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Environmental Impact of Electric & Biodiesel Car - A Review

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ABSTRACT

The transport industry has been an important sector, and controls a major portion in the country's economy. The transport sector are mainly dependent on fossil fuels. The amount of fossil fuels is limited and if we deplete the fossil fuels the future will be doubtful. The use of fossil fuels generate a lot of hazardous pollution such as CO, unburnt HC, NO_x and emission of greenhouse gases. Recently the environmental problems are increasing day by day because of the emissions. Therefore there is requirement to shift to cleaner fuels or alternate fuels. As the emissions are rising the demand for alternate fuels are increasing day by day. It is estimated that in the US, transportation sector consumes about 62% of the oil imported. Because of the rise in demand many researches have been made in the field of alternate fuels. Fuels with high oxygen content have the possibility to be used as an alternate fuel. Biodiesel is a substitute of diesel fuel, compound of ester (higher oxygen content). Another alternate to conventional fuels if the electric vehicles. The hybrid electric vehicle are mainly of two types on the basis of powertrain, firstly parallel and secondly series. The paper is a review work on different types of fuels used and throws light on the upper hand and downsides of the different fuels used. It also exhibits the effect of these fuels on the environment.

Keywords: *Hybrid Electric Vehicles; Biodiesel; Emission, NO_x; CO.*

1.0 Introduction

Transport industry/sector is a very important sector in any country's economy. It is a known fact that the transport sector is increasing day by day. The transportation sector mainly uses petrol and diesel, but these fuels are costly and produce a lot of emission and is mainly responsible for greenhouse gases. We also have a limited amount of fossil fuels and the availability of the fossil fuels in the future will doubtful [1]. The environmental problems in the recent days are increasing and the demand of alternate fuels are increasing. The transportation sector is the major sector which is responsible for the consumption of fossil fuels and the environmental impact [2]. The global energy demand has been increasing day by day. At the same time the environmental pollutants have reached a level which are alarming [5]. In the US the increasing number of motor vehicles have deteriorated the air quality. There are for sectors which consume energy, but the transportation sector consumes the maximum. Almost 62% of the oil is consumed by the transportation sector which is imported into the country [3]. The fossil fuel produces a lot of harmful pollutants when they are burnt. These pollutants are harmful for the human health which can cause respiratory diseases and can increase the chance of asthma [4].

Because of the increasing demand of the fossil fuels there is a demand to develop vehicles run by alternate fuels which can reduce the dependence on conventional fuels and reduce the emissions. Many fuels having high oxygen content have the potential to be used as an alternate of gasoline and diesel fuel. Carbonate, alcohol, ether, acetate compounds and ester have been classified as oxygenates. The substitute of diesel is biodiesel and is a compound of ester. Biodiesel is a term which mentions about oxygenated diesel fuel which are made from feedstocks by trans-esterification. The biodiesel feed stocks are categorized as firstly animal fats, secondly oilseeds (edible or inedible oil), thirdly waste materials and lastly algae. The vegetable oil can be divided into two category, edible and non-edible oils. Rice bran oil have been listed in no-edible oil but in

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some countries like Korea and India they are considered as edible oil. Biodiesel has many disadvantages like low storage and oxidation stability, inferior low temperature operability, high feedstock cost, low heating value and the major disadvantage is its higher NO_x emission when compared to conventional fuels [6].

Hybrid electric vehicles have appearing as a significant solution for solving the emission problems and the greenhouse gas emission.

Hybrid electric vehicles was first introduced in 1899 at Paris Salon exhibition. Many manufacturers have tried to produce a mass production hybrid electric vehicle. Hybrid electric vehicles can be classified as parallel and series in powertrain configuration. The parallel hybrid electric are the vehicles which can be powered by motor and engine simultaneously. In the case of a series hybrid electric vehicle it is mainly powered by electric motor which is powered by an electric battery and the battery is charged by the vehicles engine. There are powertrain configuration which combine both parallel and series [7]. As we are heading towards a situation where the conventional cars are creating a lot of pollution and damaging our health and environment. It has become very important to look for alternative solutions. HEV and biodiesel can be an alternate source and have a lot of potential to replace the conventional fuels. The paper gives an overview of the hybrid electric vehicles and biodiesel vehicles. How the two can help in reducing pollution.

2.0 Literature Review

Fontaras et al. [7] experimentally measured the pollution and the fuel economy of two different hybrid vehicles. The experiment were conducted on Honda Civic IMA and Pirus II. The experiment result showed that the fuel economy was improved for Honda Civic IMA by 1-6% with the help of the integrated gearshift. The CVT gearbox of the Pirus II showed better results when the same pattern of optimization were used. The CO_2 emission for both the hybrid vehicles were below 140g/km for every test cycle. When the two hybrid cars were driven over 65km/hr both the vehicles showed similar fuel consumption but then the hybrid vehicles were driven over the speed of 95km/hr the fuel consumption were equal to the conventional vehicles. The fuel consumption was 40-60% lower in urban driving conditions when compared to conventional cars. Temperature also plays an important role in the fuel consumption. At higher temperature the battery capacity increases and helps in penetration of electricity, which gives better economy. It was conjectured, hybrid vehicles produced less CO_2 and showed better fuel economy in the city driving conditions. Zhixin Wu et al. [8] compared the lifecycle greenhouse gas emission for conventional internal combustion engine and battery electric vehicle using life cycle assessment. The assessment were calculated for the year 2010, 2014 and 2020. Greenhouse gas emission from the battery electric vehicle were also discussed. Fuel cycle and vehicle cycle were investigated with ISO 14040/14044 standards. Electricity generation used advanced technology. Combined heat and power values increased from 2010 to 2020. It was observed that he total lifecycle of greenhouse gas emission for the battery electric vehicles improved. When compared to conventional internal combustion engine vehicle the GHG for BEV for the year 2020 improved by 13.4%. it was concluded that the electricity mixture is important for improving the combined heat and power, greenhouse gas emission. Yi Huo et al. [9] studied the parallel hybrid vehicle powertrain. In this study fueling control technique was introduced. As the study involves a diesel engine, the main issue is to control the fuel injection timing and fuel injection mass, were the control inputs in the hybrid powertrain system. Engine brake specific fuel consumption characteristics with regard to fuel injection control variables were incorporated to solve hybrid electric vehicle power management problem. Development of fixed fuel injection timing and implementation were processed to compare with the proposed control scheme and to reflect the advantages. It was seen that NO_x emission was not affected by the variation of the fuel control technique but the fuel saving improved. Juan C. Gonzalez Palencia et al. [10] used the vehicle stock turnover model. This model was utilized to estimate the possibility of reducing CO_2 emission and energy consumption in the freight vehicle fleet with the use of electric drive. The stock shares of hybrid electric vehicle will be around 82%, and the stock share of the fuel cell electric vehicle and battery electric vehicle would be 65% by the year 2050. Between the years 2012 to 2050 the tank to wheel energy consumption changed from 1300 to 635 PJ/year. The tank to wheel energy consumption for hybrid electric vehicle can be reduced to 5.7%, battery electric vehicle to 35.5%, fuel cell electric vehicle to 16.1% and zero emission vehicle to 18.2% when compared to 2050 baseline value. As more and more electric drive vehicles are being deployed but the energy consumption of the diesel and gasoline will be more than 52% in all scenarios by the year 2050. It was also observed that the tank to wheel CO_2 emission between the years 2012 to 2050 there would be a reduction from 98 to 47 Mt-CO_2/year. The reduction of CO_2 emission target with the help of alternate fuels is difficult to achieve. The possibility of decarbonizing in the road freight transport is difficult to achieve. TTW CO_2 emission reduction upto 55.8% is possible with the help of battery electric vehicle (BEV) and fuel cell electric vehicles (FCEV) in the year 2050. With more and more diffusion of BEV and FCEV there can be a change in the reduction of TTW CO_2. But it is estimated that with even aggressive popularization of electric drive vehicle, the fossil fuels would still consume 52% energy in 2050. Chiu Chuen Onn et al. [11] researched that the Malaysia government are trying to promote the electric vehicles and also develop the infrastructure required for the automobile companies to explore, alternative powered vehicles. It was also observed that the grid dependent electric vehicle could only be advantageous if the electricity grids are low carbon. Malaysia is mostly dependent on fossil fuels for the electricity generation, therefore it is a challenge for the government. The main objective of the researcher is to calculate the greenhouse gas emission related to hybrid electric vehicles, electric vehicles and internal combustion engine vehicles. The results showed that the electric vehicles powered by the national grid would produce more greenhouse gas (7% more) than hybrid electric vehicles. But when compared to internal combustion engine vehicles the electric vehicles would reduce greenhouse gas by 19%. The greenhouse gas emission by the electric vehicle were based on well-to-wheel analysis. It was analyzed that to have the benefit of electric vehicles towards improvement of climate change and global warming, massive modernization and transformation the government should look towards a greener source in the electricity grid. Marcos Vinícius Xavier Dias et al. [11] used a methodological approach to see the impact of different fuels (i.e flexible fuels) used on different electrical vehicles and the main objective of the paper was to see the penetration of the electric vehicles and its impact. The goal of the paper was to see the impact of the introduction of electric vehicle and the related environmental and electrical impact, and the ability of the suggested model to retain itself. It was possible to know the introduction of electric vehicles and its impact in terms of energy and environment. The calculations were made for different participation of the fleet. Electricity and emission were calculated for São Paulo, Brazil. The electricity consumption would increase to 40 million MWH in the case when there would be 100% electric vehicles by 2035 year, when compared to the present condition. The electricity demand will increase by 2% every year, if we add 10% electric cars yearly. But it was estimated that there will be 17.3 million ton decrease in $CO_{2.}$ Yearly there would be 1.3% reduction of total emission when there would be an increase of electric car 10% yearly. Oscar van Vliet et al. [1] studied about the three main aspects related to hybrid vehicles, firstly to acquire greenhouse gas emissions and to determine the cost required to charge an electric vehicle in the Dutch. Secondly to diagnose the outcome of charging pattern and demand electricity on the household when electric vehicle are charged. Thirdly to contrast the regular vehicles with the battery powered electric & plug in series hybrid and the greenhouse gas emission. It was observed that the haphazard charging of the electric vehicles (30%) increased the house load by 54%, whereas the nation peak load by 7%. The effect of greenhouse gas emission was studied which were emitted from the electric vehicle. The type of fuel(coal or natural gas) used, for electricity generation was the cause of greenhouse gases. The electric vehicles emitted lowed CO_2 and $NO_{x.}$ but the greenhouse gases produced by natural gas for electricity production was 0g/km and in the case of coal it was 155g/km. S. Manigandan et al. [13] studied the corn vegetable oil methyl ester with oxygenated additives and investigated the emission, combustion and performance characteristics. Pentanol and titanium oxide were used as additives in the biodiesel. The main function of the additives was to reduce the emission and to increase the efficiency of the engine. diesel, CVOME (Corn methyl ester), CVOME75P20T100 (25%Corn methyl ester+50 Diesel+20% pentanol+5% titanium dioxide at 100 ppm), CVOME75P20T200, CVOME85P10T200, CVOME85P10T100, CVOME85P10T300 and CVOME75P20T300 fuels were utilized for the test. The fuels were mixed with titanium and pentalon additives, at different ppm. Observations showed that CVOME75P25T300 had 60% reduced CO and 20% less HC when the engine was run at full load condition. CVOME75P25T300 displayed 16% less emission of NO_x. Naushad Ahamad Ansari et al. [14] researched about the use of polanga biodiesel blend and studied the injection timing, input parameter analysis and fuel injection pressure. The study was performed on a diesel engine which is single cylinder 4-stroke direct injection. Minimum exhaust emission were found with the polanga blends, and the effect of the blend on fuel injection and thermal efficiency were examined. The thermal performance of 30% polanga biodiesel blends operating condition is similar to the diesel, the blend were injected at 220bar. NO_x, BTE, smoke and UHC were the multi-response characteristics and the input parameters were optimized. The optimum value of BTE was 32.59%, UHC 20.3 ppm volume, NO_x 551 ppm volume and smoke emission was 94.2% for 30% polanga biodiesel blend. Senthil Ramalingam et al. [15] stated that many sectors have been using diesel engine.

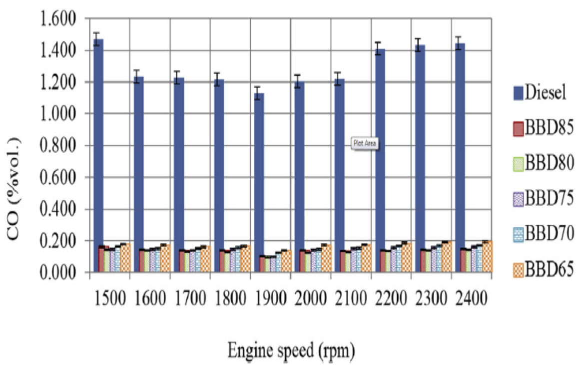
The reason for its popularity is for its high efficiency, low operating cost, good reliability and durability. Diesel engine have been using fossil fuels and it also generates a lot of pollution, therefore it is vital to use alternate fuels apart from diesel. Diesel engines generate a lot of pollutants such as carbon monoxide (CO), particulate matter (PM), unburned hydrocarbon (HC), Sulpher oxides (SOx), lead and oxides of nitrogen (NOx). Biodiesel have been an alternate to diesel but the disadvantage of this fuel is its reduced performance and higher NO_x emission. Biodiesel have higher NO_x emission because of more oxygen content. Emission catalytic converter were used by many researchers to reduce the NO_x emission. Sindhu et al. [16] compared the emission and performance of small diesel when it was fueled with pure diesel and biodiesel blends and their glycerine emulsions.

The test were conducted at different speed conditions and load on a direct injection diesel engine. The crude glycerine acquired as by-product from the onsite biodiesel produced were purified by orthogonal test method. The glycerine emulsion that were obtained were examined on its mean particle droplet size, engine performance, emissions, emulsion stability and fuel properties. The results showed that with increase in glycerine concentration, the break-thermal efficiency and break-specific fuel consumption increased. On the emission front, the unburnt hydrocarbon and carbon monoxide increased. It was also observed that oxides of nitrogen and the exhaust gas temperature were reduced. 163 ppm NO_x was emitted by B0 at low load but at high load 231 ppm was emitted. 9% higher NO_x was emitted by B100 when compared to B0. B100G10% showed 10% lower NO_x when compared to B100. B100G10% emitted 3.91 g/kWh and B100 emitted 4.77 g/kWh. CO emission was reduced because with increase in biodiesel content the oxygen molecule increased and helped in proper burning of the fuel. Around 80% smoke was reduced with increase in glycerine at high load and at 3000 rpm. C.W. Mohd Noor et al. [17] stated that exhaust emissions from the ships were the major contributor of air pollution. Ship transportation sector and the shipping activities caused a lot of air pollution.

Because of the strict policies, alternate fuels in the marine diesel engines were required. Biodiesel fuel being environment friendly and reduces many toxic gas was selected. It was observed that compared to diesel engine biodiesel had higher NO_x emission. When marine engine were propelled by biodiesel (recycled oil) showed an increase in 16% NO_x. Biodiesel produced more NO_x because of the presence of more oxygen. This oxygen acts as a combustion catalyst and releases high heat. With the use of cooking biodiesel, NO_x 1.1 % to 24.3 % reduction was observed. SO_x emission was observed to be lower. Unburnt HC emission was reduced with the use of olive oil and sunflower oil. Unburnt HC reduced because, different oils have different HC composition. In the case of automobile HC reduced between 14.9% to 29.5%.

AS Silitonga et al. [18] experimented on biodiesel-bioethanol-diesel blends on an single cylinder diesel engine and analyze the exhaust emission and performance. The exhaust emissions that were examined were smoke opacity, nitrogen oxide & carbon monoxide. Brake thermal efficiency and brake specific fuel consumption were evaluated as engine performance parameter. It was observed that the biodiesel-bioethanol-diesel blends showed higher brake thermal efficiency and lower brake specific fuel consumption. The fuel blends even showed less smoke opacity & carbon monoxide emission. It was observed that the CO emission were low for all biodiesel-bioethanol-diesel blends

Fig 1: **Carbon monoxide emission of Diesel and biodiesel-bioethanol-diesel blends [18]**



When compared to diesel at 1900rpm. The fuel blends BBD75 and BBD80 at 1900rpm displayed 0.101%vol. of CO emission, 0.099%vol. of CO emission respectively. It was also observed that BBD80 and BBD85 had the lowest NO_x emission, with the value 211 ppm vol. and 273 ppm vol. respectively. Whereas at 1900rpm diesel had the lowest NO_x emission of 162 ppm vol. Amit R Patil et al. [19] observed that common additive in biodiesel, Jatropha. With the addition of Jatropha there was increase in smoke formation and NO_x formation also increased. But there were improvement in Brake Specific Fuel Consumption and Brake Thermal Efficiency. The NO_x emission decreased only in a few situations, it has always increased. At full load condition the brake specific fuel consumption increases with the increase in the fluid density. BSFC increases because the fuel meter delivers fuel at a specific volume, but biodiesel has higher density so the meter releases more biodiesel compared to diesel. Jatropha oil and its blend showed reduction in specific fuel consumption and increased break power and brake thermal efficiency. It was observed that when Jatropha was preheated it had low viscosity which showed an increase in the BTE, higher than unheated jatropha. As the engine load was increased the NO_x emission was more because of higher combustion temperature.

3.0 Conclusions

As we have been using a lot of fossil fuels in our transportation sector it has led to the generation of different gaseous emissions. The papers gave a review on the different emissions such as CO, NO_x, HC and the greenhouse gasses form the biodiesel fuel and the electric vehicles. The electric vehicles showed that the CO_2 emissions for the hybrid electric vehicles was less. But the emissions were similar to conventional cars when the speed of the hybrid electric vehicles were more than 80km/hr. the hybrid electric vehicles can help in reducing the greenhouse gases by 13.4% by the year 2020. With the control of the fuel technique in parallel hybrid cars the NO_x emission had no effect. BEV and FCEV and reduce the CO_2 emission but even if the vehicles are made popular there would be a consumption of 52% fossil fuels in 2050.

But some researches have estimated that the electric vehicles would be able to reduce the emission by 2% every year. Biodiesel being an alternate to diesel fuel shows many advantages and disadvantages. The biodiesel reduces many pollutants when compared to conventional such as CO_2, CO, PM, HC, SO_x and lead. But the biodiesel produces more NOx compared to conventional fuel and the performance is also low.

When glyceri n was added to the biodiesel the NOx were reduced and it was seen that the smoke was also reduced by 80%. Jatropha blend biodiesel increased the NOx formation. Jatropha improved the Brake Specific Fuel Consumption and Brake Thermal Efficiency.

In the marine engine use of recycled biodiesel showed increase in NOx formation, but the SO_x emission were low. There is an immense need to shift to alternate fuels and electric vehicles to solve the emission problems. The hybrid electric vehicles could be coupled with the biodiesel engine to produce less emission and to conserve the fossil fuels.

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