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Design and Implementation of CNG - LPG Powered Hybrid Vehicle

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ABSTRACT: India is one of the fastest growing countries in the world. The status of people of our country is growing which states the peoples are getting developed in all aspects of living. Transportation is one of the basic requirements for a developed status of living. Peoples have passion towards buying motorcycles, cars for their own mode of transportation. Usage of two wheelers has been tremendously increased in our country. Availability of fossil fuels is getting decreased as the usage of vehicles is increased. Alternative energy is the only pathway to find new era in the field of vehicle technology. Technological researches are under process to get good and stable solution to this problem. Many researchers trying to develop vehicles with alternative energy source such as solar, wind, hydrogen fuel, bio fuel etc. In this proposed system, the vehicle which is powered by compressed natural gas and liquid petroleum gas as a fuel. The main objective of this project to design and develop a vehicle which should produce less emission, low maintenance and low operational cost hence the vehicle can be utilized by all peoples.

I.INTRODUCTION

In conventional system, the power to the vehicle is only by means of ICE, these results in fuel consumption. As vehicle is a mode of transport to everyone, there is a tremendous increase in usage of two wheelers in the last decade of years. The accessibility of fossil fuels (petrol, diesel) is diminishing promptly as the usage and production of vehicles are getting increased year by year. To solve this problem, hybrid vehicles have been introduced but there are many disadvantages like high installation cost, high maintenance etc., when compared conventional vehicles.

Current energy policies address environmental issues including environmentally friendly technologies to increase energy supplies and encourage cleaner, more efficient energy use, and address air pollution, greenhouse effect, global warming, and climate change. The biofuel policy aims to promote the use in transport of fuels made from biomass, as well as other renewable fuels. Biofuels provide the prospect of new economic opportunities for people in rural areas in oil importer and developing countries. The central policy of biofuel concerns job creation, greater efficiency in the general business environment, and protection of the environment. Projections are important tools for long-term planning and policy settings. Renewable energy sources that use indigenous resources have the potential to provide energy services with zero or almost zero emissions of both air pollutants and greenhouse gases. Biofuels are expected to reduce dependence on imported petroleum with associated political and economic vulnerability, reduce greenhouse gas emissions and other pollutants, and revitalize the economy by increasing demand and prices for agricultural products.

In the proposed method, the vehicle primarily ignited with petrol and it moves to CNG (Compressed Natural Gas mode) hence the operational cost becomes very low as there is no cost for bio-fuel except the installation cost of the bio-waste plant. Here, Literature review of CNG Powered hybrid vehicle is presented in various sub-sections and arranged according to past to present. Most of the published papers on Hybrid with natural gas are about the applications with CNG to meet the needs of people. Many of them generally mention about technology, economy, emission, eco-friendly etc. Advantages of natural gas and eco-friendly systems are also generally reported in several papers.

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Lynn J. Cunningham, Beth A. Roberts, Bill Canis, Brent D. Yacobucci (1970) they did for a wide array of federal incentives supports the development and deployment of alternatives to conventional fuels and engines in transportation. These incentives include tax deductions and credits for vehicle purchases and the installation of refueling systems, federal grants for conversion of older vehicles to newer technologies, mandates for the use of bio-fuels, and incentives for manufacturers to produce alternative fuel vehicles. Many of the policy choices presented for alternative fuel and advanced vehicle technologies originated as a response to the nation's interest in reducing petroleum imports, a goal first articulated at the time of the two OPEC oil embargoes in the 1970s. While President Richard Nixon is often cited as the first President to call for "energy independence," successive Presidents and Congresses have made efforts to reduce petroleum imports as well.

C. P. Sigar, S. L. Soni, J. Mathur, D. Sharma (2008) Inedible vegetable oils that can be extracted from unexploited forest produce can provide solutions to energy requirements at the grass roots level, thus obviating dependence on fossil fuels. Short-term compression ignition engine tests were carried out using karanj (*Pongamia pinnata*) oil alone and also by blending it with diesel. The calorific value of karanj oil was 14.77% less than that of diesel. Due to its high viscosity (28.63 at 40°C), the brake specific fuel consumption and brake thermal efficiency were observed to be higher and lower, respectively, in the case of karanj oil, than those obtained from diesel. But, by blending karanj oil with diesel, the difference was minimized. The performance of karanj oil was comparable to that of diesel when blended with it in 20:80 (v/v) ratios. The smoke density and total hydrocarbons in the emissions of K20 blend were higher than that of diesel fuel, but considerable reductions in CO and NO_x were obtained.

Elisabeth Wetterlund, Karin Pettersson, Mimmi Magnusson(2009) are show the effects of expanding the system when evaluating well-to-wheel (WTW) CO₂ emissions for biomass-based transportation, to include the systems surrounding the biomass conversion system. Four different cases are considered: DME via black liquor gasification (BLG), methanol via gasification of solid biomass, lignocellulosic ethanol and electricity from a biomass integrated gasification combined cycle (BIGCC) used in a battery-powered electric vehicle (BPEV). All four cases are considered with as well as without carbon capture and storage (CCS). System expansion is used consistently for all flows. The results are compared with results from a conventional WTW study that only uses system expansion for certain co-product flows. It is shown that when expanding the system, biomass-based transportation does not necessarily contribute to decreased CO₂ emissions and the results from this study in general indicate considerably lower CO₂ mitigation potential than do the results from the conventional study used for comparison. It is shown that of particular importance are assumptions regarding future biomass use, as by expanding the system, future competition for biomass feedstock can be taken into account by assuming an alternative biomass usage. Assumptions regarding other surrounding systems, such as the transportation and the electricity systems are also shown to be of significance Of the four studied cases without CCS, BIGCC with the electricity used in a BPEV is the only case that consistently shows a potential for CO₂ reduction when alternative use of biomass is considered. Inclusion of CCS is not a guarantee for achieving CO₂ reduction, and in general the system effects are equivalent or larger than the effects of CCS.

Amela Ajanovic(2011) did for rapidly growing fossil energy consumption in the transport sector in the last two centuries caused problems such as increasing greenhouse gas emissions, growing energy dependency and supply insecurity. One approach to solve these problems could be to increase the use of bio-fuels. Preferred feed stocks for current 1st generation bio-fuels production are corn, wheat, sugarcane, soybean, rapeseed and sunflowers. The major problem is that these feed stocks are also used for food and feed production. The core objective of this paper is to investigate whether the recent increase of bio-fuels production had a significant impact on the development of agricultural commodity (feedstock) prices. The most important impact factors like bio-fuels production, land use, yields, feed stock and crude oil prices are analyzed. The major conclusions of this analysis are: In recent years the share of bio-energy-based fuels has increased moderately, but continuously, and so did feedstock production, as well as yields. So far, no significant impact of bio-fuels production on feedstock prices can be observed. Hence, a co-existence of bio-fuel and food production seems possible especially for 2nd generation bio-fuels. However, sustainability criteria should be seriously considered. But even if all crops, forests and grasslands currently not used were used for bio-fuels production it would be impossible to substitute all fossil fuels used today in transport.

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II. CONSTRUCTION

2.1 CNG Powered Hybrid Vehicle



Fig.1CNG Powered Hybrid Vehicle

The proposed Hybrid (petrol – CNG) vehicle initially runs with petrol as a fuel. The fuel from the storage tank is supplied to carburetor due suction effect created in engine cylinder. The carburetor mix air and fuel based on the requirement (10:1) and supply it to engine cylinder. The piston compresses the air fuel mixture at compression stroke in engine cylinder. When spark is produced by spark plug combustion of fuel takes place. Due to combustion high heat energy is generated inside the cylinder that expands piston. After expansion burnt gases are getting exhausted in outlet valve. When engine cylinder reach the ignition temperature of CNG fuel vehicle mode changed to CNG mode. In CNG Mode, Compressed natural gas from storage tank(in high pressure) is supplied to Carburetor through conversion kits like Regulator, Injector, Refilling port, Supply tubes, Pressure Gauges. In carburetor mixing ratio in rate of 13:5. Then the air fuel mixer supplied same gasoline mode. During using of CNG as a fuel it provide more efficiency than gasoline. CNG also produces less hydrocarbon and carbon monoxide.

2.1.1CNG MODE

In this mode, Natural gas plays a major role as a source to the vehicle. Natural gas is a Hydro Carbon gas mixture in which methane is a primary element. The mixture of gases in Natural gas and its constituents is given below.

CONSTITUENTS	PERCENTAGE (%)
Methane	88.5
Ethane	5.5
Propane	3.7
Butane	1.8
Pentane	0.5

Table 1: Constituents of various gases in the Natural gas

Ignition Temperature is a major parameter while choosing a transportation fuel. It is the temperature at which the fuel gets ignited. The proposed vehicle initially cannot be started with CNG MODE as the ignition temperature of CNG is 300 - 350 Celsius hence, the vehicle should be ignited with petrol and after reaching the Ignition temperature of the CNG, the mode of the vehicle can be brought to CNG.

From the above table it is obvious that, when the vehicle runs on CNG mode it emits very less CO (Carbon monoxide) and HC (Hydro Carbons). Thus the vehicle will be a less pollutant one when compared to conventional vehicles.

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2.2 COMPONENTS OF CNG POWERED HYBRID VEHICLE

- ❖ CNG Storage Tank
- ❖ Fuel Regulator
- ❖ Fuel Supply Hose
- ❖ Fuel Injector

2.2.1 CNG STORAGE TANK

Storage tanks are containers that hold compressed gases (gas tank) used for the short- or long-term storage.



FIGURE .2 CNG TANK



FIGURE 3 CUT SECTION

In case of compressed gas such as compressed natural gas or MAPP, the storage tank must be made to withstand the sometimes immense pressures exerted by the contents. While steel and concrete remain one of the most popular choices for tanks, glass, thermoplastic and polyethylene tanks are increasing in popularity.

They offer lower build costs and greater chemical resistance, especially for storage of special chemicals. There are several relevant standards, such as British Standard 4994 (1989), DVS (German Welding Institute) 2205, and ASME (American Society of Mechanical Engineers) RTP-1 which give advice on wall thickness, quality control procedures, testing procedures, accreditation, fabrication and design criteria of final product.

Tank Specification:

Type	: G – High pressure cylinder
Length	: 20 inches (510mm)
Diameter	: 6 inches (150mm)
Average Weight	: 13 Kg
Capacity	: 7 Kg
Max. Pressure	: 230 – 275 bar (2000 -3000 psi)

2.2.2 STANDARD SYMBOLS

These are symbols used in various countries to indicate the vehicle running with CNG.



FIGURE 4 SYMBOLS

2.2.3 FUEL PRESSURE REGULATOR

A pressure regulator is a valve that automatically cuts off the flow of a liquid or gas at a certain pressure. Regulators are used to allow high-pressure fluid supply lines or tanks to be reduced to safe and usable pressures for various applications.

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FIGURE.5. REGULATOR

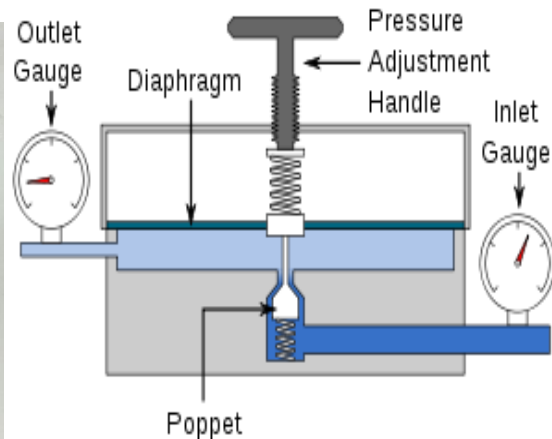


FIGURE .6.Pressure Regulator

A pressure regulator's primary function is to match the flow of gas through the regulator to the demand for gas placed upon the system. If the load flow decreases, then the regulator flow must decrease also. If the load flow increases, then the regulator flow must increase in order to keep the controlled pressure from decreasing due to a shortage of gas in the pressure system.

- ❖ A pressure regulator includes a *restricting element*, a *loading element*, and a *measuring element*:
- ❖ The restricting element is a valve that can provide a variable restriction to the flow, such as a globe valve, butterfly valve, poppet valve, etc.
- ❖ The loading element is a part that can apply the needed force to the restricting element. This loading can be provided by a weight, a spring, a piston actuator, or the diaphragm actuator in combination with a spring.
- ❖ The measuring element functions to determine when the inlet flow is equal to the outlet flow. The diaphragm itself is often used as a measuring element; it can serve as a combined element.
- ❖ In the pictured single-stage regulator, a force balance is used on the diaphragm to control a poppet valve in order to regulate pressure. With no inlet pressure, the spring above the diaphragm pushes it down on the poppet valve, holding it open. Once inlet pressure is introduced, the open poppet allows flow to the diaphragm and pressure in the upper chamber increases, until the diaphragm is pushed upward against the spring, causing the poppet to reduce flow, finally stopping further increase of pressure.
- ❖ By adjusting the top screw, the downward pressure on the diaphragm can be increased, requiring more pressure in the upper chamber to maintain equilibrium. In this way, the outlet pressure of the regulator is controlled.

Parameters and Specification:

Type : Single stage Regulator
Control Method : Manual and Presetting
Outlet Pressure : 230mpa
Method : Diaphragm operated
Adjusting Method: Screw type
Connection : Directly connected to Cylinder
Pressure Input : 200mpa to 300mpa

2.2.4 FUEL INJECTOR

The Fuel Injector is a device that injects fuel to inlet port with proper compression ratio.

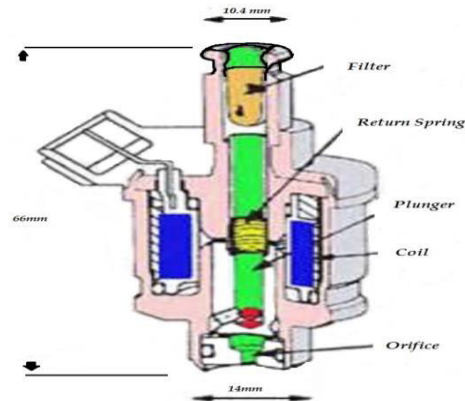
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FIGURE .7.FUEL INJECTOR



FIGURES8 .DIMENSIONS OF INJECTOR

The compression ratio of the injector, P_2/P_1 , is defined as ratio of the injector's outlet pressure P_2 to the inlet pressure of the suction fluid P_1 . The compression ratio and the entrainment ratio are key parameters in designing an injector or ejector.

Parameters:

Ratio	: 13: 5: 1
Injection Pressure	: 230mpa
Type	: Single Point Injection
Control	: Electronic Control
Length of Nozzle	: 66mm
Nozzle diameter	: 14mm
Inlet Diameter	: 10.4mm
CNG ratio	: 13: 5

2.2.5 CNG SUPPLY HOSE

CNG supply Hose is long cylindrical tubes that supply fuel from one port to another port at High pressure.



FIGURE.9.HOSE

These tubes are made to withstand high pressure intensity and also it suitable to all kind environment condition. It available in different shapes and size according to place of usage it will be varied. It consists of two ends which connect two ports.

Materials of these tubes are different for different kind of application. Materials of these tubes are like steel, polyethylene, polyurethane.

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III. WORKING PRINCIPLE

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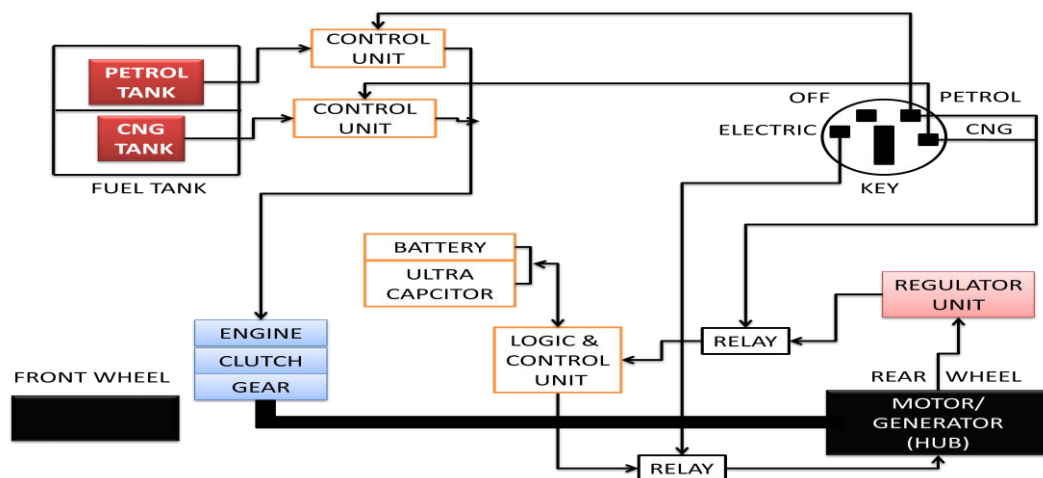


Fig.10 Schematic Arrangement of CNG Powered Hybrid Vehicle

When spark is produced by spark plug combustion of fuel takes place. Due to combustion high heat energy is generated inside the cylinder that expands piston. After expansion burnt gases are getting exhausted in outlet valve. When engine cylinder reach the ignition temperature of CNG fuel vehicle mode changed to CNG mode.

In CNG Mode, Compressed natural gas from storage tank(in high pressure) is supplied to Carburetor through conversion kits like Regulator, Injector, Refilling port, Supply tubes, Pressure Gauges. In carburetor mixing ratio in rate of 13:5. Then the air fuel mixer supplied same gasoline mode. During using of CNG as a fuel it provide more efficiency than gasoline. CNG also produces less hydrocarbon and carbon monoxide.

IV. SPECIFICATIONS OF CNG POWERED HYBRID VEHICLE

ENGINE	4-STROKE,AIR COOLED OHC
NUMBER OF CYLINDER	1
DISPLACEMENT	109.7cc
BORE *STROKE(mm)	53.5*48.8
COMPRESSION RATIO	9.8 : 1
Max. Power	6.1 KW @ 7500rpm
Max. Torque	8.1 Nm @ 5000rpm
CLUTCH	Wet, Multi –Plate
TRANSMISSION	4 –Speed constant mesh
IGNITION	VTi with high energy ignition system

Table.3 General

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CHASSIS

TYPE	Single Cradle, Tubular
SUSPENSION (Front)	Telescopic Fork (105mm Stroke)
SUSPENSION (Rear)	Hydraulic, Co-axial Spring, Triple rated, Two way adjustable

Table.4.CHASIS

BRAKES & WHEELS

FRONT BRAKE	110mm / 130mm Drum
REAR BRAKE	110mm / 130 mm Drum
TYRES	Front – 2.75*18 Rear – 3.00*18(1.6*18)

Table.5.Brake & Wheels

DIMENSIONS

WHEEL BASE	1250mm
LENGTH	2005mm
GROUND CLEARANCE	165mm
SPOKE WHEEL	110Kg

Table.6.Dimensions

V. COMPARISION RESULT

PARAMETERS	CONVENTIONAL VEHICLE	PROPOSED HYBRID VEHICLE
Major Parts	a. IC Engine	a.IC Engine b. DC Hub Motor/generator c.Battery d. Ultra Capacitor
Assume that vehicle is running at a constant speed of 50kmph and mileage of the vehicle is 50Kmpl. The calculation is done on the basis of distance covered by vehicle and source utilized to drive a vehicle is shown below.		
Source utilized	1 Liter	50ml of petrol (for ignition purpose) + 1Kg of Biofuel
Recovered energy	-	5 KW/hr (Engine Mode + CNG Mode)
Total distance travelled	50 Km (1 liter)	100Km 50 Km on engine mode with (CNG as a fuel). While running on CNG mode, the battery gets charge in 1 hr. once the battery gets fully charged it run for 2 hrs with constant load current of 20A. As the speed is assumed to be constant 50Kmph and battery backup will be 1hr for load current 20A. The vehicle can cover 100 Km
Fuel cost	Rs. 75	Rs. 45 (bio-fuel has no fuel cost but this represent the maintenance of the biomass plant & the maintenance of electrical systems in the vehicle)
Cost for 1Km Drive (Rs.)	Rs.1.50	Rs. 0.45
Amount of Fuel (Liters) (Assume that vehicle is running	600	300

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30000 Km/ Year.)		
The fuel cost in Rs.	45,000	13,500
Vehicle initial cost in Rs.	50,000	IC Engine Vehicle 50,000
		CNG Arrangement 15,000

Table.7.COMPARISON44422

PARAMETERS	CONVENTIONAL VEHICLE	PROPOSED VEHICLE
Initial Cost (Rs.)	50,000	95,000
% of increased initial cost	-	37.5 % $((80,000-50,000)/ 80,000)*100$
Fuel (liters)	600	300
Fuel Cost (Rs.) (Considered 75Rs./Lt)	$600*75 = 45,000$	$300*45 = 13,500$
Cost of Fuel saved in proposed system (Rs.)	-	(fuel cost of conventional vehicle) - (fuel cost of bio fuel powered vehicle) $45,000 - 13,500 = 31,500$

Table.8.Payback

VI. CONCLUSION

In conventional system, the power to the vehicle is only by means of ICE, these results in fuel consumption. As vehicle is a mode of transport to everyone, there is a tremendous increase in usage of two wheelers in the last decade of years. The accessibility of fossil fuels (petrol, diesel) is diminishing promptly as the usage and production of vehicles are getting increased year by year. To solve this problem, hybrid vehicles have been introduced but there are many disadvantages like high installation cost, high maintenance etc., when compared conventional vehicles.

In the proposed method, the vehicle primarily ignited with petrol and it moves to CNG (Compressed Natural Gas mode) hence the operational cost becomes very low as there is no cost for bio-fuel except the installation cost of the bio-waste plant.

Thus Vehicle produces less emission of carbon monoxide and Hydrocarbon which pollute our environment. In future by use of this vehicle definitely get increase while conventional fuels are not available. And our implementation will be needed to country like India and other growing countries.

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