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Design and Fabrication of an Acetylene Fuel Vehicle

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Abstract: The transition towards sustainable transportation necessitates exploring alternative fuels with reduced environmental impacts. Acetylene has emerged as a promising candidate due to its clean combustion characteristics and high energy density. This abstract outline the design and fabrication process of an acetylene fuel vehicle, focusing on its feasibility and performance. The design phase involves meticulous material selection to ensure compatibility with acetylene's properties while prioritizing safety measures. Key components such as the fuel storage system, combustion chamber, and propulsion system are engineered to maximize energy conversion efficiency and minimize emissions. Safety protocols for acetylene handling and storage are integrated into the design to mitigate risks associated with its high reactivity. Fabrication incorporates advanced manufacturing techniques like additive manufacturing and precision machining to create a robust vehicle prototype. The integration of selected components is optimized to enhance structural integrity and overall performance. Rigorous testing procedures are conducted to validate the vehicle's functionality, including performance metrics, emissions analysis, and safety evaluations. The outcomes of this study provide valuable insights into the feasibility of acetylene as a sustainable transportation fuel. The design and fabrication processes contribute to ongoing research efforts aimed at reducing the carbon footprint of the transportation sector. The results also offer a pathway for future developments in alternative fuel technologies, driving towards a more environmentally friendly and energy-efficient transportation ecosystem.
Keywords: cac$_2$, Acetylene fuel, 3-wheeler bike, Emissions

I. INTRODUCTION

Acetylene, a hydrocarbon compound composed of two carbon atoms and two triple-bonded hydrogen atoms, has garnered interest as a potential alternative fuel due to its high energy density and clean combustion characteristics [1]. Compared to conventional fuels like gasoline and diesel, acetylene offers the advantage of lower carbon emissions and reduced environmental impact [2]. When calcium carbide reacts with water forms acetylene gas, it is an exothermic reaction releases heat on reacting with water. [3] This process doesn't require any complicated machinery [4].

In olden days Carbide lamps are used by mine workers for lighting [5]. Acetylene, with its high energy content and potential for clean combustion, has emerged as a promising candidate for sustainable transportation solutions [6]. Unlike traditional hydrocarbon fuels, acetylene does not contain carbon-carbon bonds, leading to lower CO_2 emissions upon combustion [7].

After the acetylene was produced a flame test was conducted, it was used to run a fuel generator using a fuel carburettor for the acetylene gas intake with the mixture of air to run the engine [8].

II. WORKING

The process of gas flow in an acetylene fuel vehicle is a carefully orchestrated sequence that optimizes combustion for generating kinetic energy. It begins as the gas within the cylinder is drawn into the diaphragm through a suction mechanism. From there, the gas travels to the carburettor, where it undergoes mixing with air to achieve the ideal fuel-air ratio. This mixture is then supplied to the engine's intake manifold, where it enters the combustion chamber.

Inside the combustion chamber, the gas-air mixture undergoes compression, a crucial step that increases its pressure and temperature, priming it for ignition. This ignition process is initiated by the spark plug, which generates a spark to ignite the compressed mixture. As combustion occurs, the chemical energy stored in the gas is rapidly converted into thermal energy, expanding the gases and creating high-pressure exhaust.

Ultimately, this controlled combustion and energy release drive the piston within the engine, converting the thermal energy into mechanical energy that powers the vehicle. Each step in this process, from gas intake to compression to ignition, is finely tuned to ensure efficient energy conversion and optimal performance of the acetylene fuel vehicle.

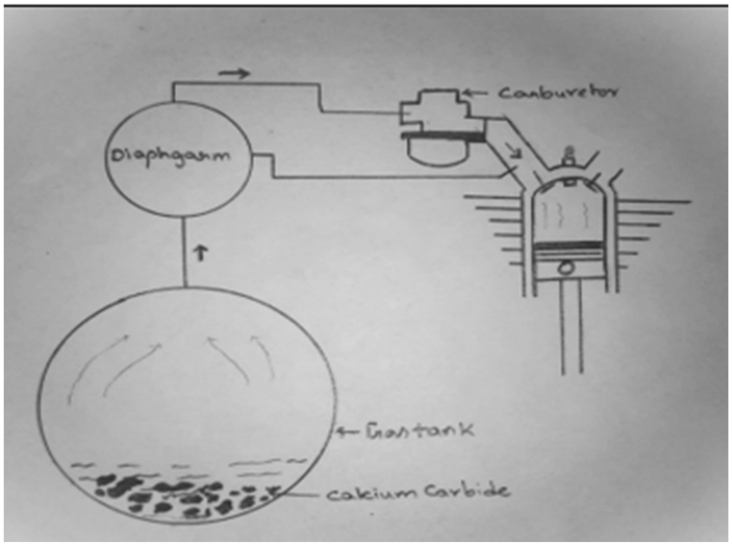

Fig:1 Apparatus

A. Design Considerations

The design phase of an acetylene fuel vehicle encompasses several key considerations to ensure optimal performance, safety, and environmental sustainability. One of the primary aspects is material selection, where materials with high compatibility with acetylene are chosen for critical components such as fuel tanks, pipelines, and engine parts. Specialized materials that can withstand acetylene's high reactivity and pressure conditions are utilized to prevent leaks or hazards during operation.

Safety measures play a crucial role in the design process, particularly in handling and storing acetylene. Due to its high flammability and explosive potential, strict protocols for acetylene storage, filling, and venting are implemented to minimize risks. Safety features such as pressure relief valves, flame arrestors, and leak detection systems are integrated into the vehicle's design to ensure safe operation under varying conditions.

Another important consideration is the optimization of the vehicle's propulsion system for efficient utilization of acetylene fuel. Engine tuning and calibration are also tailored to acetylene's combustion characteristics to achieve optimal power output and fuel efficiency.

B. Fabrication Techniques

The fabrication of an acetylene fuel vehicle involves employing advanced manufacturing techniques to ensure precision, durability, and reliability in the vehicle's components and systems. Additive manufacturing, commonly known as 3D printing, is utilized for creating intricate parts with complex geometries, allowing for customization and optimization of design features. This method enhances manufacturing efficiency and reduces material waste compared to traditional machining processes.

In parallel with component fabrication, assembly processes are carefully executed to integrate the various subsystems of the acetylene fuel vehicle. Skilled technicians and engineers oversee the assembly process to ensure proper alignment, fitment, and functionality of each component. Quality control measures, including inspections and testing protocols, are implemented at each stage of fabrication to verify compliance with design specifications and safety standards.

Additionally, safety features specific to acetylene fuel handling, such as reinforced fuel tanks, secure fuel line connections, and emergency shut-off systems, are incorporated during fabrication. These safety measures are crucial for preventing accidents and ensuring the vehicle's safe operation under normal driving conditions and in emergency situations.

Overall, the fabrication process combines advanced manufacturing techniques, stringent quality control measures, and safety considerations to produce a reliable and high-performance acetylene fuel vehicle ready for testing and validation.

III. COMPONENTS

A. Diaphragm Valve

Diaphragm valves (or membrane valves) consists of a valve body with two or more ports, a diaphragm, and a "weir or saddle" or seat upon which the diaphragm closes the valve. The valve body may be constructed from plastic, metal, wood or other materials depending on the intended use. Originally, the diaphragm valve was developed for use in industrial applications and/or pipe-organs. Later on, the design was adapted for use in the bio-pharmaceutical industry by using compliant materials that can withstand sanitizing and sterilizing methods. There are two main categories of diaphragm valves: one type seals over a "weir" (saddle) and the other (sometimes called a "full bore or straight-way" valve) seals seat.

Fig 2: diaphragm valve

The weir or saddle type is the most common in process applications and the seat-type is more commonly used in slurry applications to reduce blocking issues but exists also as a process valve. While diaphragm valves usually come in two-port forms (2/2-way diaphragm valve), they can also come with three ports (3/2-way diaphragm valves also called T-valves) and more (so called block-valves). When more than three ports are included, they generally require more than one diaphragm seat; however, special dual actuators can handle more ports with one membrane.

Diaphragm valves can be manual or automated. Their application is generally as shutoff valves in process systems within the industrial, food and beverage, pharmaceutical and biotech industries. The older generation of these valves is not suited for regulating and controlling process flows, however newer developments in this area have successfully tackled this problem.

B. Carburettor

A carburettor is a device that mixes air and fuel for internal combustion engines in the proper ratio for combustion. It is sometimes colloquially shortened to carb in the UK and North America or carby in Australia. To carburate or carburet (and thus carburation or carburetion, respectively) means to mix the air and fuel or to equip (an engine) with a carburettor for that purpose.

Fig 3: Carburettor

Carburettors have largely been supplanted in the automotive and, to a lesser extent, aviation industries by fuel injection. They are still common on small engines for lawn mowers, rototillers and other equipment.

C. Pressure Gauge

A pressure gauge is a fluid intensity measurement device. Pressure gauges are required for the set-up and tuning of fluid power machines, and are indispensable in troubleshooting them. Without pressure gauges, fluid power systems would be both unpredictable and unreliable. Gauges help to ensure there are no leaks or pressure changes that could affect the operating condition of the hydraulic system. The hydraulic system is designed to work in a set pressure range so the gauge must be rated for that range. Hydraulic pressure gauges are available to measure up to 1,000 psi, although maximum hydraulic pressure is typically in the 3,000 to 5,000 psi range. Hydraulic gauges are often installed at or near the pump's pressure port for indication of system pressure, but can be installed anywhere on the machine where pressure needs to be monitored especially if sub-circuits operate at a pressure rate different from pump pressure, such as after a reducing valve. Often, pressure-reducing valves have a gauge port to tap into, allowing you to directly monitor its downstream pressure setting.

Fig 4: Pressure Guage

Pressure gauges have been used in fluid power systems for well over a hundred years, so it might be a surprise that pressure gauge designs continue to evolve. The evolution of pressure gauges for fluid power applications has, generally, been an increase in application specific features. For instance, pressure gauges are now more routinely designed with hydraulic friendly pressure connections (such as SAE/Metric straight threads) to prevent system leaks. Analog gauges with custom scales are more common and digital pressure gauges with customizable firmware allow process measurement of pressure-based measurement of leaks or other parameters like torque, load, force and hardness.

IV. RESULT AND DISCUSSION

The results of the acetylene fuel vehicle project showcase improved fuel efficiency, lower emissions, and enhanced safety measures. Performance data highlights the vehicle's viability as a clean and high-energy-density fuel option, contributing to reduced environmental impact. Emissions reductions in CO2, NOx, PM, and HC align with global sustainability goals. Technological advancements in fuel storage, combustion systems, and safety engineering drive innovation in the automotive industry. Positive outcomes may influence policy support and market demand for acetylene-powered vehicles, fostering a more sustainable transportation ecosystem.

V. CONCLUSION

The experimental work was conducted to study and recognize the capability to execute and run such an engine which uses acetylene enhanced charge by blending acetylene with the air that is supplied amid suction stroke into the chamber, and moreover the quality of emission gases of such modified diesel engine. The following conclusions were drawn after careful analysis and observation.

The essential conclusion that we make is that it is promising to work a diesel engine of the direct infusion sort easily with stable ignition utilizing acetylene as an improved fuel to the engine air and by changing the acetylene stream rate from 7.2 g/h to280 g/h with no unusual burning in the engine. In the event of faster stream rates, it further increases and there is a tendency of knocking inclination in the ignition.

On the other hand, the smoke levels do not follow the same trend as the NOx are but they steadily grow. At a charge input of 280 g/h it was only 1.04%, which rose up to 3.07%. Hydrocarbon emissions were noticed to be diminishing to be marginal in comparison with standard diesel engines. It is almost 17% less in acetylene enriched engine when compared to a diesel engine.

The CO in engine exhaust was seen unimportant when compared with the benchmark diesel engine. However, CO_2 also decreased from 4.8% to 7.65% of the charge flow rates of 140 g/h to 280 g/h respectively.

At last it is reasoned that the acetylene rich diesel engine is constructible and safe to operate without major design modifications, with reduced hydrocarbon and carbon dioxide emission, but in contrast with more NOx emissions and with no noteworthy change in CO emission levels. The thermal efficiency of an engine can be improved with an interesting possibility of acetylene as an IC engine fuel in the years to come.

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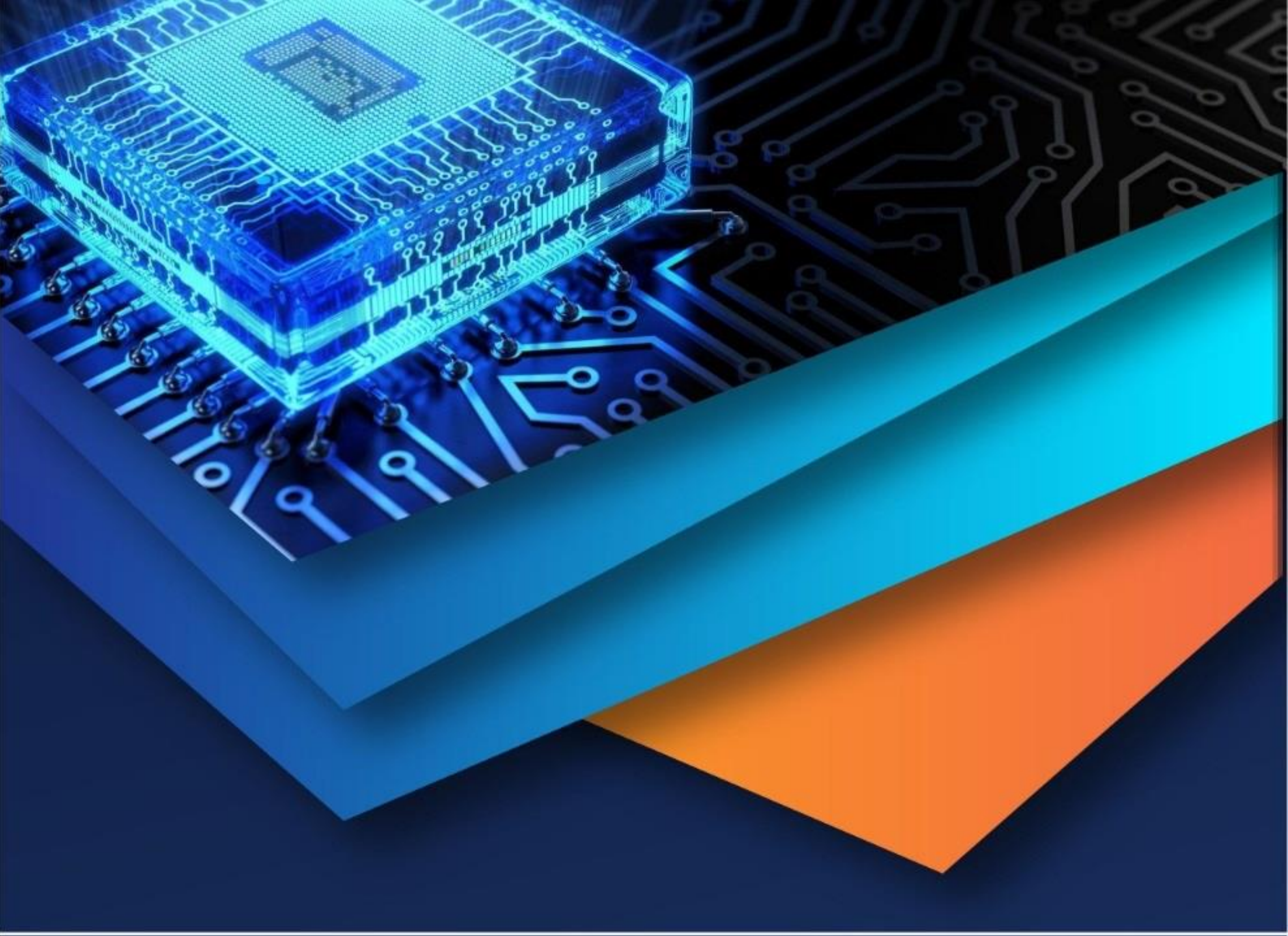

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