# Investigating the effect of use of hydrogen gas in diesel engine

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**Abstract**

The performance of the conventional diesel engine depends on the different process parameters. For further enhancement of the performance of the engine the researchers are putting log of efforts. Different other fluids or gases were added with the conventional fuel to increase the performance; hydrogen addition is conventional diesel have attracted the most attention. Researcher added the hydrogen and analysed the different performance parameters of the engine. This paper review the effect of use of hydrogen gas in conventional diesel engine.

## 1. Introduction

Energy is a primary source for monetary development and social growth. The role of energy has got a direct impact on the growth of industries which contributes for the enlargement of country's economy. In many countries, the diesel engines are broadly used as prime movers in the field of power generation, agriculture and transportation. The rapid diminution of petroleum fuels and their ever snowballing costs had directed to a concentrated pursuit for alternative fuels. Also there had a prerequisite to diminish the ingesting of diesel fuel in the developed and in the developing countries. The sufficient amounts of energy resources are available which is essential to meet out our basic needs and thereby assuring a sustainable development. The economic forecasting in the near future shall significantly depend on the long standing accessibility of energy in growing quantities from sources that are reliable, harmless and eco-friendly (Banapurmath et al. (2008) and Deepak Agarwal et al. (2006)).

The strong desire and demand for energy sources is growing significantly. The proposed need for energy resources would be increased by 36% in 2035. The fast emergent demand for fuel will be increased, since there will be a increase in the population, the inhabitants is expected to raise by 25% in the next 20 years, in the developing countries like India and China. Hence there is a crucial need to upsurge the energy demand from economic output in mandate to advance the standard of living which will probably assign pressure on energy supplies. For example, in India alone, the need for an energy source is expected, to increase by 75 percent in 2035 (Edwin Corporan et al. (2004)).

## 2. Energy demand

Global fossil fuel consumption stands next to population from the year 1900 to 2050.Consumption of energy is increasing worldwide in various procedures for a variety of purposes. The aggregate of consumption is directly proportional to a society's growth. Today developing countries are prospering through economic reforms and are becoming technologically advanced. Recently, oil prices fell sharply, with the prices of other fuels moving in tandem in many section of the world. Developing countries like India and Indonesia have taken advantage of falling oil prices to move ahead with the suspension of fossil fuel subsidies. Fuel is vital to the strategic plan for profitable growth and national security. In developing countries such as India, fuel has indirect economic costs in the form of budget deficits caused by oil imports and severe environmental conditions caused by pollution. The importation of these items is around 18,000 kroner and the diesel consumption rate is more than 15% per year (36).Once it emanates to the world, energy consumption has augmented melodramatically over the last era. People still rely largely on fossil fuels to power their vehicles, despite the environmental problems caused by burning oil, coal and natural gas. Much research is being done in countries like India to find the right source of fuel, such as sunlight and wind, as a great alternative to large quantities and is reaching a mass production in the coming days. Always look around the corner still forever.

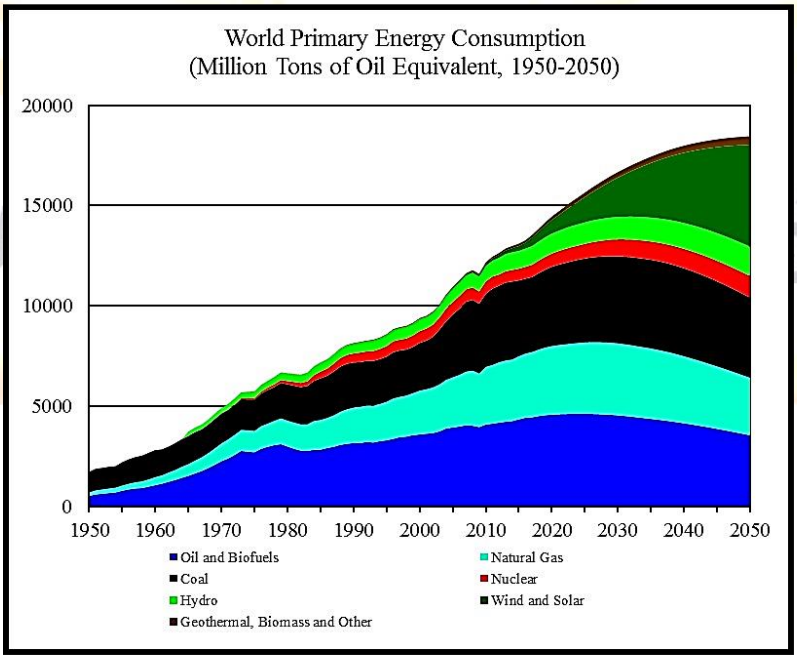


Fig. 1.2 World Energy 1990-2050: Annual Report » Peak Oil Barrel

It is estimated that by 2020, the world may be consuming the energy 15 times higher when compared to the usages of energy in 1980. Possibly as abundant as numerous conservationists, the oil companies are willing to find substitutions to fossil fuels, since they comprehend that over the subsequent period they will see their source diminishing. Nowadays, renewable energy sources of the world's supply, fossil fuels afford about 85% technically higher which have restrained the cost of renewable power sources, but expertise has also kept down the price using fossil fuels and some cases reduced their unsafe possessions on the environment. The major oil companies like, IOCL (Indian Oil Corporation Limited) in India are doing their research towards renewable energy sources. The possibility of substituting some alternatives for petrol and diesel has become aware of the automobile industry over the last decade.

Here is a list of fuels that are being used in automobiles.

- Compressed natural gases (CNG)
- Liquefied petroleum gas (LPG)
- Alcohol gasolines such as methanol, ethanol, and other alcohols
- Hydrogen (including fuel cells)
- Coal-derived liquid fuels
- Biodiesel prepared from vegetable oils animal fats
- Biodiesel prepared from animal fats

## 3. Energy crisis

The crisis of fuel and energy sources is due to the excess consumption of it, without proper infrastructure facilities, disruption of choke point, troubles in oil factories and port amenities that controls the supply of fuel. The growing mandate for fuel arises extraordinarily during the cold season due to higher utilization of energy (Gillet al. (2012) and Hanumantha Rao et al. (2012)). A minor interruption in energy provisions is caused due to pipeline catastrophes and additional accidents. A crisis of energy sources might arise due to vital weather changes which results in infrastructure damage (Karthick et al. (2014) and Lenin et al. (2013)).

## 4. Energy in developing countries (India)

In India, freight and passenger transportation bags a big deal in energy consumption in the transport sector. However, road transport is the most recurrently used means of transport, followed by rail and then air. Lastly, a very small quantity of energy is used for water ways

transport. Diesel and motor gasoline epitomise 90% of the final energy disbursed in the transport sector, while jet kerosene epitomise 8% and electricity 2%.

India is prosperous in coal production and richly gifted with renewable solar energy, wind energy, hydro energy and bio energy, its hydrocarbon reserve is 0.8 billion tones (at the end 2015) which are really very small (0.5 percent of world's reserve). India is counted for 10.88 % of entire principal utilization of energy in region of Asia-Pacific and 3.83 % of world major energy utilization in 2008. The energy utilization per capita remains little as 510.0 KGOE (Kilogram of oil equivalent) differentiated with an average of energy consumption of 1820.0 KGOE in 2006. Indian economy is influencing the world and has to extensively use energy to sustain its growth.

## 5. Existing research work

1. **Saravan*et.al* (2019)** This study had demonstrated the enactment and emission physiognomies of a variable compression ratio diesel engine (VCRDE) employing the dual biodiesel. The dual biodiesel employed was a assortment of Rapeseed (RA) and Mahua biodiesel (MU) in equivalent ratio by volume. The investigation had accompanied underneath altered load circumstances with constant engine speed of 1500 rpm. The biodiesels adopted here were organised by trans esterification process and fashioned one new biodiesel (RM) with mingling of Rapeseed biodiesel and Mahua biodiesel by equal ratio (1:1). The performance assessment was done for 100% RA, 100% MU and different RM blends such as BL20, BL40, BL60 and BL80, along with diesel.
2. **Devarajan*et.al* (2018)** This work had investigated the experimental study for examined the operational physiognomies of a neat neem oil methyl ester (BD100) along with silver oxide nano-particles with a metal-based additive in several ratio fractions. Silver oxide nano-particle was mixed into 100% of BD100 at 5 and 10 ppm. The experimental examination on diesel engine had showed that the addition of silver oxide nano-particles to BD100 resulted in enhancement of brake thermal efficiency (BTE) with a reduction in brake specific fuel consumption (BSFC). The tested emission parameters such as CO, HC, NOx, and smoke were lowered by 12.22, 10.89, 4.24, and 6.61% for BD100+ $Ag_2O$ (5 ppm**)** and 16.47, 14.21, 6.66, and 8.34% for BD100 respectively when associated to BD100.
3. **Tuccar*et.al* (2017)** In this study, they had concluded the accessibility of pomegranate seed oil biodiesel (POB) employing as an substitute fuel in diesel engines then appraise engine

enactment and emission physiognomies of pure hydrogen enriched POB by means of diesel engine. For this persistence, the intake manifold of the tested engine was adapted and hydrogen enriched intake air was abounding throughout the experimentations. Physical properties of POB and its blend with diesel fuel were also strong minded. It had been unstated that high viscosity and density values of POB fuel can be remunerated by mingling it with diesel fuel. The drawback instigated by low cetane number value of POB, can be abolished by diesel addition.

4. **Verma et al. (2016)** investigated that process of bio diesel production mainly depends on five process parameters such as free fatty acid content, molar ratio of alcohol to oil, concentration and type of catalyst, reaction temperature and reaction time. In general, methanol and ethanol are frequently recycled alcohol for bio diesel production in presence
5. **Subramonia et al. (2016)** investigated about the concert of DI compression ignition engine with blends of 5-carbon alcohol, rubber seed biodiesel and diesel at numerous compression ratio (CR) viz.16: 1, 17.5: 1, 19: 1. It proves that CR 17.5 is the best compression ratio for all the blends. The upshot illustrations that the emission is abridged except for NOx when associated with the diesel fuel. Lastly determined that emission was abridged in R10P10 blend at CR 17.5 and it is an eco-friendly alternative fuel.
6. **Selvam et al. (2015)** examined that the combustion of Vegetable oils was completely recycled as a carbon dioxide (CO2) as the oil is extracted from plants. Table 2.2 lists out the numerous types of vegetable oils with their properties. It specified that the viscosity of vegetable oils is somewhere around 11 – 17 times more than that of diesel. The heating values of vegetable oil was around 37 – 40 MJ / kg whereas, it is 42.8 MJ / kg for diesel. Vegetable oil has very high flash point more than 200 °C, and found to be an alternative fuel in conventional diesel engine. Usages of vegetable oil is not advisable during winter owing to its higher pour and cloud point compared to diesel. In addition, vegetable oils reduce the ignition delay because of its high cetane number. Furthermore, long time storage is not suggested for these fuels owing to their high iodine value thereby increasing its oxidation rate.
7. **Sunilkumar et al. (2014)** carried out experiments under various characteristics in twofold biodiesel of Thumba biodiesel on a mono cylinder VCR diesel engine that has bore diameter 87.50mm, imperial power 3.5kw at 1500rpm, firmness ratios 12 to 18, stroke length 110mm,

water cooled engine. Biodiesel unifies B10% (combination of Diesel 90% by quantity, biodiesel 10% by volume) and B20% (mishmash of Diesel 80% by quantity, biodiesel 20% by quantity) gave better BTE and lower BSFC than other biodiesel blends. The blends of B10% and B20% have lower emission than other blends which are similar to diesel. Investigation reports show that unified thumba oil is noticed to be a capable and suitable fuel for firmness and detonation of engines. At CR 18 BTE and BSFC of Thumba B10, B20 and BP of Thumba B40 confirmed better recital.CO, HC, CO2 of B100 of Thumba biodiesel which showed less emission percentage/ppm, for NOx emission B10 and B20 of Thumba, biodiesel presented less emission of ppm.

8. **Karthick et al. (2014)** Analyse combustion and exhaust emissions with castor nuts and ethylene blends in a fully engineered diesel engine with a properly engineered cylinder. Parameters were measured for two different compression ratios. The compression ratio was reduced from 17.5 to 16.8: 1, increasing the plate size of the piston. The purpose of the reduced compression ratio is to reduce the cylinder temperature. Various mixtures such as J20, J17 + DEE3%, J16 + DEE4%, J15 + DEE 5% were used for the machine experiments. The experimental results show that the BTE of the higher and higher load at higher load was 30.31% for the J17 + DEE 3%, which was 7.3% higher than diesel. NOx emissions decrease as the compression ratio decreases, but combustion consumption increases the NO volume by 10% due to the high amount of ketone.
9. **Sangeeta et al. (2013)** stated that usage of straight vegetable oil (SVO) directly into diesel engine as fuel creates various problems. The main problems is due to higher viscosity of SVOs compared to diesel oil. Owing to higher viscosity, incomplete combustion, poor fuel atomization and deposits in the combustion chamber occur. To utilize vegetable oils as diesel fuel substitute's potential methods like heating, dilution, blending, emulsification and transesterification may be employed.
10. **Mishra et al. (2013)** used simaroubaglauca oil to produce bio diesel by transesterification with methanol in the presence of KOH as a catalyst. To produce simarouba oil methyl ester, optimization of reaction parameters such as catalyst concentration, alcohol to oil molar ration, temperature and rate of mixing were done. Under optimal conditions 94-955 of methyl esters from simarouba oil is yielded. Comparison with ASTM and DIN EN 13214 was made for essential fuel properties of methyl esters of simarouba oil (biodiesel). At 400C,

4.68 cst viscosity and 1650C flash point were found. The obtained results denote tranesterified oil properties were very close to diesel properties.

11. **Lohan et al. (2013)** produced bio diesel from in-edible oils like Jatropha, Neem, Karanja, Mahua, Simarouba oil. Their work had presented the current status, deliberates the future projection and scrutinizes the critical constraints and impediments in India to the path of development of Indian bio diesel program. Their work also offers recommendations and alternative policy possibilities so as to permit the sequencer to accomplish its intentions. The belongings of bio diesel on engine enactment i.e. brake power, brake thermal efficiency, specific fuel consumption and substantial decrease in particulate matter (PM), hydrocarbons (HC), carbon monoxide (CO) and oxide of nitrogen (NOx) were also swotted.
12. **Atabani et al. (2013)** studied on non-edible oil resources for biodiesel production, their advantages, oil extraction techniques and properties. Biodiesel from non-edible would play a role in using the waste land areas. The physical and chemical properties of biodiesel produced from non-edible feed stock such as jatropha, Pongamia and Madhuca are within the limits of ASDM and DIN EN specifications.
13. **Jawalkar et al (2012)** investigated that the biodiesel derived from nonedible feed stocks such as Mahua, Jatropha, Pongamia, Linseed are reported to be feasible implementations for developing countries comprising India. The consequences of exploration of enactment and emissions physiognomies of diesel engine employing Mahua and Linseed biodiesel. In this investigation, the blends of varying proportions of Mahua biodiesel with diesel such as M25, M50, M75, M100 and Linseed biodiesel with diesel such as L25, L50, L75, L100 were prepared, analyzed, and associated the enactment and exhaust emission with diesel using a single cylinder diesel engine. The brake thermal efficiency, brake-specific fuel
14. **Bhupendra et al (2012)** Conducted a study comparing the performance characteristics and biodiesel emissions obtained from castor oil in dual-fuel diesel engines with basic diesel output. The estimated parameters of efficiency and emission are: BTE, BSFC, power output, CO, CO2, HC, NOx and smoke opacity. Jatropha methyl ester BTE and its diesel were lower than diesel, and BSFC was originate to be higher. However, HCS and smoke were found to be lower in biodiesel than in pumpkin oil. NOx emissions in bio digester and their mixtures are higher than diesel emissions.

15. **Durairaj et al. (2012)** researched with crude Jatropha Curcas oil to produce bio diesel in two steps. Free fatty acid content of Jatropha Curcus was converted into bio diesel by acid transesterification in the first step. By maintaining 9:1 molar ratio of methanol to oil, 1% w/w of oil of H2SO4 and 60°C temperature for one hour of reaction time reduces free fatty acid to 1.12%. The mixture was tolerable to settle atleast for 2 hours after the completion of reaction, and the top layer of methanol-water mixture was unconcerned. Alkali catalyzed transesterification is employed as second step using 5.41:1 molar ratio of methanol to oil and 0.55% w/w ratio of catalyst to oil for producing bio diesel from the product of the first step at 60°C. The maximum yield of 93% w/w of Jatropha Curcus bio diesel was produced which was more than the bio diesel yield (80.5%).
16. **Rahman et al. (2011)** experimented with Jatropha oil for the production of bio diesel. Jatropha curcas grows to be a wild hardy plant, a renewable non-edible plant found in arid and semi-arid regions on degraded soils having low moisture and fertility. 50 – 60% of oil is found naturally in the seeds of Jatropha. Transesterification process is employed in this study to convert oil in bio diesel for performance evaluation in diesel engine.

## 6. Conclusion

For meeting the demand of current scenario and to reduce the pollution level in environment, bio-fuels was introducing. Research work is also going on toward the increasing the performance of conventional compressive ignition engines. Different types of blends are used to increase the performance of engine or to reduce the amount of harmful gases that are produce during the combustion of conventional diesel. Enriching conventional diesel with different natural gases is the other means of improving the enactment of the conventional diesel engine performance. Addition of hydrogen in to conventional diesel is also one of the means of increasing the performance of conventional engines. For the same, current work is carried out to analysed the effect of addition of hydrogen in conventional diesel.

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