

A Review on Implementation of CNG on Two Wheelers

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Abstract— Man has always been in need for energy to meet his increasing demands. In last decades, pollution emission generated by road transport sector has increased and becoming worse day by day. Depletion of petroleum (oils) deposits and increasing costs and pollution has led Engineers to search for alternative fuels that are eco-friendly as well as less costly. Environmental pollution due to vehicles is biggest problem that world faces today. The only way to decrease the amount of pollution is by using alternate solutions that are more eco-friendly [1]. CNG is an alternative way for reducing pollution. Compressed Natural Gas (CNG) is environment friendly and one of the cleanest burning transportation fuel in the market today. Petrol Fuel can be replaced by CNG readily using a conversion kit. As in India the number of two wheelers is more compared to other vehicles on roads. So implementing CNG on two wheelers can be beneficial for obtaining an eco-friendly environment.

Key words: Implementation of CNG on Two Wheelers, NAAQS, CNG Cylinder

I. INTRODUCTION

Motor vehicles are identified with increasing the rate of air pollution levels in urban parts of the world. Substantial CO₂ emission, significant quantities of CO, HC, NO_x, SPM and air toxins are emitted, causing serious environmental and health impacts. Like many other parts of the world, air pollution from two wheelers is one of the most serious and rapidly increasing problems in urban parts of India [2]. In India, the number of two wheeler has grown from 0.3 million in 1951 to approximately 50 million in 2010 of which two wheelers account for more than 70 percent of the total vehicular population. Moreover 25% of the total energy in the country is consumed by the road transport sector of which 95% comes from crude oil. The higher consumption of gasoline has lead to increase in air pollution loads and deterioration in air quality especially in metropolitan areas. Air pollution levels exceeds the limits of NAAQS (National Ambient Air Quality Standards) in large urban parts [3]. Vehicles emission has been identified as one of the major contributors in worsening air quality. India is facing serious environmental problems due to increasing vehicular emissions and high concentrations of pollutants in its urban atmosphere.

II. LITERATURE REVIEW

U.S. Environmental Protection Agency (EPA) declared four wheelers as "mobile sources" of pollution; they are not the only culprits. Two wheelers, bulldozers, ships and boats, big trucks, trains and even snow blowers pollute the air. According to the EPA, two wheelers collectively cause upto 75 percent of carbon monoxide pollution in the U.S. The Environmental Defense Fund (EDF) estimates that road vehicles cause one-third of the air pollution which produces

smog in the U.S., and transportation causes 28 percent of greenhouse gas emissions. The U.S. has 35 percent of the globe's automobiles; still it contributes half of the world's emissions from four wheelers [2]. The United States was long considered as the world's biggest polluter with respect to carbon dioxide and other greenhouse gases, but by 2008, the United Nations reported that China had moved to the top position. The two-wheeler market of China is the largest in the world, standing in 2010 at over 100 million, two-wheelers running on petrol engine. The second-largest two-wheeler market is in India estimated at 56 million units mainly petrol in 2015. In OECD countries uptake is much less; Europe is the largest market outside of Asia, with 38 million units in circulation. Two-wheelers market is split between high quality vehicles used in developed countries and lower quality cheaper vehicles in developing countries. The air pollution levels generally cross the NAAQS and WHO guidelines. It has been reported that contribution of motor vehicle emissions to total air pollution has increased from 43% in 1981 to 65% in 1991 and projected to increase to 82% in 2020. It has also been estimated that motor vehicles account for approx. 97% of total HC, 48% of NO_x, 76% of CO, 10% of SPM and 6% of SO₂ emissions in India.

III. INTRODUCTION OF CNG

CNG is known for Compressed Natural Gas. CNG gas is marginally cheaper than ordinary gasoline or diesel. In addition, the CNG is considered to be environment friendly. There are less pollutants associated with compressed natural gas being ignited, and studies show that it gives 40 percent less greenhouse gas. It is a gaseous fuel and mixture of hydrocarbons, mainly methane in the range of 95%. Due to its low density, it is compressed to a pressure of 210 bar to enhance the vehicle on-board storage capacity. These properties of CNG make it a safe fuel. It is lighter as compared to air, and hence in case of leakage it disperses into the atmosphere rapidly. Its high auto-ignition temperature of 540 Degrees Celsius as against petrol's 360 Degrees Celsius makes it even more safe fuel. CNG also has a narrow range of in flammability of 5% to 15%, making it much safer than other fuels.

IV. IMPLEMENTATION OF CNG ON TWO WHEELER

We don't need to buy new CNG-powered vehicles to start using clean and safe CNG and reduce your carbon footprint. Any vehicle running on gasoline can be converted to CNG. Natural gas conversion may cost a significant amount of money. At the conversion center, there are skilled technicians that can install compressed natural gas (CNG components to your existing vehicle) [1]. These components when installed make CNG the primary fuel for your vehicle with gasoline as the back-up fuel. A fuel selection switch can be installed (usually on the dashboard) that will allow the driver to manually select either CNG or gasoline. CNG

storage cylinders will also be installed underneath the vehicle or in the trunk. Stainless steel lines and tubes will transport the CNG to regulator present in the vehicle's engine compartment to reduce the pressure. The CNG will then pass through a fuel-air mixer to the intake manifold which is to be introduced for combustion. Having a dual fuel system will ensure that there is adequate fuel reserves in between the natural gas fills. Drivers can switch from CNG to gasoline even while driving, idling or parked. Some CNG systems switch automatically to gasoline when the natural gas level reaches a present low pressure setting.

Initially in four wheelers, CNG is fed into the high pressure cylinders through the natural gas receptacle, when the engine needs natural gas CNG leaves the storage cylinders and passes through the master manual shut-off valve. CNG then enters the engine chamber via the stainless steel high pressure line. The regulator then accepts the CNG and it reduces its pressure from 3,000 psi to approximate atmospheric pressure. The natural gas solenoid valve helps the natural gas flow from the regulator into the gas mixer or fuel injectors. This same solenoid valve also shuts off the natural gas when the engine is stopped. CNG mixes with air and flows down through the carburetor or fuel injection system and enters the engine's combustion chambers.

V. COMPONENTS REQUIRED

For a CNG conversion of a two wheeler it basically requires a conversion kit. Conversion kit includes regulator, solenoid valves, low pressure hose, pressure gauge. And to store the gas it requires a storage tank i.e. cylinder. Basically CNG is stored at high pressure inside cylinder it is supplied to the engine using transfer lines made of stainless steel. Then it is passed to regulator in which the pressure of 200-250 bar is reduced to atmospheric pressure and supplied by the low pressure hose to the solenoid valve which is required for shut off, release, dose, and mixing purposes. Then CNG is passed to intake manifold of the engine at low pressure.

VI. CNG CYLINDER

All CNG tanks are of cylinder shape with a semi-spherical shape covering each end. The cylinders and their semi-spherical shapes provides the strongest structural shape because of the circular and the spherical shapes that are provided for equal distribution of stresses throughout the inner area of the tank which produce the highest safety for high-pressure vessels. Differentiation between the four types of CNG cylinders are the type of materials used to create the basic structure of the tank, the materials used to wrap the inside and outside of the tank, and how they are manufactured [1]. The types of materials that are used to create the structure of the tank determine the weight and cost of the tank. Heavier tanks are the least expensive and the lighter tanks are more expensive. The materials used for the tank are used to add not only strength, but also protection from corrosion. All gasses have the capability to cause corrosion. For example, the air we breathe and exhale is a gas. If we leave metal to sit out in the open air, it soon oxidizes or corrodes. Therefore, to protect the integrity of the tank, tanks are lined inside and are covered outside. CNG cylinders are basically available in four different types. Type 1 cylinders are among the heaviest and also

least expensive, and the Type 4 cylinders are lightest and the most expensive. Cylinders are available at large range of size and configurations. It is then also possible to install more than one tank within one vehicle. CNG stored in on-board vehicles that are in high working pressure are rated at either 3,000psi or 3,600psi pounds per square inch. Therefore, CNG cylinders meet very rigorous safety standards. Cylinders withstand impact and puncture because of high strength materials. Capacity of CNG cylinder is measured in gasoline-gallon equivalents (GGE). Because of the natural gas that remains in a gaseous state when compressed, a GGE of CNG is calculated which is based on the equivalent energy content of a gallon of gasoline.

The seamless steel cylinders that are manufactured by closing bottom and neck forming on CNC hot spinning machines and they are subjected to all internal test and controls at every stage of production to assure a quality product with cylinders diameters ranging from 76mm to 406mm. Accessories such as neck ring, valve fixing, cap, and guard are fitted on cylinders as per customer's requirement.

34CrMo4, 34CrMoS4 30CrMo, 37Mn, 35CrMo are some of the most used composite materials for manufacturing CNG cylinders. Composite materials have different properties such as Cr has high strength as well as corrosion resistant. Molybdenum is having properties such as it can withstand high temperatures as well as it is corrosion resistant and also has high weldability. Combined it forms a composite material which makes them more superior for use as a storage tank for CNG.

For two wheelers, it requires a tank that is light in weight as well as having less capacity as the capacity increases the size increases therefore the weight increases.

Therefore it requires a small tank of about 2-4kg capacity with minimum weight of 1 kg or less.

VII. ADVANTAGES

CNG does not have any lead contents; thereby it eliminates fouling of spark plugs. CNG powered vehicle have low maintenance cost than any other hydrocarbon-fuel powered vehicle. The CNG fuel systems are sealed, which prevents the fuel loss from spills or evaporation. It has increased life of lubricating oils, because CNG do not contaminate and dilute the crankcase oil. CNG is gaseous fuel and it mixes easily and evenly in the air. CNG is less likely to have ignition on hot surfaces, since it has some high auto-ignition temperature (540 °C), and a narrow range (5–15 percent) of flammability. CNG creates less pollution and more efficiency. CNG gives significantly lesser pollutants than petrol (e.g., carbon dioxide (CO₂), unburned hydrocarbons (UHC), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x) and PM (particulate matter). For example, an engine which is running on petrol for 100 km gives 22 kilograms of CO₂, while covering the same distance on CNG gives only 16.3 kg of CO₂. In CNG the Carbon monoxide emissions are reduced even further. Switching to CNG can help mitigate greenhouse gas emissions due to its lower carbon dioxide and nitrogen oxides emissions. CNG-powered vehicles are considered safer than gasoline-powered vehicles. CNG tank requires

more storage space. CNG is less costly than other fuels and price fluctuation is rare in CNG.

VIII. SAFETY

Fewer undesirable gases are produced in CNG combustion than the other fuels. CNG is flammable but it has a narrow range of flammability, U.S. Environmental Protection Agency, making CNG a safe fuel for use. Strict safety standards make CNG vehicles safe as gasoline-driven vehicles. In the event of an accidental release or spill, CNG has no threat to land or water, as it is nontoxic in nature. CNG disperses rapidly, minimizing ignition risk when compared to gasoline. It will not pool as a liquid or vapor as natural gas is lighter than air if leaked. CNG is primarily hydrocarbon mainly methane, which is a GHG that could contribute to global climate change if leaked [1]. The gas can bubble in water creating a possible risk of fire or explosion if an excess amount accumulates.

IX. CONCLUSION

CNG is viable or preferable because it has a host of advantages as against traditional fuels. CNG is available in abundance, environment friendly and economic. Continuous rise in the price of petrol and diesel alternative fuels are becoming the preference of Indian consumers. CNG hosts an advantage than other fuels related to environmental hazards. CNG is safer because of its high ignition temperature than petrol and diesel. CNG bike can also run by petrol so it is also called as Hybrid Bike.

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