Solenoid Motion System for Electric Vehicle

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Abstract--- *Designing an electric vehicle (EV) using electric motor as its prime mover is very common. However, incorporating the electric motor to the overall EV design is relatively complex. The latest layout design of an EV requires a complex controller to govern the whole system especially the electric motors. Due to this complexity, the authors have developed an alternative electromagnetic prime mover for EV to replace the existing electric motor. This new prime mover is designed based on the solenoid concept and the internal combustion engine (ICE) working mechanisms. In this paper, the authors are introducing a new electromagnetic prime mover known as Solenoid Powered Engine (SPE). The paper describes the SPE underlying concepts, its comparison with electric motor in EV design, overall system layout, operations and characteristics.*

Keywords--- *Solenoid Engine, Combustion Engine, Automobiles.*

I. INTRODUCTION

For the past few decades, the use of electric vehicle (EV) is becoming popular in the automotive industry and slowly gained some interest from the public community. This is due to the fact that these vehicles are widely known for their zero emission and powered by renewable energy sources. In general, EVs are driven and controlled by the integration of electrical, electronics and also mechanical components but the main component that actually moves these vehicles is the electric motor. Electric motor works on the principles of electromagnetic by converting electrical energy to kinetic energy. This energy conversion is the main purpose of an electric motor and it is thus far, the only known prime mover for a non-tracked EV that operates solely on electricity [1] [2] [3]. Even hybrid vehicles utilise electric motors as one of their prime mover [4]. That is why electric motors are highly popularised in most EVs designs. Large amount of research work has been conducted for proper analysis of alternative automotive fuel in different parts of the world. A few studies are available on the performance and emission characteristics of engines with CNG and LPG as fuels. The theoretical background and the literature related to the present study have been reviewed in this chapter.

Ravi Kumar Reddy C. [3]explained how a CNG is a viable alternative. The keyenergy challenge facing India today is preventing bottlenecks in energy supply from constraining economic growth. The transport sector in India is a major energy-consuming sector, particularly of oil. The dependence on liquid fuels in road transport sector is so deep-routed and is increasing exponentially as the number of vehicles on road is shooting up. This dependence on oil, in the coming years would be still more to satisfy the needs of transportation. Besides dependence on oil, another problem is environmental pollution that our modern society is facing today. The exhaust from liquid fuels is diminishing the air quality day by day.

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The increasing respiratory diseases, increasing hospitalization, decreasing visibility during peak hours in Indian metros and other cities, makes sense to find alternatives to improve the urban quality of life. Hence it is the time to reduce dependence on liquid fuels by switching over to alternative fuelled vehicles. The paper briefly describes the need for switching over to CNG operated vehicles, the safety aspects, techno-feasibility of CNG conversion, performance of CNG vehicles and economics of CNG vehicles. It also explains different kinds of refilling systems and installation of kits. It is also shown that how good the CNG is and how promising it is as a vehicular fuel.

Engine maintenance cost can be reduced by extending time between oil changes because the particulate materials that are produced during the combustion cycle of Gasoline engines and cause the engine oil to get dirty are not present in the CNG engine.

The reduction of hazardous pollutants from CNG vehicles is substantial. There are no particulates, either sulphur or lead and no visible smoke, as CNG burns very cleanly. The success of CNG operation depends on various factors like infrastructure, subsidies on CNG and availability of gas etc. However factors like filling time, isolated filling stations, low range of CNG operated vehicles and power loss may impede the progress of switching to CNG operation. There is an urgent need to provide interest free loans to the users for getting their vehicles converted to operate on CNG. Although CNG is a safer fuel, it requires special attention to avoid gas leaks. Careful maintenance and driving practices are, therefore a pre-requisite for the success of the CNG vehicle.

Y.Satyanarayana[4]describes CNG experience in Delhi. In July 1998 theSupreme Court of India issued directions to replace all eight years old buses in Delhi to CNG by 1st April 2000 and to convert all private and Delhi Transport Corporation buses to CNG by 31st March 2001. This mandate was extended to January 2002. The use of CNG for transport in Delhi led to raging controversy. Based on the experiences in Delhi and elsewhere, there is a general feeling that emission norms and time table should have been suggested instead of giving guidelines on ways of achieving it.

Considering the cost-effectiveness and health hazards of ultra-fine particulates that are emitted by CNG engine, it is advisable to evaluate different technologies and alternate propulsion systems for urban buses than leaving the option to CNG buses alone. It may be necessary to look at alternate fuels and alternate propulsion systems including CNG through large scale experimentation while continuing diesel vehicles with Euro II and Euro III standards and ultra lowsulphur diesel. The diesel buses manufactured should be to Euro II standards with immediate effect. It is also required to examine the feasibility of retrofitting catalytic converters or particle traps on buses already under operation to bring their emissions closer to new vehicles. Few electric hybrid and fuel cell buses which are considered to be successors to diesel buses should be imported and operated for gaining experience while encouraging some of the local manufacturers to produce them in the country **M.U. Aslam et al** [7] conducted experiments for investigation of performance, fuel consumption and exhaust emissions under steady state operating conditions for Gasoline and CNG on 1.5 L, 4-cylinder Proton Magma retrofitted SI car engine with dynamometer. The engine was converted to computer integrated bi-fuelling system from a Gasoline engine and was operated separately either with Gasoline or CNG using an electronically controlled solenoid actuated valve system. A computer based data acquisition and control system was used for controlling all the operation. A comparative analysis of the performance and emissions has been made for Gasoline and CNG.

Based on the experimental results, it is transparent that retrofitted NGV engines produce about 10-15% less power than the same engine fuelled by Gasoline. The study has demonstrated that retrofitted CNG fuelled engines have a potential for higher fuel conversion efficiency (FCE) and significant reduction of emissions. Retrofitted CNG engine produces around 16% less brake mean effective pressure (bmep) and consumes 17-18% less bsfc or consumes an average of 1.65 MJ less energy per KWh at wide open throttle (WOT) condition with CNG compared to Gasoline. The engine shows an average of 2.90% higher FCE nearly at stoichiometric air-fuel ratio (λ=1) with CNG at WOT condition and this higher value decreases with the decrease of λ value. On average retrofitted engine reduced CO by around 80%, CO_2 by 20% and HC by 50% and increases NO_x emissions by around 33% with CNG compared to Gasoline. For reducing CNG vehicles efficiency penalty due to heavier CNG storage tank and for providing easy refueling it is required to develop lighter CNG storage tank and extensive networks of CNG supply stations at convenient locations through out the country. Retrofitted CNG fuelled engines can be used for the moment of economic, environment and energy security reasons.

Rosli Abu Bakar et al [8]carried out experiments to evaluate engine performance and heat transfer characteristics of CNG and Gasoline fuelled electronic fuel injection (EFI) engine. Pressure transducer was installed with the crank encoder to measure the pressure inside the combustion chamber. A series of temperature measurements were obtained to deduce the engine's heat transfer profile. To vary the coolant temperature, an independent cooling system was connected to 1.6 L EFI engine replacing the radiator. All the data were recorded using data acquisition system for internal combustion engine.

It was found that CNG fuelled engine produced lower torque and brake power compared to Gasoline for all engine speed. The power loss is partly explained by the low density of natural gas (NG) whereby gaseous fuel occupies a larger volume per unit energy than liquid fuel. NG in mixture drawn into the cylinder displaces approximately 10% of oxygen available for combustion. The maximum potential power therefore will reduce by up to 10% compared to Gasoline engine under similar condition. The other main factor that reduces the power output is the low flame speed of NG, which requires a

more advance spark timing to achieve complete combustion within the correct portion of the engine cycle. The experimental results also showed that CNG produce lower cylinder pressure compared to Gasoline

The analysis of all results shows that CNG fuelled engine produced less torque, power, work and cylinder pressure compared to Gasoline engine. The power reduction occurred due to initial condition of the operating engine was not optimized for CNG fuel running. CNG heat rejection is higher compared to Gasoline. In the overall, the CNG fuelled engines have a great possibility to be comparable to that of Gasoline.

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