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ALTERNATIVE FUELS FOR AUTOMOBILES

Shyam Patidar

Assistant Professor, Department of Mechanical Engineering (SVITS), Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore (M.P.), India

ABSTRACT

India is large automobile market and its energy demand is increasing year by year. Most of energy demand of transportation sector in India is fulfilled by crude oil. But continuously increasing demand of crude oil is an issue for Indian economy because of its import dependency and higher crude oil price. Due to large number of automobiles and its continuously increasing demand impact on Indian economy. Automobile emission by use of conventional fuels (petrol & diesel) is another concern. As reduction of green house gases & other emissions from automobiles and reduce import dependency, maximum use of alternative fuel in automobiles is a better option. There are several alternative fuels available for their use for automobiles such as methanol, ethanol, Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), Liquid Petroleum Gas (LPG), hydrogen, bio-fuels, electricity (battery), fuel cells etc. The alternative fuels not only reduce automotive emissions but also reduce import dependency thus it protects energy security as well as. This paper focuses on recent alternative fuels scenario in India, use and advantages of alternative fuels in automobiles.

KEYWORDS: *Alternative fuels, automobile, biofuel, automotive emission.*

I. INTRODUCTION

Conventional liquid fuels for automobiles are being used for more than 100 years. Commercial and public vehicles mainly based on petroleum (diesel and petrol). Due to inadequate resources of crude oil and its uneven distribution & exploration by oil exploration countries always have impact on fuel cost. There is widespread use of the conventional fuel and dependency on foreign crude oil is an issue for Indian economy. Automotive segment is one of the large & emerging sector in India [1]; thus the demand of vehicles increasing as well as consumption of fuel also increasing. The major emissions that come out from automobiles are; CO₂, NO_x, SO_x, CO, unburned hydrocarbons, particulate matters, smog etc. These emissions come out from diesel and petrol vehicle is an issue for environmental pollution & global warming. Also, price and taxation of these fuels are making them very expensive, especially in India. Thus development and consideration of alternative fuels will not only solve environmental pollution issue but it will reduce dependency and good for Indian economy too. Use of alternative fuel and advanced technology vehicles or hybrid vehicles

reduce the foreign oil dependency and reduce emission of green house gases. Reduction of green house gases is an international challenge to overcome the issue of global warming. Alternative fuels not only have high heating values but also lowered the emissions as comparative to petroleum fuels.

II. PRESENT SCENARIO IN INDIA

Indian automotive segment is a growing sector and large market of automobiles in near future. According to annual report of ministry of heavy industries and public enterprises of govt. of India, in quarter Apr-Sept. 2017, total 14.7 million vehicles (commercial, passenger, 3-wheeler & 2-wheelers) produced as compare to 13.4 million vehicles during Apr-Sept. 2016 by Indian automotive industries with a growth rate of 9.81% and reported 10.71% double figure export growth rate [2]. As demand of automobile in India increasing significantly, thus demand of fuel will increase too. According to annual report of ministry of petroleum and natural gas, govt. of India; the consumption of petroleum product in India during the year 2016-17 was 194.60 MMT with a growth of 5.37% as compare to 184.67 MMT during the year 2015-16 and the consumption

of petroleum products for period April-November, 2017 was at 134.60 MMT with a growth of 3.40% compare to 130.17 MMT in April-November, 2016. However the import of crude oil for the year 2016-17 was 213.93 MMT of 470.159 thousands crore rupees against 202.85 MMT of value at 416.579 thousands crore rupees with increase of 5.46% in quantity and 12.86% in money term as against to the import of crude oil during 2015-16. Import of crude oil for the term April-November, 2017 recorded as 144.75 MMT in quantity and total priced at 342.673 thousands crore rupees, which found with increase 9.31% in quantity and 15.32% in price as respect to the import of crude oil of 143.81 MMT valued at 297.161 thousands crore rupees for the duration of April-November, 2016 [3].

III. INDIAN GOVERNMENT INITIATIVES

In India the energy demand in transport sector is the highest across the other major sectors in terms of end usage. As number of vehicles increase, the demand of petroleum products will increase. According to the estimation of ministry of petroleum and natural gas, govt. of India, the demand for diesel and petrol (in the year 2017-18) raised from 80.4 MMT and 26.1 MMT respectively to 110 MMT and 31.1 MMT by the year 2021-22; if the current circumstances prevails. Thus government has taken many steps to fulfil the demand as well as decrease the dependency on foreign oil [3].

Government of India has been promoting and empowering the making and use of an ethanol made from sugar molasses and/or second generation bio-fuels (biomass, horticulture waste, agricultural waste and so on) for blending with petrol and biodiesel which made from non-edible oils, tree borne oil seeds and other oil blending with diesel [3].

India's energy security will remain defenceless until alternative fuels to whenever the import dependency of crude oil will not reduce. Government has taken initiatives to reduce import dependency 10% till the end of year 2022. The goal of the policy is to ensure the availability of bio-fuels in the Indian market thus the decision has taken to increase the amount of blending. At presently the limit is 2 % of ethanol can be blend in petrol and maximum 0.1% of biodiesel in diesel. The government has proposed a target 20% blending of ethanol in petrol and 5% of biodiesel in diesel by the year 2030 [4]. There are many other steps has taken by Indian government such as development of second generation (2G) ethanol technologies and its commercialization, produce fuel from municipal solid waste(MSW), production of other bio-fuel (like bio-CNG, bio-methanol, di-methyl ester, bio-hydrogen etc. Department of heavy industry has formulated a scheme under the national electric mobility mission plan 2020 (NEMMP-2020) named Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME-India). Under the scheme FAME-India, government has providing intended support to concern industries for development of market and

eco-system for hybrid/electric vehicles manufacturing within the specified period (6 years). The global demand of electric vehicle expected to 70 million (4-wheelers) and 76 million (2-wheelers) units by 2020. According to plan NEMMP-2020, India expected to sell of 5 to 7 million units of new electric vehicles by 2020; on which, 3.5 to 5 million pure electric two wheelers, 1.3 to 1.4 million hybrid electric vehicles (4W, buses, LCVs) and other 0.2 to 0.4 million other pure electric vehicles. Through these efforts Indian government is looking to meet their target of automotive emission reduction and reduce import dependency. Further, it is expected to sell only electric vehicle by 2030 under the national electric mobility mission plan [5].

IV. ALTERNATIVE FUELS

Fast depletion of petroleum resources, availability crisis, hike in price, dependency on foreign etc. are issues for India and its economy. To fulfil the need of fuel for automobiles and decrease the dependency on foreign oil, there is need to migrate from conventional fuel to alternative fuel for transportation. In future, world energy demand will increase and to fulfil the same there will be need of energy sources. These energy sources must be renewable, cheap & easily available, sustainable, efficient and safe. To meet the energy demand of automotive sector alternative fuels like; methanol, ethanol, Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), Hydrogen, bio-fuels, fatty acid esters, fuel cells or batteries, hybrid technology etc. can play significance role. The automotive alternative fuels can be classified as follows:

A. Alcohols

Methanol: Methanol is also known as wood alcohol or wood naphtha or methyl alcohol (CH_3OH). It is produce by distillation of wood/coal. In modern days it is produce by directly catalytic industrial process of natural gas or directly from CO , CO_2 , or H_2 . Methanol is less dense, colourless, flammable, volatile and toxic. M-85 and M-100 is used as alternatives fuels in automobiles. M-85 is blend of 85% methanol & 15% gasoline. It has lower energy per unit of fuel thus mileage is less [6, 7]. With very minor change in fuel system, it can be used as fuel in automobiles. It has lower emission than the gasoline.

Ethanol: It is a common alternative fuel produce by the fermentation of biomass like sugar, corn waste, potato waste, grains etc. E-85 is commonly used in automobiles. It is mainly suitable for spark ignition engines because of its high octane number [8]. Its anti-knock properties and high octane number results in maximum engine power output. It is colourless, clear and contain odour. The overall emission from the ethanol is less relative to gasoline but fraction of NO_x increases and increase in non-regulated toxics. The main drawback of ethanol is corrosion effect on metal parts and damage to rubber/sealing.

B. Gaseous Fuels

CNG & LNG: It consist of CH_4 (majorly), C_2H_6 and inert gas. It is derived either from crude oil or gas

well. It is compressed upto pressure of 200-250 bars thus it is known as compressed natural gas. India has around 690 billion cubic meters resources thus it could be better alternative fuel. Because of its high compression ratio and high octane number, it has capability to suitable mixture formation and fast combustion. Thus engine operates smoothly without knocking as well as low emission [9]. These make it better than the petrol. Many automobile companies are providing kit for the conversion now a day. LNG is similar as CNG but the composition of inert gas is less than 0.5% in it. Also, it is stored in the form of liquid. Presently CNG is being used as a prominent alternative fuels in automobiles. It has certain qualities like; cheap, eco-friendly, safe, availability etc. that makes better than the petrol.

LPG: Liquid Petroleum Gas (LPG) is mainly consisting propane around 57.3%, butane percentage near about 41.1% and remaining is other gases. It is a by product of crude oil refineries and natural gas processing. Its higher octane rating and capability to form homogeneous mixture result in lower emission as compare to conventional automobile fuels. Another advantage of LPG is no carbon deposit on spark plug and other parts of engine. It is good alternative fuel but in India develop auto LPG dispensing facility is the challenge and huge demand for domestic cooking use of LPG is another barrier. Safety is another issue with LPG and for the storage reinforced cylinder are to be required as in CNG.

Hydrogen: Hydrogen generally produces by electrolysis and synthesis gas production. In electrolysis water molecules are splits into hydrogen and oxygen by using electricity and in synthesis gas production method it is produced from steam reforming or partial oxidation. The major advantage of hydrogen gas is its great emission reduction characteristics because it only produce water vapour as a by product [10]. Hydrogen is very light fuel. Its main drawback is its storage and distribution. The hydrogen has been used as fuel in some of the vehicle but not as a commercial purpose. Mercedes-Benz and BMW vehicles used liquid hydrogen. Hydrogen may be a good alternative fuel with its great eco-friendly characteristics [11].

C. Bio-fuels

The fuel which is derived from various vegetable oil/animal fats is known as bio-fuel. The oil of various crops such as soybean, peanut, sunflower, rape, coconut, karanja, neem, cotton, mustard, jatropha, linseed, castor etc. are renewable sources, degradable and environment friendly energy source. Bio-fuel is can be used directly and it can be bled with diesel; thus it is known as biodiesel. This fuel is most suitable for compression ignition engines. Blending with diesel increases engine efficiency and its higher flash point make it safe for storage. Emission from biodiesel is almost free from sulphur oxides and other emissions are also less as compare to diesel [12]. The calorific value of fuel is less compare to diesel thus performance of engine reduce.

But this problem can be overcome by blending of diesel. Biodiesel has higher cloud and pour point thus the problem of starting of engine occurs in cold. Due to high viscosity poor atomization lead to incomplete combustion and choking of injectors & carbonization may occur. Biodiesel is non-toxic, biodegradable, sustainable and eco-friendly. Also, it has good lubrication properties [13]. Some of other fuels such as Fatty Acid Methyl Esters (FAME), Hydrotreated Vegetable Oil (HVO), Biomass to Liquid (BTL based on Fischer Tropsch synthesis) and Fermentation based fuels i.e. Farnesene are used for diesel engine applications in automobiles.

D. Electricity and fuel cells

Electricity: Electricity based vehicle direct get power from the battery and run an electric motor for mechanical output. It has zero emission and can be best alternative fuel because there is no combustion like as petrol, diesel or gas etc. Hybrid electric vehicles (HEVs) are another good option for near future, whenever the charging infrastructure for pure electric vehicle is not developed. HEVs have double advantage because it is powered by two energy sources; one is energy conversion unit (energy supplied by fuel cell or any alternative fuel e.g. CNG, LNG) and other is battery. Whenever the battery will low or discharge it can be recharge by generator (powered by energy conversion unit) [14].

Fuel cell: Fuel cell is also a good alternative fuel because it is work on electrochemical energy conversion principle. Fuel cell uses hydrogen and oxygen to generate electricity and their main by product is water. Proton exchange membrane (PEM) is most useful method to generate electricity. Basically it consist three parts namely; an anode, a cathode and an electrolyte which separate anode from cathode. Hydrogen is flow from the anode side and oxygen from cathode side. Electrolyte (membrane) allows protons to pass through it but restrict electrons. These electrons are travel from anode to cathode through the electric circuit which generate electricity. The by product in this process is water [15].

V. CONCLUSION

Diminishing convention fuels resources and increasing world's energy demand is very crucial issues. Now, it is time to use alternative fuels to fulfil the energy demand because of various issues like global warming, depleting conventional source of energy, increasing emissions, increasing energy demand etc. alternative fuels may overcome these issues. Growing automobile sector in India is result in increasing fuel demand. Dependency on foreign oil and price hike of crude oil directly impact Indian economy. As many initiatives are taken to promote and develop technologies towards alternative fuels for automobiles. The maximum use of alternative fuel based automobiles has several advantages for country such as; strengthen the Indian economy, reduce import dependency thus protect energy security, reduce emissions and help in sustainable development.

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