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A Literature Survey Exhaust Manifold Depended on The Analysis Results of An Already Established Exhaust Manifold: A Review

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***Abstract*— The Exhaust manifolds collect exhaust gases from engine cylinders and release them into the atmosphere via the exhaust system. The efficiency of the engine and the combustion characteristics are largely determined by how the burned gases are evacuated from the cylinder. One of the most important parts of an IC engine is the exhaust manifold. The design of an exhaust manifold is a complicated process that is influenced by a number of factors such as exhaust back pressure, mechanical efficiency, and exhaust gas velocity, among others. Recent studies on exhaust manifold design and performance evaluation using experimental and numerical methods are discussed in this literature review (CFD). The influence of different geometrical forms of exhaust manifolds on performance has been investigated and debated.**

***Keywords*— Exhaust-manifold; Established Exhaust Manifold;.**

I. Introduction

An effective diesel engine entered the scene around the 1920s. Due to their reduced reliance on flammable, unstable fuel, diesel engines quickly became extremely popular[1]. Following the Second World War, saw numerous changes within the economy, among people, the trend towards urbanisation, and the increasing reliance on private vehicles due to the closure of certain significant transit networks. Within the United States, the number of vehicles and trucks increased substantially. Air pollution caused harm to both humans and the environment as a result of the rapid increase in engine-powered vehicles[2].

A non-renewable form of energy being petroleum fuel. The cost of petroleum has increased as the reserves of petroleum have progressively depleted. However, there is a significant annual increase in the number of automobiles, which has rekindled interest in alternative energy sources. Because of its renewable origin, superior ignition quality, equivalent energy content, and higher point of ignition, biodiesel has become a viable alternative to gasoline and diesel. The term "biodiesel" describes a diesel fuel made from animal or vegetable fats that has a lengthy chain of ester. Fatty acid compounds are created by reacting lipids using an alcohol.

Interestingly, compared to all other sectors since 1979, the earth's transport system releases the most carbon pollution onto the atmosphere over the course of around a year. Approximately 85% of the pollutants are linked to road transport systems including public roads as well as government highways[3]. Since single-occupant vehicles are used more frequently than other modes of transportation, they produce more carbon dioxide than any other type of transportation. Buses generate 50% less carbon dioxide every mile than one passenger vehicle. According to a survey by ICF International, taking public transports not just reduces carbon dioxide emissions by 4800 pounds but additionally saves an average family of two people 6,251 Rupees a year.

Sorts of Engine Manifolds

1. Inlet Manifold
2. Exhaust Manifold

Intake Manifold- A complex network of pipes containing one input side and multiple output endpoints is called an intake manifold. The inlet manifold is another name for this manifold. Like the name implies, the fluid is delivered into the combustion chamber via a valve called an inlet using an inlet manifold. Air and a fuel-air combination are the fluids that drive diesel and gasoline (Petrol) engines, respectively.

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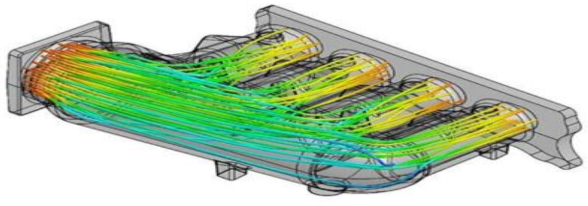

Fig.1: Construction of Inlet Manifold

There is only one inlet tube and four exit tubes shown in the picture. This indicates that a 4-cylinder engine uses the inlet manifold. The 4 output tubes are linked to the intake valves, one on each side. This ensures a consistent transfer of air or charges in each cylinder. With the event of a petrol engine, the fuel flows via a carburettor, and whereas in the instance of a diesel engine, just air comes via an air filter. The structure of inlet manifolds ensures that the amount of charge or air inside every cylinder is distributed evenly[19].

In order to prevent condensation of the air-fuel combination in the cylinder head of a petrol engine, the inlet manifold must be heated. For this purpose, hot exhaust gases are used to maintain a higher inlet manifold temperature. In colder locales, this is a dire necessity. The inlet manifold of today has an ECU sensor which detects the input pressure, charges flow, etc.

Working of Inlet Manifold- In the instance of gasoline engines, the engine has to be charged, and when it comes to of diesel engines, it needs to be given air. With a multi-cylinder engine, the charge and air have to be divided equally among the cylinders. The intake manifold's single aperture receives the air/charge through an air filter, which is then equally dispersed throughout the bifurcation tubes. Then, via the inlet valve, the air or charge coming from the branching tubes reaches the cylinder head.

Exhaust Manifold- With numerous input ports and one exit opening, the exhaust manifold has a complicated tube structure. They are employed to drain the engine's exhaust fumes through the exhaust and outlet valves. It enables the vehicle's muffler to receive the burnt fumes via the engine that contain carbon as well as additional chemical pollutants[20], [21].

Construction of Exhaust Manifold- Following is a basic illustration of an emission manifold. The exhaust manifold illustrated in the diagram has three intake piping and one exhaust pipe, indicating that it's meant for a three-cylinder engine

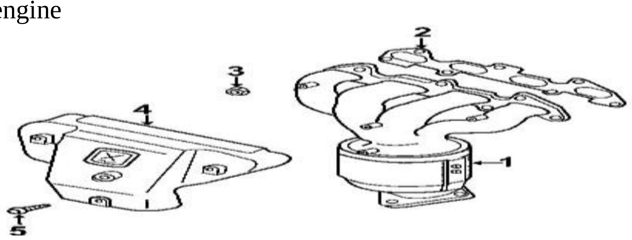

Fig.2:1.Manifold. 2. Gasket, 3. Nut, 4. Heat Shield, 5. Heat-Shield Bold[19]

Cleaner exhaust gas exit from the cylinder block is made possible by the exhaust manifold. The rearward force caused by the exhaust fumes is lessened by the method they are made. A sealant is used to join the exhaust manifold with the engine cylinder to ensure there won't be any leaks. The exhaust fumes from the cylinder enter the exhaust manifold's intake aperture when the exhaust valve activates. The exhaust manifold receives the gases coming from every cylinder, which are subsequently forced out of the single output channel.

To measure the quantity of oxygen contained in the exhaust fumes, an oxygen sensor has been installed within the exhaust manifold. The coronary valve is a crucial component of the gasoline engine's exhaust manifold. In order to prevent condensation of the air-fuel combination, heat is used to send warm exhaust fumes to the inlet manifold.

Working of Exhaust Manifold- Within a multi-cylinder engine, the exhaust fumes via each cylinder must be properly emitted without creating back pressure. Every of the cylinders block is joined to the exhaust manifold's intake holes. Each aperture collects exhaust gases, that are then expelled via one exhaust tube that is attached to the vehicle's muffler.

II. LITERATURE REVIEW

The impact of fuel consumption as well as exhaust pollutant features during stop/start, Acceleration/deceleration, stationary vehicle, and various road conditions, etc., have been studied in the literature. Additionally studied is the wide literature on various methods, including idle fuel savings solutions. For both spark ignition as well as compression ignition automobiles, the varied effects of equipment on the vehicles, including the air conditioner and heating element, have been compiled to analyse the harmful exhaust emissions and the pace of fuel consumption at all loading and ambient circumstances.

The emission regulation regions and their effect on maritime transport have been examined in the research by Cullinane et al[22]. The Marine Environmental Protection Committee (MEPC) established a limit upon the amount of sulphur allowed within ship fuel during April 2008. Under the list of items for controlling SOx and NOx emissions, various legislative and regulatory actions were required.

Following the Hansen et al investigation, a study was conducted to compare the emissions of catalyst-equipped versus non-catalysed petrol automobiles while travelling on a highway[23]. The journey speed for the various roadways affected the speed variation. The emissions rates were lowest when the speed was constant rather than varying in relation to a specified average trip velocity. The exhaust contaminants were measured using accurate constant volume collection and gas analyser equipment. At the slowest speeds, emissions for non-catalysed cars rose with divergence by 25%. Lower speeds exhibited the smallest variances in lowest exhaust emissions. On the contrary, the biggest variability in exhaust emissions occurred at the slowest speeds. Exhaust emissions within the catalyst fleet vehicles ranged from 0.3 to 0.05 gramme per km, and

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carbon monoxide emissions were extremely low at slower speeds with higher variation.

Johnston et al.'s research included methods that was trustworthy for specific methods of analysing the amount of fuel consumption and concurrent effects of transportation adjustments[24]. The study was conducted over 2.25 km throughout morning peak. The 20 different car kinds with various specifications were picked for testing. The car's idle time, fuel usage readings, and the number of stops were all noted. During cycles of 140 seconds within non-transit zones as opposed to cycles of 90 seconds, that were substantially more prevalent the car used 35% more gasoline. On the contrary, the test cars had to remain within their lane under the conditions of a transit lane runs. In contrast to runs within non-transit paths, fuel consumption was greater during transit lane drives by 24%, and stops remained almost three times more often.

The specifics of exhaust pollutants along with fuel consumption driving high-performance diesel cars when idling was examined in the research by Khan et al[25]. 75 automobiles were chosen so that the variances in exhaust pollutants could be studied. On the foundation of mechanical fuel injection (MFI) as well as electronic fuel injection (EFI), the cars were divided into two categories. Vehicles equipped with electronic fuel injection released 4636 g/h of carbon dioxide every hour when idling, 20 g/h of carbon monoxide, 6 g/h of hydrocarbon emissions, 86 g/h of nitrogen oxides, and 1 g/h of particulate matter. When the impact of air conditioning is taken into account, the amount of carbon dioxides, nitrogen oxides, particulates, hydrocarbons, and fuel consumed under idling conditions was increased by up to 25%. Vehicles with manual fuel injection averaged fuel consumption rates of 0.46 gal every hour, while those with electronic fuel injection averaged 0.47 gal every hour. When stationary vehicle rpm climbed from 600 to 1100, emission pollutants like carbon dioxide as well as oxides of nitrogen rose by up to 165% as well as 225%, accordingly, while particulate matter with fuel consumption rose by up to 76% and 170%.

According to Parida et al.'s research, the quick increase increasing vehicle density increased gasoline consumption, the frequency of signals for traffic, and fuel waste[26]. The evaluations were conducted on a few particular cycles, particular days during the month, and several kinds of traffic signals within Delhi that contributed significantly to fuel waste. Additionally, it was shown that 98% or greater of drivers weren't turning off their engines at intersections with traffic signals. In Delhi, there were over upwards of 600 signal crossings where idle operation of vehicles resulted in the daily waste of 0.37 million kg of compressed natural gas with 0.13 million litres of petrol. The overall financial loss due to fuel waste ranged from Rs. 27.25 million per day through Rs. 9944.5 million per year.

Analysis of the emissions generated during rush-hour traffic, free flow conditions, and overcrowding was covered in the work by Zhang et al[27]. The amount of fuel usage and exhaust particles were assessed using a microscopic method under varied scenarios. When there was traffic, there were a few high-range emission pollutants, including nitrogen oxide, hydrocarbon, including carbon monoxide. In a low-speed working zone, lesser exhaust gas was emitted. The congested work zone caused a substantial quantity of exhaust pollutants. While taking into account the combined impact of driving behaviour and vehicle volume, peak-hour periods had exhaust emission coefficients for carbon monoxide, hydrocarbon, as well as nitrogen oxide that were approximately twice as high as free-flow periods. The degree and kind of congestion affected emission rates.

To examine the frequency of fuel used by an automobile, experimental research was carried out in transportation and road research facilities for Ferreira's study[28]. The financed research of urban transport planning was a trial measuring effort. A 1500 cc automobile fleet within the UK was used for the fuel usage analysis. Throughout the Leeds test, it was determined how much fuel was used when vehicles were stopped for brief periods of time. A mean fuel circulation rate of 1.3 litres per hour was measured. It was investigated how much fuel is consumed under idling conditions in relation to vehicle engine capacity. It was chosen to utilise an initial threshold of 1.2 l/hr for building a fuel usage sub-model for typical urban driving situations. Additionally, fuel usage at constant speed (cruising speed) as well as start/stop manoeuvre were calculated using regression analysis.

Compared to petrol engines, diesel-powered ones have historically been more adaptable as well as cheaper to maintain. However, compounds included in the diesel engine's exhaust fumes have the potential to be harmful to human health[29]. The Office of Environmental Health Hazard Assessment (OEHHA) of the California EPA completed a thorough health study of diesel exhaust during 1998. The California Air Resources Boards (CRB) has determined that diesel exhaust emissions are the primary offender according to the evaluation described above. Diesel exhaust particulates account for a significant portion of the particles released in many cities and metropolitan areas, despite the fact that they are the main cause of the harm to human health since diesel engine cars produced air pollutants.Diesel fuel's incomplete burning into motor vehicles results in a variety of liquids, gases, including solid particles. Although compared to a petrol engine, it generates lesser carbon monoxide, yet more nitrogen oxides as well as aldehydes[29]. These exhausts have the potential to be morbid, such irritating the upper respiratory tract. Additionally, it releases submicron particles that reduce sight and promote soiling[30]

Marupilla Akhil Teja et al. researched on the proper configuration of motor fumes frameworks and engine vapour structures can generally improve an engine's performance[31]. There's a requirement to develop and construct practical burning chambers, bays, and outlet complexes in relation to severe emission enactment in the vehicle area. Some of the crucial components that affects how the engine operates is the architecture of the system for airflow. Time is given consideration to the position of the wrench point when moving through an airflow

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framework. The numerical analysis of a four-chamber petroleum engine featuring two air intakes operating at an accurate speed of 2800 rpm has been studied as part of the fluctuation research project.

Kanupriya Bajpai and colleagues, 2017 For the purposes of estimating flow features, thermal features, and minimal back pressure, the efficiency of a 4-stroke, 4-cylinder petrol engine's exhaust manifold has been examined in this study utilising three different fuels, including gasoline, alcohol, as well as LPG. Creo 2.0 is used for manifold simulation, and ANSYS is used for meshing as well as analysis[32]

Shinde and others, 2020 In this research, four distinct kinds of exhaust mufflers are thoroughly analysed in order to determine the optimal design with the least amount of pressure fall[33]. In accordance with the flow's field study, back pressure has been determined and it was contrasted to all silencer designs. Acusolve CFD is used in computational fluid dynamics (CFD) analysis to simulate back-pressure tests virtually. The exhaust pipe structure's Finite Elements (FE) model is created using Hyper Mesh as the preprocessing. Utilising 2D shell components, the interior tubes with tiny perforations are taken into account when modelling the framework mesh.

IV. CONCLUSION

The Study provided better understanding of the working of exhaust manifold on various boundary conditions and various temperatures with the to the defined time. The study concludes with the result findings of test analysis of both the designs in which it totally shows the temperature convergence of the exhaust manifold, as we can see in the analysis result in which the already established exhaust manifold temperature distribution only transferring onto the manifold input heat which results in higher exhaust fumes, and higher temperature in exhaust sensor as well. The vibration and noise of the manifold also increases because of uneven temperature distribution onto the manifold.

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