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SUSTAINABLE ECO-FRIENDLY MEANS OF ENERGY FOR AUTOMOBILE- PRESPECTIVE & CHALLANGES

Engineering

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ABSTRACT

Conventional fossil fuels are being widely used in automotive operations throughout the world. However, these fuels are the viable source of many environmental problems. In order to eradicate the ill effects associated with these fuels, it is necessary to shift towards sustainable means of energy for automotive applications. Such sustainable means of energy are Bio-fuels, fuel cells, electric power and solar energy based vehicles. These sustainable modes of vehicular energy are considered to be totally Eco-friendly. This paper is a thorough review of all the modern sustainable modes of energy for automotive applications. It has been also found that these sustainable energy modes most of the time gives better results in terms of improved pollution level, improved running cost and low maintenance as compared to conventional fuels. The main purpose of this review work is to identify the different sustainable modes of energy for automotive applications and encourage the use of such modes of energy by giving certain recommendations, which can help in encouraging the people to use such eco-friendly modes of energy.

INTRODUCTION

With Economic growth throughout the Globe, consumption and distribution of energy has quickly become mankind's highest priority. Transport is the major sector, which consumes large amount of energy and for this main potential source is fossil fuels. These days economy of any nation dependent upon its resources of transportation for human and goods. As a global economy which is largely dependent on oil, the price and origin of oil has a heavy bearing on many countries foreign policy. With Growing economy throughout the globe, the numbers of vehicles which are added on road are also increasing. Day by day the network of roads and motorways are expanding in way to facilitate the system of mobility with which it is possible to move human and goods at faster pace. Majority of these mobility vehicles are using fossil fuels (Jefferson, Tzeng et al.,).There is a finite life to the world's resource of fossil fuels, and already some of it is becoming increasingly difficult to extract as once-prolific deposits (especially oil) become depleted. Use of these fossil fuels in vehicles lead to increase in atmospheric pollution, especially carbon dioxide, oxides of nitrogen and particulate emissions Vehicle emission is contributing lot to environment degradation. Global warming is a reality which was acknowledged by governments at the Rio summit in 1992and at Kyoto in 1997. Further it was accepted that the global climate is changing as a result of anthropogenic activities. Caused by the release of greenhouse gases, climate change (CC) is one of the biggest challenges facing the global community today. In looking at the causes of climate change, transport is one of the key factors amplifying the current situation. Transport emissions are the fastest rising cause of green house gases (GHG's) (Turton, Hickman) . This increase is expected to continue into the foreseeable future, with emissions from transport expected to be higher in 2020than they were in 1990. Out of all the polluting sectors, transport is the only one with predicted emissions due to uniform increase in number of vehicles, which are added throughout the globe every year (Maban, McDowall) .These reasons highlight the seriousness of the issue of transport's contribution to climate change.

In the more recent years the dependability of commuters has increased on the individual vehicles, which has not only increased the shear amount of oil consumed annually but also drastically augmented our dependence upon It in our daily lives. Our oil 'addiction' has lead us to the realization that our usage has its limits, not only does the environment suffer adverse effects because of its use but our society is so dependent upon that if it were suddenly removed, most of modern society would cease to function properly. The first and most important question for us is can this independence be accomplished through the use alternative sources of energy like Biodiesels, Hydrogen Fuel cells, solar Vehicles, electric vehicles, hybrid cars etc. In this paper the alternative sources of energy for vehicle propulsion, which are eco-friendly are reviewed for their suitability and in the last recommendations in the form of initiatives required by the regulating bodies to enhance the use of eco-friendly alternatives of mobility has been described.

BIO-FUELS

Bio-fuels have been recognized as a major world renewable energy source. They offer total carbon savings because fuels are made from waste or plant material which absorb CO2 during growth thereby making the fuel emissions carbon neutral. Once the feedstock, waste and plant material is collected it is converted into useful energy but this process is not cheap, costing three times more than petroleum fuels (Canakei, Galbe). As well as the cost, producing biofuels from grain feedstock requires a huge amount of land. As a consequence of the high costs and large land areas involved in the collection and manufacturing of biofuels, the number of vehicles running on them is low. Future technologies are likely to produce cost improvements but it remains unlikely that biofuels will ever provide enough fuel to meet transport demands, however they could contribute (Kallivroussis et al) . There are three main bio-fuels: bio-ethanol, bio-methanol and bio-diesel.

Advantageous of bio-fuels in comparison to conventional fuels

- In contrast to fossil fuels, which are exhaustible resources, biofuels are produced from renewable feed-stocks. Thus, their production and use could, be sustained indefinitely
- Biofuels have the potential to be significantly less expensive than gasoline and other fossil fuels.
- Biofuels could yield lower lifecycle GHG emissions than gasoline
- Biofuels can be produced domestically, which could lead to lower fossil fuel imports
- Biofuels may reduce some pollutant emissions. Ethanol, in particular, can ensure complete combustion, reducing carbon monoxide emission

Bio-Diesel

Biodiesel are environmentally friendly alternatives to traditional petroleum-based fuels. This is produced from renewable energy sources such as sugar beet, rape seed, palm oil and sunflowers. It is a biological substitute for regular diesel. A production process is used to convert the base oil to the desired esters and to remove fatty acids. After this process, bio diesels have similar combustion properties to petroleum diesel, and can replace diesels in their most frequent uses (Bender, coasta et al.,) . Bio-diesel cars are more environmentally friendly than conventional cars which run on petrol and diesel for

many reasons; for example it is not toxic and doesn't produce as much damaging exhaust emissions. Even though bio-diesel produces carbon dioxide as a by-product, the plants grown to create the fuel absorb carbon dioxide from the atmosphere during photosynthesis (Ang et al.,) . This means that the net carbon emission into the atmosphere is much less than non-bio-fuels such as petrol. Currently, bio diesels are most commonly used as an additive to diesel, improving the lubricity of pure, ultra-low sulphur diesel (Du et al, Knothe) . Biodiesel can also be made from other oils, fats, and recycled oils such as mustard, palm, coconut, peanut, olive, sesame, and safflower oils, trap greases, and even oils produced from algae, fungi, bacteria, molds, and yeast. Some properties of finished biodiesel such as cetane number, cloud point, and stability depend heavily on the feedstock (Enciner et al., Enweremadu et al.,) . Biodiesels are the number one option in replacing fossil fuels as the world's main transport fuel. The production and use of biodiesel is increasing rapidly, and Europe, the US and Asia has the fastest growing production of bio-diesels. Although there is a danger of deforestation in rainforests to create space for plantations needed to create bio-diesel. Bio-diesel is not available at all petrol stations but can usually be purchased for less than the price of diesel and unleaded petrol. You could even get free bio-diesel if you collect old oil from restaurants and filter it yourself. Biodiesel can be used as a pure fuel in modified engines or mixed with petroleum-diesel and used in current engines without modification. It produces fewer PM10, CO and sulphur dioxide (SO2) emissions than a petroleum diesel engine as well as reducing CO2 emissions by more than 75%. Using a blend of 20% reduces CO2 emissions by 15%. Biodiesel can be blended with fossil diesel at any ratio. The most frequently used ratio is B20 or 20% biodiesel. B100 or 100% biodiesel is referred to as "neat" biodiesel.

Advantageous of bio-Diesel (Fukuda et al., Barnwal et al.,)

- It is a fuel produced from renewable sources: vegetable oils, waste cooking oils and animal fat.
- It is biodegradable. The use of a mixture of 20% v/v biodiesel (B20) raises significantly the degradation of diesel in the presence of water.
- It is a non-toxic fuel. The use of biodiesel reduces the emission of carbon monoxide and is virtually free from sulfur compounds.
- It is essentially aliphatic whereas the fossil diesel contains from 20 to 40% v/v aromatic compounds, which increase the emissions of particulates and nitrogen compounds.
- The CO2 emitted in its combustion is recycled. The reduced amount of CO2 emitted is absorbed during the growth of the oilseeds, reducing globally the presence of gases responsible for the greenhouse effect. The replacement of diesel by biodiesel can reduce up to 41% the emissions of greenhouse gases in the atmosphere.
- It has a higher cetane number. For diesel engines, a low cetane number results in a longer delay during ignition, raising rapidly the pressure inside the combustion chamber and producing a loud and characteristic noise, not to mention the accumulation of fuel inside the chamber. Hence fuels with higher cetane number yield better ignition and efficiency. Methyl and ethyl esters have a higher cetane number than diesel. When the ester derives from saturated compounds like cooking oil and saturated fats, the cetane number is even higher.
- It has lubrication properties. The use of biodiesel can easily increase the lubricity of the diesel with a low sulfuric content, enhancing the operation of the moving parts of the engine and the fuel pump
- Mainly in developing countries, it presents a number of social and economic advantages. Besides the reduction in the import of diesel, the biodiesel industry creates new opportunities in less developed regions working on an agricultural framework.
- Beside all advantage biodiesel contains 10-11% v/v oxygen, making it easier the combustion in the engine.

Bio-methanol

Methanol was widely used in the early part of the century before inexpensive petrol was introduced. It is predominantly produced from natural gas but can be produced from biomass, hence producing bio-methanol (Clausen et al., Renó et al.,).Due to the environmental constraints alternative processes for methanol production based on renewable sources such as biogas from landfill, sewage, solid waste treatment, glycerin (glycerol) from biodiesel production, and black liquor from the pulp and paper industry are preferred these days. Bio-methanol from renewable sources and processes is chemically identical to fossil fuel-based methanol but involves significantly lower GHG emissions during the entire lifecycle. In addition, the use of bio-methanol can reduce the dependency on fossil energy imports and stimulate local economies. The day will come when the technology will be focused on bio-methanol as a replacement for fossil fuel-based methanol in the chemical industry (Fan et al., Li et al.,). Numerous disadvantages of methanol; including its corrosiveness, lower vapor pressure (making cold starts difficult), water contamination and toxicity to ecosystems; have led to its predominant use as a blend with petrol (Wiliams et al.,). Bio-methanol could play a part in meeting future transport demands as a fuel with advances in technology and a shift to producing methanol from biomass rather than from natural gas. It is a liquid fuel which can be blended with gasoline and ethanol and can be used with today's vehicle technology at minimal incremental costs. It is a safe fuel. The toxicity (mortality) is comparable to or better than gasoline. Produced from renewable biomass, methanol is an attractive green house gas reduction transportation fuel option in the longer term. Multiple ways exist for introduction of methanol into the fuel infrastructure (light blends or heavy blends) and into vehicles (light duty or heavy duty applications). The optimal approaches are different in different countries and in different markets.

Advantageous of Bio-methanol

- By spreading out the production of fuel over multiple feedstocks, we can more quickly realize our goal of employing domestically-produced fuels in the transportation sector.
- Relative to gasoline, methanol is a safer and more environmentally benign fuel.
- As a fuel, bio-methanol can either be blended with gasoline, or it can be used as a feedstock for other environmentally friendly fuels.
- The great benefit of bio-methanol is that it can be used in similar engine and fuel systems to those found in today's cars.
- It can be stored, transported and sold in much the same way as petrol and diesel. This makes it even easier for fuel manufacturers to achieve EU targets as defined in the RED (Renewable Energy Directive).
- Bio-methanol can also be used as a chemical building block for a range of future-oriented products, including bio-MTBE, bio-DME, bio-hydrogen and synthetic biofuels (synthetic hydrocarbons).

Bio-ethanol

This is a biological fuel substitute for petrol and is made from renewable energy sources. It has much the same benefits as bio-diesel but is less common. Its popularity as a bio-product is increasing especially in countries like Brazil. Bio-ethanol is a simple alcohol that can be used as a fuel or blended with petrol to power vehicles (Diasa et al., Ali). It is derived from renewable sources of feedstock; typically plants such as wheat, sugar beet, corn, straw, and wood but it is also to produce bio-ethanol from converted household waste. The most efficient production of bio-ethanol is from sugarcane in the tropics where no external energy supply is required for its conversion to a fuel. Brazil in particular produces much bio-ethanol.

Fuel Cell Vehicles

Fuel cell is one option which can become replacement of fossil fuels for automotive applications in near future. A fuel cell is an

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electrochemical device, similar to a battery, that generally combines hydrogen from any of several sources and oxygen (which can come from air) to produce electricity, heat, and water. Basically, a fuel cell is composed of an anode (a negative electrode) and a cathode (a positive electrode), which are separated by a liquid or solid electrolyte. Generally, the electrodes are permeable or contain channels that distribute hydrogen or other substances and oxygen. The electrodes are frequently accompanied by catalysts, commonly platinum or palladium (Schwoon, Pischinger et al). In most fuel cells, hydrogen atoms enter the cell at the anode where their electrons are removed, producing direct current electricity and positively charged hydrogen ions (cations). Direct current can be converted to alternating current by an inverter. The electrons flow through an external circuit that extends from the anode to the cathode. The external circuit can include electric motors, lighting systems, or other electrical devices. The hydrogen ions travel through the electrolyte to the cathode where they recombine with the electrons and oxygen to produce water and heat (Tseng, ogawa et al.,). The schematic construction details of fuel cell is presented in Figure.1

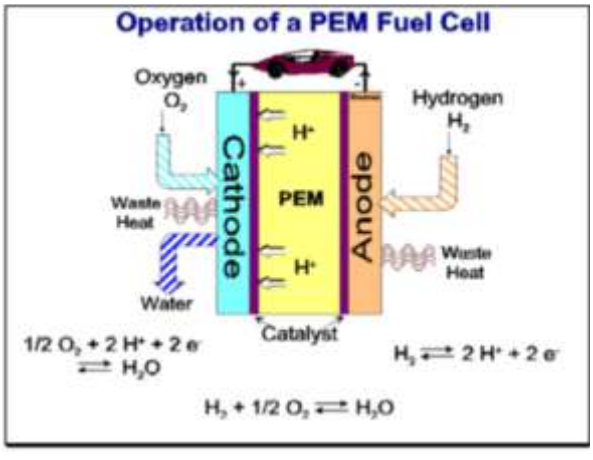

Figure.1 Construction and operation detail of Fuel cell

Fuel cells are almost endlessly rechargeable and productive, operate without combustion, have no moving parts, are nearly silent, and have an excellent safety record. Those recently developed for powering automobiles have an estimated life span of decades. Fuel cells can be modular and scaleable; many joined together are called a fuel cell stack. These characteristics allow the gradual addition of electrical capacity in response to increases in demand (Ellis et al., Larminie) . Presently, the main planned uses of fuel cells are for the production of electricity at stationary power plants and to supply electricity for motors that move buses, trucks, and cars. Hydrogen for fuel cells that power vehicles is derived from external sources and thereafter placed in onboard [32].

Fuel Cell Vehicles (FCV's) are considered by many to be the most promising alternative technology for personal transportation vehicles in the future. Essentially, a fuel cell is a catalytic device which converts the energy stored in fuel (e.g. hydrogen) directly into electrical energy to turn an electric motor. Unlike a battery, where the supply of chemicals is limited by its size, fuel cells can be continuously fed with fuel to produce electricity indefinitely. The current fundamental fuel required in order for FCV's to produce zero-emissions and high efficiency is hydrogen. Hydrogen fuel cell vehicles (HFCV's) are zero emission, this does not account for any emissions created during the process of producing the hydrogen inthe first place. Ideally, the hydrogen is produced by renewable means. FCVs are propelled by electric motors. But while battery electric vehicles use electricity from an external source (and store it in a battery), FCVs create their own electricity from an on-board the vehicle creates electricity through a chemical process using hydrogen fuel and oxygen from the air. • FCVs can be fuelled with pure hydrogen gas stored on-board in high-pressure tanks. FCVS are fuelled with pure hydrogen emit no pollutants; only water and heat; while those using hydrogen-rich fuels and a reformer produce only small amounts of air pollutants. In addition, FCVs can be twice as efficient as similarly sized conventional vehicles and may also incorporate other advanced technologies to increase efficiency. All the features promote the use of fuel cell for future automotive applications.

Advantageous and disadvantages associated with FCV

One advantage of operating a fuel cell powered vehicle is greatly reduced emissions. Pure hydrogen fuelled FCV's will emit only water during operation.

Fuel cells have no moving parts and electric motors are significantly quieter than internal combustion engines fuel cell powered vehicles are generally at least 40% efficient, making them twice as efficient as petroleum powered vehicles moving to a hydrogen-based economy could save billions of dollars.

Hydrogen is a gas, and a highly diffuse one at that. At room temperature it takes up a huge amount of space per unit of energy. In order to be useful as a fuel, it must be compressed or potentially liquefied. These processes use a great deal of energy, reducing the overall energy value of the hydrogen.

Electric Vehicles

Electric vehicles, otherwise known as battery powered vehicles (BPV's), are powered by rechargeable batteries, producing no local emissions and running very quietly during operation (Balat). There is a range of battery technologies currently including lead-acid, nickel-metal and lithium polymer batteries. Each can be recharged off of the national grid at home or in the future at recharging stations (Lucena, et al.,). Depending on the source of energy used to charge the batteries EV's have ranging total emissions, from low-zero Environmentally Friendly Cars: Promoting and increasing their use in the UK. Earth & Environment 3:282-317- 290 -charging is from renewable or nuclear sources) to slightly higher (when the source of energy for charging is from coal or non-renewable sources). In comparison to fossil fuel vehicles, overall emission in EV's remain 90% cleaner than the cleanest conventional vehicle. Among the other advantages of EV's are lower fuel and maintenance costs. On the other hand EV's do have disadvantages. Batteries are expensive, take prolonged periods of time to charge (about 6-7 hours) and must be replaced every four to six years (Sioshansi etal.,). Their driving range is significantly lower than that of a petrol/diesel car, averaging between 60 and 120 miles which although suitable for urban travel and commuting, is not suitable for longer distances. The top speed of a BPV is also lower than for an equivalent petrol/diesel. There is a lack of current infrastructure for charging batteries. Having researched the positive and negative aspects of EV's, one of the common recommendations in order for them to be able to compete in the market is to improve the performance of the batteries to give better top speeds and vehicle ranges. Research is underway but the mainstream application of full electric vehicles does not appear too likely in the near future.

Some steps to be implemented Advantageous by the regulating bodies to encourage the use of sustainable energy powered automobiles.

- Expedite the spreading of Knowledge on Climate Change
- Show Concern on the effects of Climate Change in its policies and motivate the people to participate through optimum utilisation of resources, which can affect the climate change.
- Policy of promotion of Environmental friendly Vehicles by Govt, to reduce the cost , to provide subsidy, to install more filling/ charging station, to give special concession by the transport department and impart Knowledge of Alternative Fuel Vehicles to the users
- To reduces road taxes on eco-friendly vehicles and on other hand Increase the cost to drive of non-alternative vehicles. Further

more stringent policy and legislation in order to promote alternatives and discourage current conventional vehicles.

- Subsidies and incentives for EFV's to be made available, but more importantly to ensure the public know about them and use these vehicles. Making sure that people know the true performance capabilities of EFV's today similar to standard petrol/diesel vehicles– plus the advantages associated with them(quieter, more efficient, cheaper to run Increase knowledge and awareness of EFV's.
- Advertising campaigns on a national scale for eco-friendly vehicles.
- Increased government subsidies and incentives.
- Possible vehicle access restrictions to city centres for all but low-emission vehicles.
- More positive advertising and increased knowledge of the current situation supported by Government subsidies/ Incentives shall lead to more adoption and use of Eco-friendly vehicles by the society. In reality, to increase and promote their use, a holistic integrated strategy must be put into place.
- In the short term, the strategy must aim to promote and increase the publics' awareness and knowledge of EFV's and the related technologies. Increased advertising may be the most effective way of achieving this. The need for co-ordinated fiscal incentives has been recognised by many in order to promote sustainable transport.
- Change cannot be expected over night and though their uptake is currently slow, the implementation of new and improved promotion schemes and legislation could significantly boost the uptake and use of environmentally friendly vehicles in the future.

CONCLUSIONS

Each of the alternatives presented has advantages and disadvantages. However, it is also important to note that most of the alternatives only address a few of the problems associated with the automobile, namely pollution and foreign oil dependence. Bio- fuels seems to be significant alternative to conventional fossil fuels, high yielding short rotation woody crops also provide biofuel feedstock potential. Processing feed stocks into ethanol to displace gasoline contributes directly to energy independence objectives. Use of bio-fuels shall maintain a balance in eco-chain to minimize the affect of pollution on environment. Methanol is a high octane fuel with combustion characteristics that allow engines specifically designed for methanol fuel to match the best efficiencies of diesels while meeting current pollutant emission regulations.

Fuel cells could be a major and necessary source of energy within a decade. They have great potential as the basic elements power of electricity for vehicles and smaller devices. They are modular, have no moving parts, operate without combustion, are comparatively efficient and reliable and are nearly silent, generally do not pollute the environment, and are quite safe. The newest research focuses on carbon nanotubes that can absorb large amounts of hydrogen and can become safer viable solution for hydrogen based fuel cell operated vehicles. Currently, the most promising of these is the hybrid electric vehicle (HEV). It is likely that the HEV will be the dominant EFV in the near-term but that it may be replaced by the fuel cell vehicle (FCV), which offers zero local emissions and potentially zero total emissions, in the future. Due to technological constraints and a lack of demand it is not yet feasible to mass produce the FCV and producing them on a smaller scale entails huge economic costs. A literature review outlined the wider problem posed by GHG emissions from transport, considered the range of different environmentally friendly vehicles available to combat this problem and examined the reasons behind the lack of peoples dependability on these vehicles. The major factors responsible for adaptability of these EFV as public choice includes a lack of public knowledge and awareness of EFV's, additional costs of alternative technologies, cost and difficulty of developing new infrastructure, a considerable shortage of effective promotions. In order to address these greater issues, growth-related policies need to be implemented ensuring the protection of the environment, maximizing efficient land use, and the promotion of eco-friendly mass transit as a viable means of transportation.

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