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PERFORMANCE AND EMISSION CHARACTERISTICS OF BROWN'S GAS ENRICHED AIR IN SPARK IGNITION ENGINE

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Abstract: The world is facing declining liquid fuel reserves at a time when energy demand is exploding. As the supply decreases and costs rise, everyone will be forced to adopt the alternative energy resources. In order to achieve a secure and stable energy supply that does not cause environmental damage, renewable energy sources must be explored and promising technologies should be developed. Considering various gaseous fuels, Brown's gas produced by the electrolysis process has the high potential for cost effective and emission aspects. It is identified as the one of the best partial alternate gaseous fuel to be enriched with intake air in a spark ignition engine or compression ignition engine. The present investigation involves the usage of Brown's gas in SI engines. The experiment was carried out in a 100 cc single cylinder air cooled engine at 1500 rpm for various loads. The performance characteristics such as Brake thermal efficiency and Specific fuel consumption and emission characteristics such as Carbon monoxide (CO), Unburnt hydrocarbon (UBHC), Smoke (BSN) and Oxides of Nitrogen (NOx) were studied. The results are compared and found that the Brown's gas enriched operation gives better results when compared with conventional engine operation.

Keywords: Spark Ignition (SI), Compression Ignition (CI), Brake Power (BP), Brake Thermal Efficiency (BTE), Total Fuel Consumption (TFC), Specific Fuel Consumption (SFC), Unburnt Hydrocarbon (UBHC), Carbon Monoxide (CO), Oxides of Nitrogen (NOx), Bosch Smoke Number (Smoke Emission).

I.INTRODUCTION

Hydrocarbon fuel is one of the sources of energy used for electrical power generation, heating and transportation in the world. But they have negative side effects like polluting emissions, large scale oil spill, etc. Due to its widespread dependence and difficulties in getting other alternatives the use of hydrocarbon fuel could not be eliminated. To mitigate the above problems and to reduce the use of hydrocarbon fuel, hydrogen gas can be supplemented. Hydrogen gas to air intake of a combustion process will improve flame speed, lean burn ability and flame quenching distance. But scarcity and production cost makes it more difficult to implement. Hydrogen rich gas produced from electrolysis of water called the Brown's Gas or HHO could solve the potential difficulties. Moreover, it has its properties that make more reactive than standard bottled hydrogen. It improves engine emission, performance and fuel efficiency when powered by engines electrical system fitted with other generator or automobile engine.

All internal combustion engines depend on the combustion of a chemical fuel typically with oxygen from air. It produces heat steam, carbon-di-oxide and other chemicals at a very high temperature. The most common modern fuels are derived from fossils fuels like gasoline, petroleum gas and the propane. These engines are designed for gasoline use and the diesel engines run with air mixed with gas and a pilot diesel fuel injection. For this, ethanol and a form of diesel fuel produced from crops can also be used.

II.HYDROGEN AS A FUEL FOR IC ENGINES

Hydrogen could eventually replace conventional fossil fuels in traditional internal combustion engines. Alternatively fuel cell technology may come to deliver its promise and the use of the internal combustion engines could even be phased out.

Although there are multiple ways of producing free hydrogen, those methods require converting combustible molecules into hydrogen or consuming electric energy. The disadvantage of hydrogen, relative to carbon fuels, is its storage. Liquid hydrogen has extremely low density (14 times lower than water) and requires extensive insulation—whilst gaseous hydrogen requires heavy tankage. Even when liquefied, hydrogen has a higher specific energy but the volumetric energetic storage is still roughly five times lower than petrol. However, the energy density of hydrogen is considerably higher than that of electric batteries, making it a serious contender as an energy carrier to replace fossil fuels. The Hydrogen on demand

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process creates hydrogen as it is needed, but has other issues such as the high price of the sodium borohydride which is the raw material.

III.THEORY OF BROWN'S GAS

Brown's gas is a mixture of monatomic and diatomic hydrogen and oxygen and a special form of water called Electrically Expanded Water (EEW) or Santilli Magnecules. Brown's Gas is produced by a similar design of the electrolyzer that will split water into its various components. Brown's gas has a plethora of unusual characteristics that seem to defy current chemistry. The goal is to confirm claims of the Brown's gas and to help solidify the current theory of Brown's gas. George Wiseman defines Brown's gas as: "The entire mixture of gases evolving from an electrolyzer specifically designed to electrolyze water and not to separate the resulting gases."

IV.BROWN'S GAS ELECTROLYSER

Electrolyzer is a fancy word for hydrogen generator. Electrolyzers make hydrogen by passing an electric current through water containing an electrolyte as shown in Fig 1. The diagram clearly represents a schematic view of the Brown's gas electrolyzer. The electromagnetic field changes the atomic structure of the hydrogen (H2) and oxygen (0) found in water from diatomic to monatomic. In addition, the neutron bond holding H & 0 together releases. As H & 0 separate, H is drawn to the positive and 0 to the negative terminal of the electrolyzer. This is called disassociation. As the process continues, volume increases, and the H & 0 gas bubbles which stick to the fins of the electrolyzer become dislodged and float to the top. As the monatomic hydrogen and oxygen gas bubbles break the surface of the water they recombine in the air space in the top of the electrolyzer as Brown's gas.

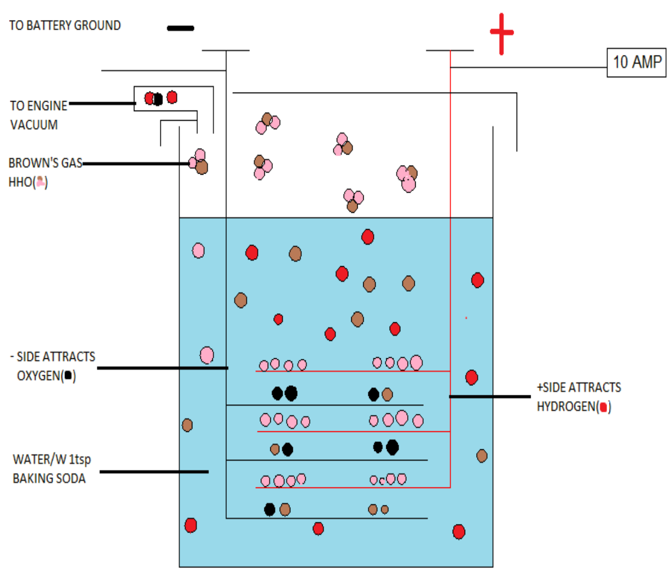

Figure 1: Schematic of Brown's Gas Electrolyzer

V.EXPERIMENTAL SET UP OF THE TEST ENGINE

Fig 2 shows the experimental set up of the test engine. After the production of Brown's gas, it is directed to the engine by the sealed piping. The piping is connected to the passage between the carburettor and air filter. The engine is allowed to operate with Brown's gas enriched air. At this instant, time taken for 10cc fuel consumption is noted at three load conditions; viz- No load, Half load and Full load. Emission characteristics of the test engine after using Brown's gas enriched air is measured with the exhaust gas analyzer.

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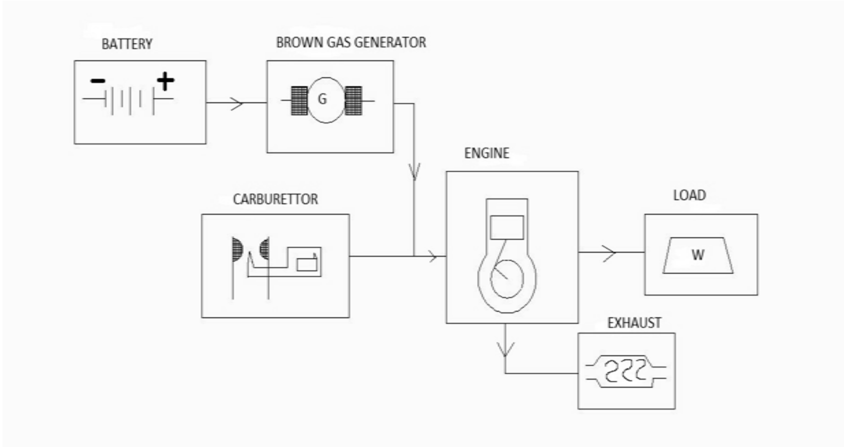

Figure 2: Experimental set up of the Test Engine

Engine Specification

Table 1: Engine Specification

Engine	Splendor, Air cooled
Cubic Capacity	100 cc
Stroke	4 Stroke
Brake Power	7.37 HP (5.4KW) @ 8000 RPM
Speed	1500 RPM
Number of Cylinders	Single
Radius of the Brake Drum	0.083m

VI.PERFORMANCE CHARACTERISTICS

Brake Power (BP)

Brake Power is the actual work output of the engine available at the crankshaft and is obtained by the means of some form of a brake. Fig 3 shows the characteristic curves of load with brake power for gasoline fuel and gasoline with Brown's gas. Figure illustrates that there is a increase in the Brake power for gasoline with Brown's gas fuel.

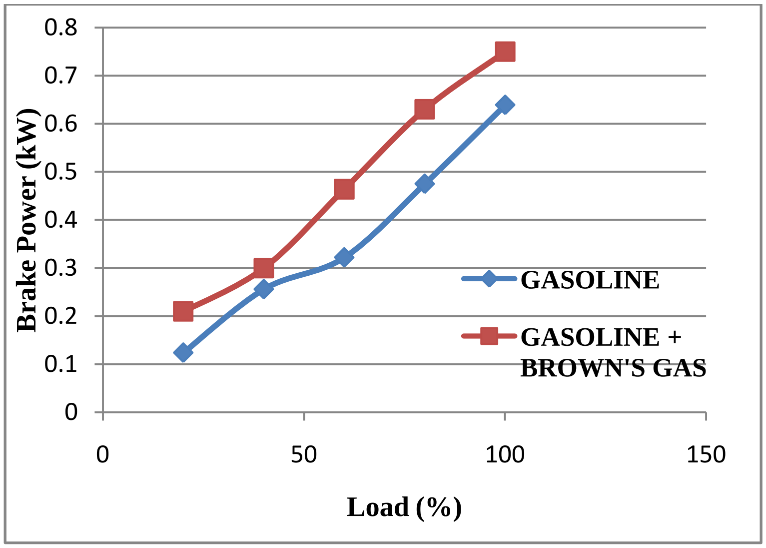

Figure 3: Comparison of Brake Power

Brake Thermal Efficiency (BTE)

Brake Thermal Efficiency indicates the fraction of heat supplied that is transformed into engine shaft work. Fig 4 shows the variation of load with Brake thermal efficiency values for gasoline and gasoline with Brown's gas fuel. Graph shows the steep increase in the Brake thermal efficiency for gasoline with Brown's gas.

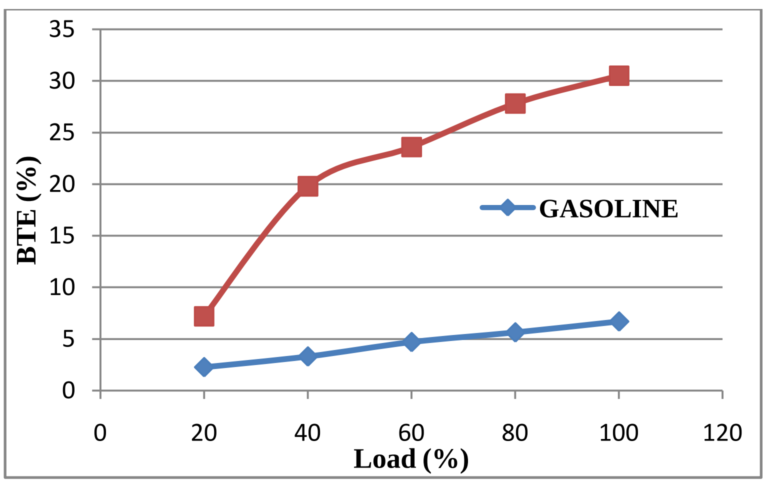

Figure 4: Comparison of Brake Thermal Efficiency

Total Fuel Consumption (TFC)

Total fuel Consumption for any fuel depends on the Brake power. Fig 5 illustrates the characteristic curves of load with Total fuel consumption for gasoline and gasoline with Brown's gas fueled engines. Graph shows the decrease in Total fuel consumption of the engine for Brown's gas enriched fuel than gasoline fuel. Since there is an increase in the Brake Power values for gasoline with Brown's gas fuel, the Total fuel consumption for gasoline with Brown's gas is reduced.

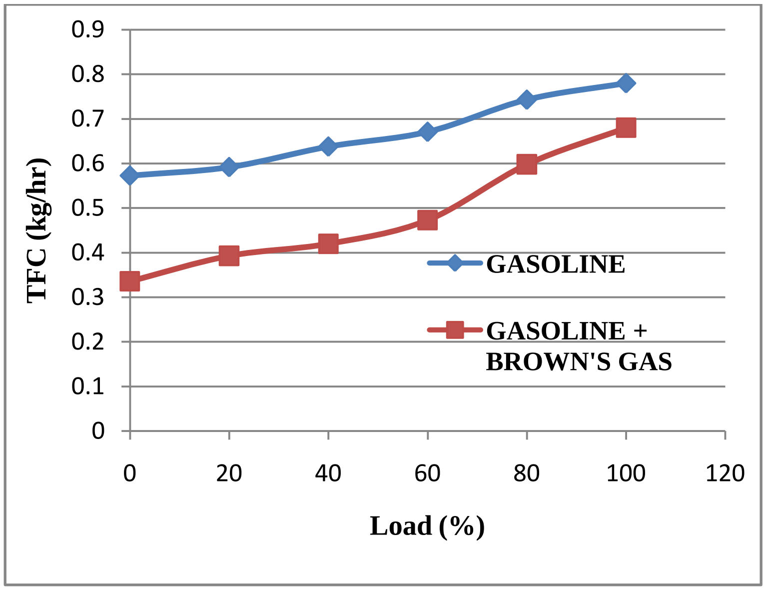

Figure 5: Comparison of Total Fuel Consumption

Specific Fuel Consumption (SFC)

Specific fuel Consumption is the fuel flow rate per unit of power. Fig 6 shows the curves for Specific fuel Consumption at various loading conditions for gasoline fuel and Brown's gas enriched fuel. There is a decrease in the Specific Fuel Consumption of Brown's gas enriched fuel when compared to that of gasoline.

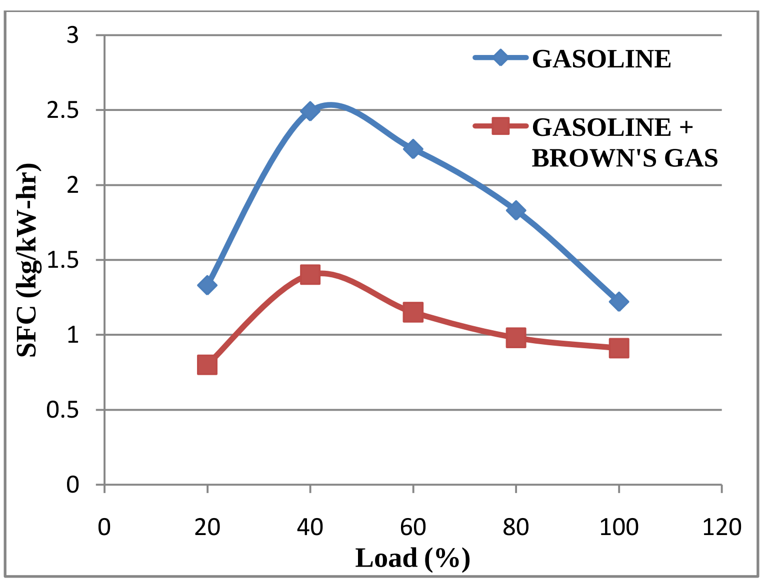

Figure 6: Comparison of Specific Fuel Consumption

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VII.EMISSION CHARACTERISTICS

UnBurnt HydroCarbon (UBHC)

As the Brown's gas engine operates at fuel-lean equivalence ratio, it has only one-fifth of the Unburnt Hydrocarbon emissions of a rich equivalence ratio operating engines. Gasoline engine operates at fuel-rich ratios and thus resulting in increased amount of Unburnt Hydrocarbon emissions compared to that of Brown's gas enriched air operating engines. Fig 7 shows the curves between load and Unburnt Hydrocarbons at various loads. It is inferred from the graph that the Hydocarbon emissions are reduced for the engines operating on gasoline with Brown's gas.

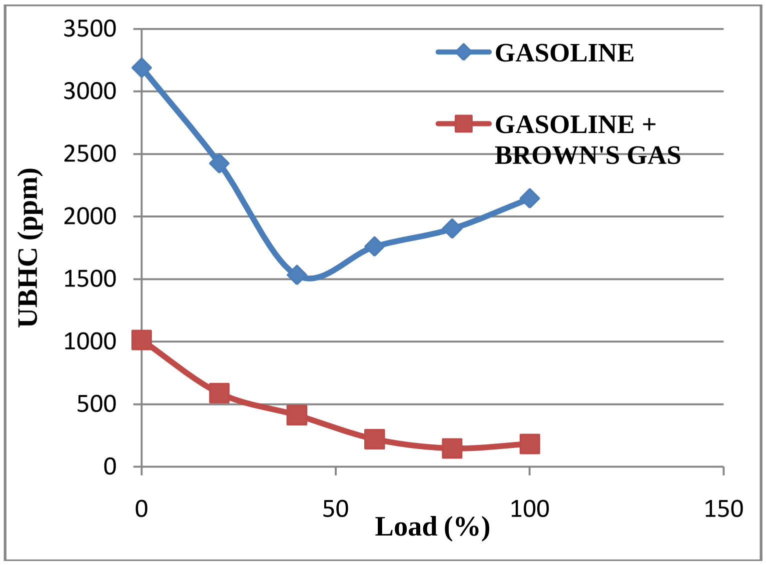

Figure 7: Comparison of Unburnt Hydrocarbon

Carbon Monoxide (CO)

Carbon Monoxide emissions are generated in an engine when it is operated with a fuel-rich equivalence ratio. These emissions can be reduced by operating the engines at leaner ratios. Brown's gas fueled engine can be operated at leaner ratios, thus resulting in reduced level of CO emissions. Fig 8 shows the reduction in Carbon Monoxide emission level for gasoline with Brown's gas fuel compared to that of gasoline fuel. This is because of the operation of the engine at lean ratios.

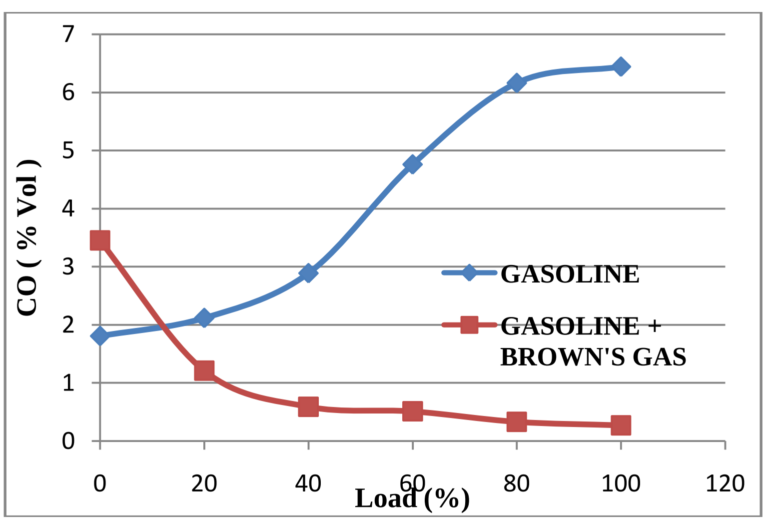

Figure 8: Comparison of Carbon Monoxide

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Oxides of Nitrogen (Nox)

It is a major constituent of exhaust from the engines. Exhaust gases of an engine can have up to 2000ppm of Oxides of Nitrogen. Most of them are nitrogen oxide with a small amount of nitrogen dioxide. The main advantage of using Brown's gas enriched fuel is that there is a significant reduction in the Nitrogen oxide emissions level. Fig 9 shows the curves of oxides of nitrogen emissions for gasoline and gasoline with Brown's gas. There is a decrease in the level of nitrogen oxide emissions for Brown's gas enriched fuel.

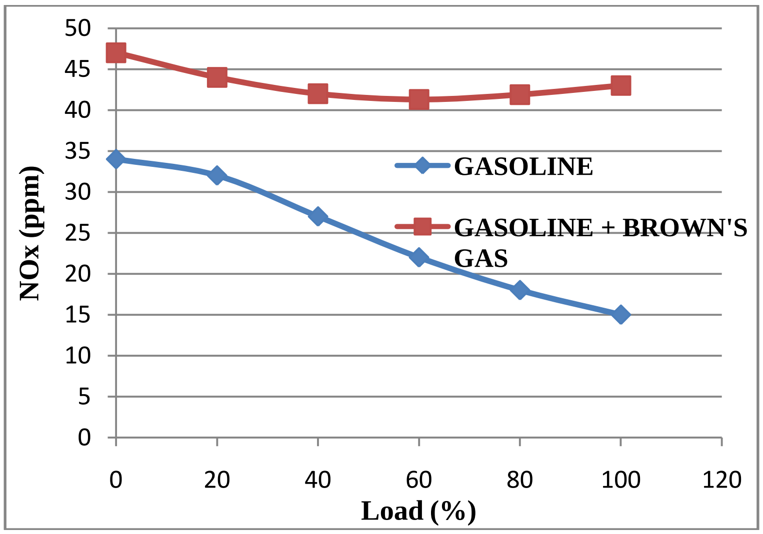

Figure 9: Comparison of Oxides of Nitrogen

Smoke Emission (BSN)

Smoke emission is another major constituent of the exhaust from the engines. Fig 10 represents the uniform decrease in the smoke emission level for smoke emission for gasoline with Brown's gas compared to that of gasoline. Smoke emission level is measured in BSN (Bosch Smoke Number). From the graph values, it is observed that there is a decrease in the smoke emission level for Brown's gas enriched fuel.

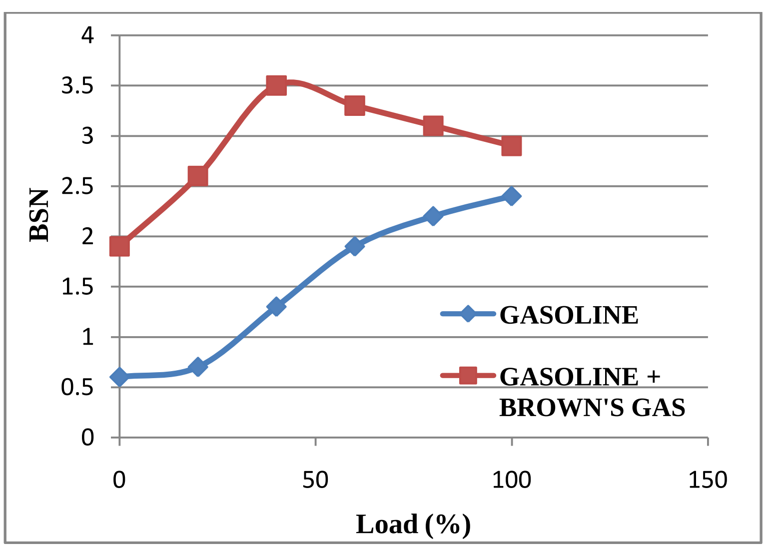

Figure 10: Comparison of Smoke Emission

VIII.CONCLUSION

It is evident from the study that it is advantageous to use Brown's gas enriched air as a fuel in internal combustion engines. Significant impact on brake thermal efficiency and brake power is observed upon the addition of Brown's gas enriched air. Fuel consumption and other emissions viz: NOx and smoke emissions are reduced to considerable amount.

From the experimental work the following conclusions were made.

- At full load, Brake Power for Brown's gas enriched engine operation gives 5% higher than conventional engine operation.
- At full load, Brake thermal efficiency for Brown's gas enriched operation gives 7% higher than conventional engine operation.
- Total fuel consumption for Brown's gas enriched operation at full load gives 6% lesser than conventional engine operation.
- Specific fuel consumption for Brown's gas enriched operation at full load gives 11% lesser than conventional engine operation.
- Unburnt Hydrocarbon emission for Brown's gas enriched operation at full load gives 88% lesser than conventional engine operation.
- Carbon Monoxide emission for Brown's gas enriched operation at full load gives 94% lesser than conventional engine operation.
- At full load, Oxides of Nitrogen emissions for Brown's gas enriched operation gives 58% lesser than conventional engine operation.
- At full load, Smoke emission for Brown's gas enriched operation gives 18% lesser than conventional engine operation.

This makes it possible to run the engine leaner, resulting in reduced pollutant level of Carbon Monoxide (CO), Unburnt Hydrocarbon (HC). This work proves that using Brown's gas enriched air in internal combustion engine is significantly advantageous compared to Gasoline.

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