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Experimental Study on 4-Stroke Petrol Engine Using Water Misting Kit

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ABSTRACT

With the increasing price of oil and the ever reducing supplyies of petroleum, it is necessary to look towards new solution for transport purposes. Electric vehicles will undoubtedly be the solution.Till then, there is a need for optimum use of current technology as well as resources. Global warming is another problem which is caused largely due to the harmful emissions from the exhaust of automobiles. The pollutants exhausted from the I.C engines have an effect on the atmosphere causing issues such as smog, acid rain, global warming, respiratory hazards etc.Non stoichiometric combustion,separation of nitrogen and impurities in the air fuel mixtures cause these emissions.The higher amounts of emissions include unburnt hydrocarbons(HC), Nitrogen Oxides(NOx), Oxides of sulphur, Oxides of carbon and soot. The pollutants can be treatedby a process called water misting water has a very high heat of vapourization. As the ambient temperature water is injected into the engine, heat transfers from hot cylinder head and intake air into the water. This makes it evaporate, cooling the intake charge. A cooler intake charge means it is more dense and also has a lower tendency to knock. However, the water vapour displaces some air, negating some of the denser intake charge benefit. Knocking is generally more of a problem in forced induction engines rather than naturally aspirated, so this can help prevent it. On electronic ignition systems the ignition timing is generally retarded to prevent knock from occurring but with water injection it can be advanced closer to Maximum Brake Torque (MBT) timing for additional power. In I.C engines, water injection also known as Anti-Detonant Injection (ADI), can spray water into incoming air or fuel air mixture or directly into cylinder to cool certain parts of the induction system where "hot points" could produce premature ignition (knocking)

Keywords- Water Misting, Knocking, Maximum Brake Torque, Anti-Detonant Injection.

I. INTRODUCTION

The performance, fuel consumption, and emission of a spark ignition (SI) fuel injection system can be investigated by adding a small amount of water mist (WM) through the intake manifold to the EFI system of a four-stroke SI engine[2]. In IC engines, water injection, also known as Anti-Detonant Injection (ADI), is a method for cooling the combustion chambers of engines by adding water to the cylinder or incoming fuel-air

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mixture, generally enabling greater compression ratios and essentially eliminating the problem of knocking. Water injection is not a novel concept. Introduced in IC engines during the 1920s, water injection was a key enabler of high speed IC engines in the early 1930s[3]. When calibrated engines are operated with a small amount of water, knocking can be suppressed, hydrocarbon emissions become slightly higher, NOx emissions decrease, CO emission does not change significantly, and fuel and energy consumption increase. Further, water gasoline fuels have higher octane ratings that can increase engine performance and decrease NOx emissions. It is predicted that the water injection method will increase the octane level (replacement of the primary anti-knocking additive in petroleum refining technology) and reduce NOx emissions in exhaust gas. An aqueous fuel comprising water and gasoline has approximately half- operate an internal combustion engine, it will produce approximately as much power as compared with the same amount of gasoline. The use of water fuel emulsion for controlled NOx emission can be described in the following manner. Pre-ignition and detonation is suppressed by water addition: Aqueous fuel is vaporized by the water component as steam in the combustion chamber. The expansion of the steam together with the combustion of the hydrogen released by dissociation of the water molecule results in the generation of the required power output necessary for satisfactory operation of the engine. With the increasing prices of Oil and the ever reducing supplies of Petroleum, it is necessary to look towards new solutions for transport purposes. Electric vehicles will undoubtedly be the solution. Till then, there is need for optimum use of current technology as well as resources. Global warming is another problem which is caused largely due to the harmful emissions from the exhausts of automobiles. The pollutants exhausted from the I.C. engines have an effect on the atmosphere causing issues such as smog, acid rain, global warming, respiratory hazards etc. Non-stoichiometric combustion, separation of nitrogen and impurities in the air fuel mixture cause these emissions. The higher amounts of emissions include unburnt Hydrocarbons (HC), Nitrogen Oxides (NOx), Oxides of Sulphur, oxides of Carbon, and soot. These pollutants can be treated by a process called Water Misting[1]. for various applications. These include aircraft, automobiles, electrical generators and multipurpose industrial engines. Water injection produces to reduce pre-detonation in the combustion chamber and fuel consumption was studied extensively. The experiment worked that carried out on a single cylinder engine established water injection system, different water quantities supplied constantly with air to the engine. Data was recorded over a period of time. Significantly, fuel and energy consumption rate increased with small amounts of water addition, water injection really represents a new way to avoid detonation and control NOx formation in SI engines[2]. Several different methods of water addition have been developed. These studies have shown that further reduction of harmful emissions is still possible. The aim of the project work is to investigate experimentally the effect of the water injection to reduce the fuel conception and temperature of a 110 cc petrol engine.

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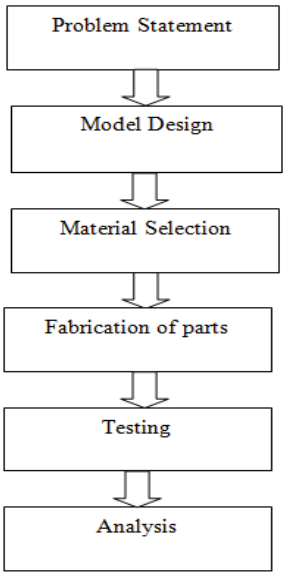
II. METHODOLOGY

Following are the steps involved in our present work



A. Problem Statement

Automobiles are a part of almost every human civilization and will continue to be for a very long time. This comes with a drawback of air pollution. Taking this as a challenge, we came up with an idea to overcome the problems up to a certain extent

B. Model Design

The prototype model follows a very simple yet an ingenious process. The Fig 1 shows a clear representation of the model as a block diagram

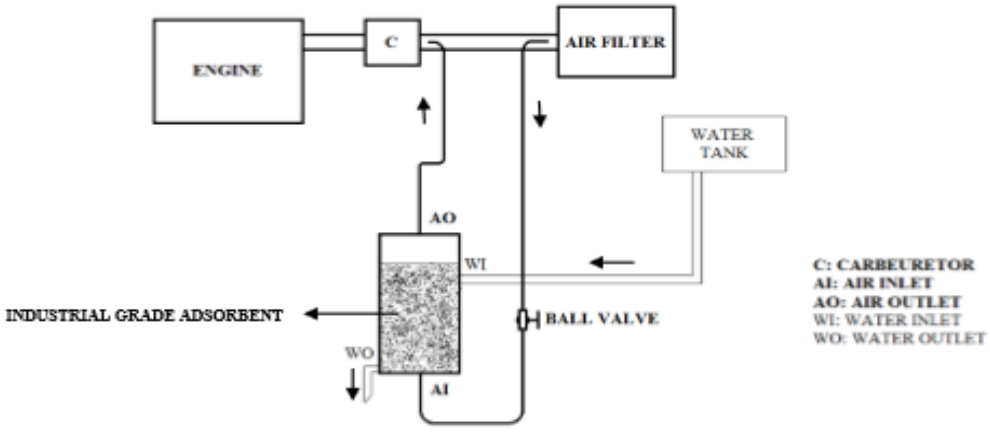


Fig 1: Model block diagram

As shown in Fig 1, the suction of air by the carburettor is bypassed by the kit circuit. Due to the suction at Air outlet, air is pulled into the circuit through the piping. The flow of air is controlled by a ball valve. The chamber of the kit is packed with an industrial grade absorbent (sponge). Water from a reservoir tank is introduced at the upper side of the sponge from a water inlet. This water is allowed to flow slowly through the

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sponge and the excess water is taken out by the water outlet. The flow of water can be controlled by small gate valves. The air entering the kit leaves from the air outlet to the carburettor.

C. Material Selection

After model design, the next important task in hand is the material selection. There are various factors which effect the selection of material. The factors effecting the selection of materials are as follows

Properties of the materials: The materials selected must have the necessary properties for the device to work smoothly and for a durable use.

Manufacturing cost: There is always a demand for the lowest possible manufacturing cost for the best quality results. This can be obtained by mating multiple parts together to form a sub assembled part, rather than manufacturing a single part which may have no use if any damage occurs. This reduces the risk of unavailability and thus the need for re-manufacturing. This also helps in easy maintenance of the device allowing complete dismantling of parts.

Quality required: Quality requirement generally effects the manufacturing process and the materials. For example, it is not desirable to cast less number of components which can be fabricated economically by screwing, mating or welding two subcomponents.

Availability of material: It is important to consider the availability of a materials as some materials may be short in supply or rather scarce. It then becomes obligatory to use a different material which though may not be a perfect substitute for the designed material. The delivery of materials and the delivery dates of the product should also be considered relatively.

Space consideration: The materials selected should fulfil the required properties within the space available in the previous setup. Or else the extra space taken by the parts or the device itself may seem uncomfortable or unsophisticated.

III. FABRICATION OF WATER MISTING KIT

The suction pressure developed by the engine is diverted to the device with the help of the necessary modifications done on the air intake hose. The elbows direct the pressure into the flexible air hose which further connect to the piping. The pressure of air in the piping is controlled by the ball valves. The ball valve at the device controls the air flow inside the device. There is a provision for a bypass ball valve given near the ends of the flexible hose in case of a normal run of the engine The suction stroke of the 4-stroke petrol engine causes the pressure build up. The amount of air sucked by the engine in a stroke is equal to the volume of the cylinder of the engine. This causes a certain portion of the air to be sucked through the prototype due to the presence of the sponge member. Meanwhile the water is let to flow into the misting cylinder. The water is absorbed by the sponge uniformly into its pores. Once the water is uniformly distributed throughout the sponge, it now starts acting as an adsorbent where the tiny water droplets now sitting until it is forced out of its place. The air enters the air intake hose and a portion of this is directed to the device air inlet via the piping. Once the air enters the misting cylinder, it starts pushing the water droplets out of its place and starts taking out a small portion of these droplets. This process is very essential for the misting of water. This happens in a way similar to the bubbling of water at the bottom of a water tank. When the bubbles pop, small droplets suspend in the air above the tank for a small period of time. In this prototype, since the air flow is

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continuous, the droplets suspended in the air are continuously taken to the engine giving them no time to settle down. The air-water mist mixture mixes with the fuel in the carburettor forming an air-water mist-fuel mixture, which then let into the engine cylinder for combustion. The flow of air & water mist must be maintained for the smooth working of the prototype as well as the engine.

Fig .2 Prototype model

IV. RESULTS & DISCUSSIONS

A. Emission

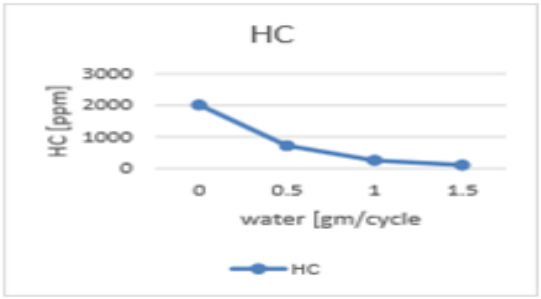

Fig 3(a): NOx results

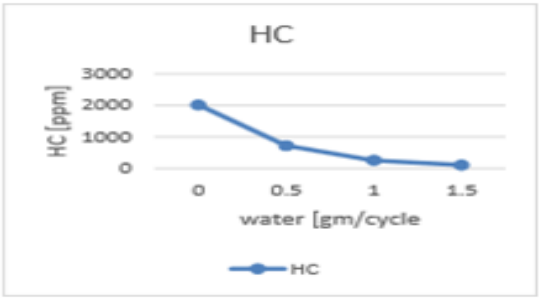

Fig 3(b): HC results

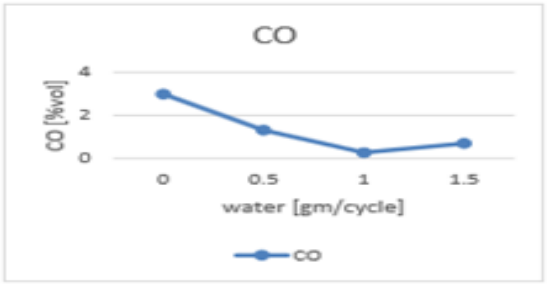

Fig 3(c): CO results

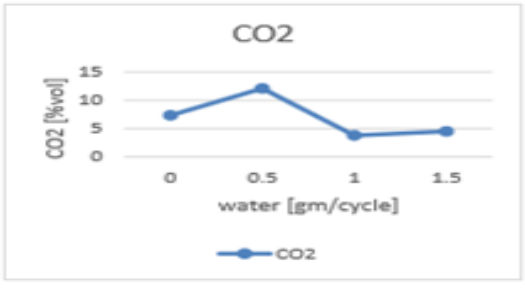

Fig 3(d): CO_2 results

The emission of HC was observed to be reducing up to an extent. This reduction later seizes for some values of water mist flow but then it starts increasing rapidly for higher mist flow rates due to the resistance of ignition. This phenomenon could not be recorded due to the limitations of the emission test.

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B. NOx Emission

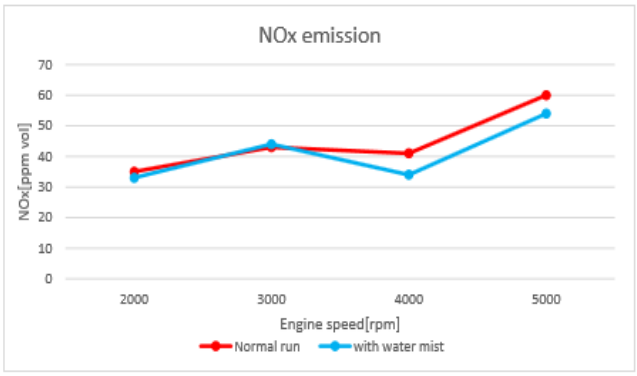

Fig 4: NOx emission graph

NOx is formed in a high temperature environment and an engine gathers enough heat energy during a long run to facilitate the required conditions for this process. This process of NOx formation will continue until the temperature of the engine cylinder is reduced. This is done by air or liquid cooling. The water mist also helps in reducing the temperature and thus the emission of NOx.

C. Knocking

It was observed that the knocking of the 4-stroke petrol engine was apparently reduced after water misting a previously knocking engine. The engine/vehicle was run for a considerable period of time to check for knocking. Once the knocks started occurring the bypass was closed slowly to test the device for knocking. The engine goes through some cycles before damping the knocks. Once stabilized, the knocks were considerably reduced.

D. CO Emission

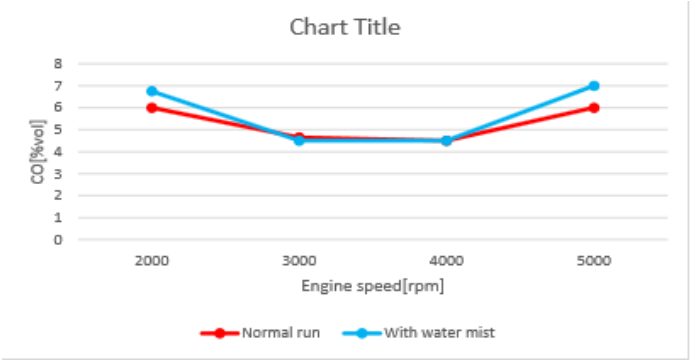

Fig 5: CO emission graph

The readings of emission of CO for the different values of engine speed were recorded for both, normal run and with the water misting. The same is graphically represented in Fig 5. The graph indicate there is a small differences in emissions for normal run and water mist

E. Cooling

The water misting provides an extra cooling effect to the engine apart from the air or liquid cooling. This helps the engine to utilize the complete power of the fuel to the maximum.

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V. CONCLUSIONS

The paper gives an idea about how a simple concept of water misting can help in improving the characteristics of a 4-stroke petrol engine. The modern day environmental problems a duty to conserve the environment and the nature . The process of taking the concept and converting it into a materialistic model turned out to be easy. But testing the model turned out to be a herculean task. There were many difficulties faced during the testing. The engine shut down in the first trial. After analysing the situation the problem was found to be the resistance to the suction pressure. This was solved by reducing the thickness of the sponge member. After testing, the results were recorded and tabulated for the graphical analysis. We achieved the desired results after continuous parameter variations and testing. These tests were conducted after long runs of the engine.

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