18 while H2 is 0.025, which is very less WRT to CNG.

The schematic is same like CNG fuel system.

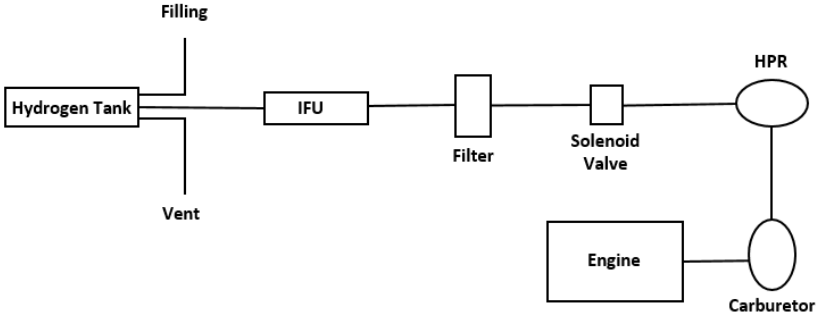


Figure 14. H2 Fuel system Schematic

VI. COMPARISON OF FUEL SYSTEM

Following is the fuel comparisons of Diesel, CNG, LNG, Liquid Hydrogen (LH2) & gaseous Hydrogen (@300 bar & 700 bar).

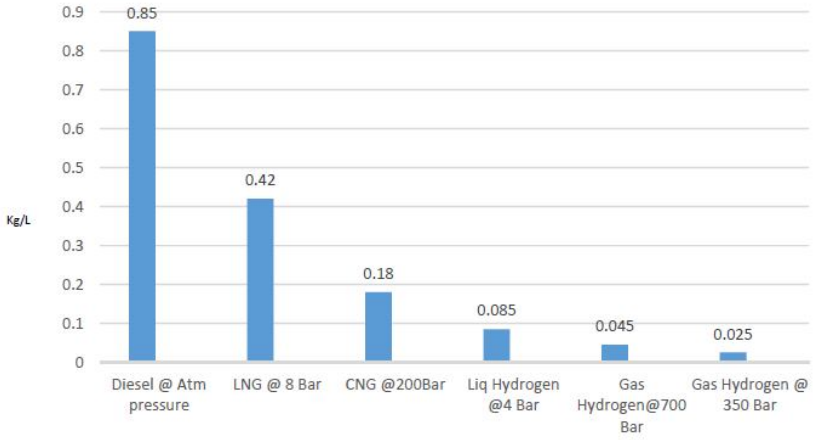


Figure 15. Density (kg/L) Comparison of Fuels

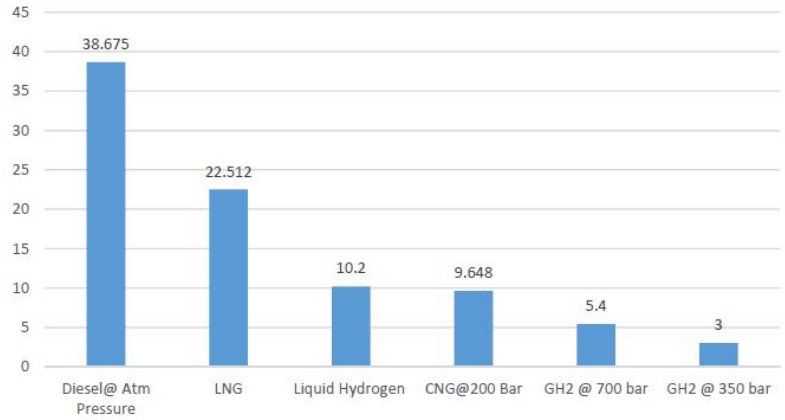


Figure 15. Energy (MJ/L) Density Comparison

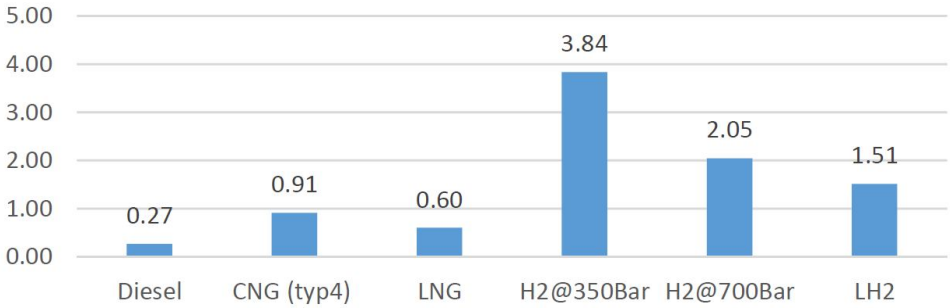


Figure 15. Fuel System weight (kg/km) Comparison

VII. DEFINITIONS/ABBREVIATIONS

1) CNG: Compressed Natural Gas
2) NGV: Natural gas vehicle
3) LNG: Liquefied Natural Gas

VIII. CONCLUSION

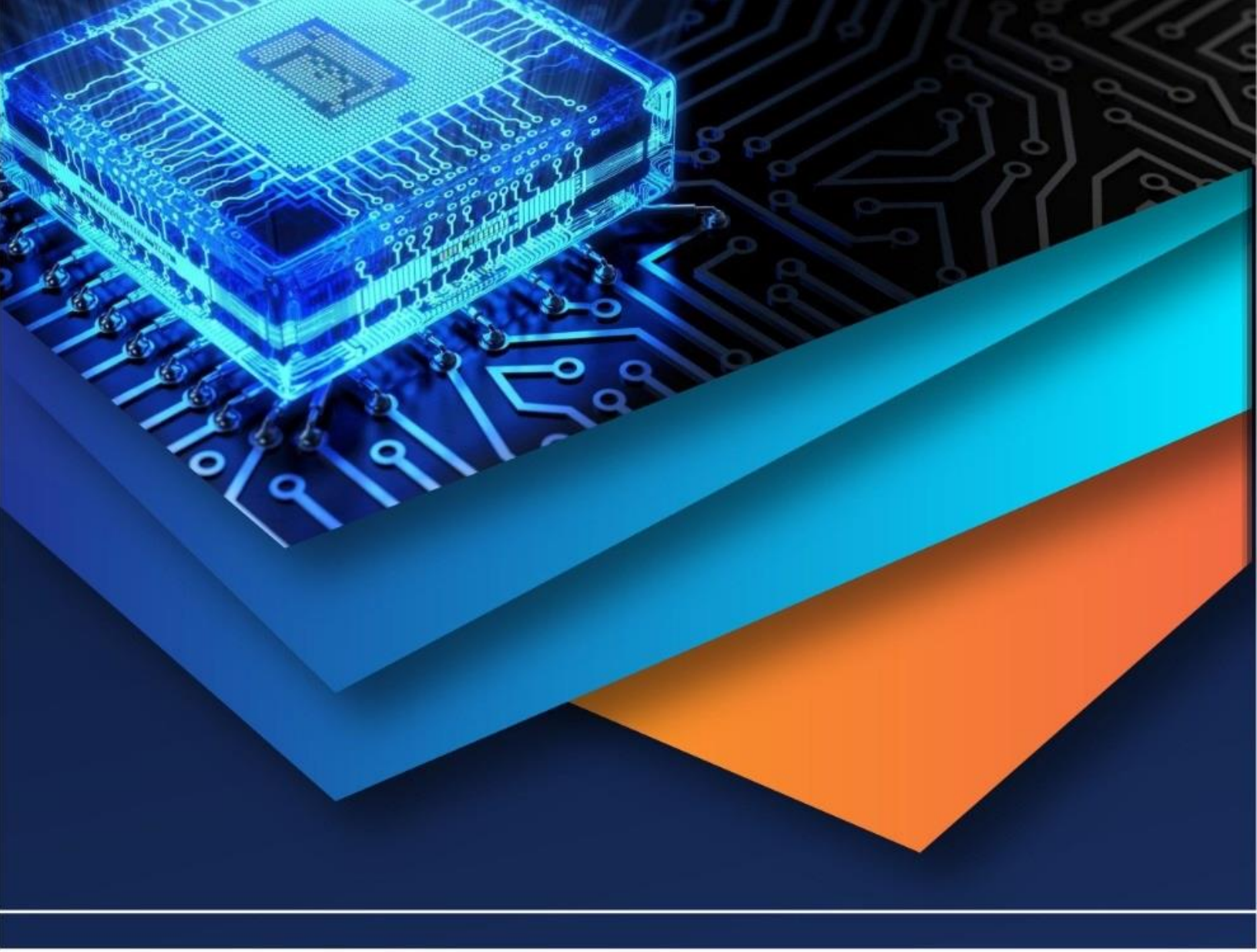
We have seen in depth different types of fuel for the automotive application, dependency only on the fossil fuels will not be more than sufficient in upcoming days, also it is not cost effective & most importunately environment friendly, so alternate fuel is the only solution for next generation. We need to shift on the alternate fuel to fulfill the future requirements.

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