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Exhaust Manifold: A Review

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ABSTRACT: The design and operational variables of exhaust systems are decisive to work out overall engine performance. The best engine overall performance are often obtained by proper design of the engine exhaust systems. Using this engine model, the consequences of the parameters of the exhaust systems on the engine performance are obtained. Especially, the following parameters are chosen: diameter of the exhaust manifold, pipe lengths, and geometry of pipe junctions. This investigation helps to seek out the optimized size of pipe system which may be used further designing also because the manufacturing of exhaust manifold.

KEYWORDS: CFD, Exhaust Manifold, IC Engine, Simulation.

INTRODUCTION

The Exhaust manifold of an engine is an important component which has a considerable effect on the performance of the I.C engine. The exhaust manifold operates under high temperature and pressure conditions, which collects exhaust gases from the engine and passes it to the atmosphere. Their design usually has to be performed by trial and error method through many experiments and analysis. This designed and analyzed model can be used in different vehicles of designing competition like Supra SAE India, FSB, and FSG etc. for getting better performance with the same engine.

Figure 1: Exhaust manifold[1]

Exhaust manifold pressure is one among the foremost important engine system design parameters (figure 1). A radical understanding of the impact of this parameter on durability is required so as to specify an appropriate design limit for the manifold pressure. Manifold pressure is governed mainly by engine exhaust flow, turbine area, and manifold volume. It affects turbine pressure ratio and hence manifold boost pressure. It also largely affects the engine delta P (i.e., manifold pressure minus manifold pressure). Because the engine power density increases and therefore the allowable engine-out soot level decreases, higher manifold pressure is required at the rated power condition. This leads to the challenging demand on the engine structural strength to sustain the upper peak cylinder pressure, higher compressor outlet pressure and temperature, and better manifold pressure. (Note that the compressor out temperature affects the LCF lifetime of the compressor wheel and housing, the rubber seals, and therefore the charge air cooler.)

There are two different limits that ought to not be exceeded in engine design and performance/emissions calibration thanks to durability concerns: the engine delta P and therefore the manifold pressure. The engine delta P is an indicator of pumping loss. It also affects valve floating off the valve seat during the intake stroke. During the fast transient acceleration, operation in cold climate or exhaust braking, the EGR valve may stay closed in order that an outsized amount of exhaust gas flows through the turbine to make a really high engine delta P. A sufficiently high valve spring preload must be utilized in order to stop the valve from floating off the valve seat. If the spring preload is just too low, excessive valve bouncing may occur after the valve floating. If the spring preload is just too high, valve train friction and cam stress could also be too high.

Exhaust manifold connecting to the engine cylinder collects the exhaust gas from each cylinder into the exhaust collector. Since the manifold is that the first component through which the heat exhaust passes, within the exhaust of the engine, it works under the tough condition of an alternating state between heat and normal temperature. Problems, like thermal fatigue cracking, fracture, and leakage may occur thanks to an extreme stress alternation caused by the cross-shock heating and cooling process.

Exhaust manifold pressure usually has large pulsating amplitude thanks to gas wave dynamic effects. a really high manifold pressure itself doesn't cause structural failure of the manifold because the manifold wall is typically sufficiently thick[2]. A gasket is employed between the manifold and therefore the plate to stop heat exhaust leaks or air seepages from the surface. The gasket can tolerate a way higher pressure than the traditional operating pressure of the manifold. The gasket leakage problem is typically not caused by the manifold pressure. Instead, the leakage is caused by the deformation thanks to thermal fatigue. A high manifold pressure itself also doesn't adversely affect the exhaust valve train when the engine delta P is in check. The utmost allowable manifold pressure, often occurring at full load or exhaust braking condition, is typically not constrained or determined by the following: EGR cooler pickup joint at the manifold, turbine shaft bearing, bearing and seals, and turbocharger oil leakage[3].

Exhaust systems comprise the manifold from the engine, the converter (for petrol engines), the DPF (for diesel engines), the silencer/muffler, and therefore the tailpipe. Exhaust manifolds and silencers are normally made from mild-steel tubing and sheet, which corrode progressively under the action of hot gases, including water vapor. The silencer is usually the primary a part of the exhaust to corrode through as this is often towards the rear where it's cooler and where acid, formed from reaction of NOx with steam, condenses. As soon as a hole develops within the silencer, the background level increases dramatically[4]. Corrosion of low-carbon steel is inevitable and, conventionally, exhaust systems are treated as ‘consumables’, alongside fuel, oil, batteries and tires. The lifetime of a silencer is prolonged if the low-carbon steel is aluminized. Some cars are fitted with stainless-steel exhaust systems, but these are expensive and may still fail through breakdown of internal welds within the silencer[5]. Exhausts now last for much longer than formerly since sulfur has been far away from the fuel and therefore the bulk of the NOx from the exhaust[6].

The manifold collects the exhaust gas and expels it through the pipe. At the present, the manifold must be capable of withstanding continuous operating temperatures as high as 900 °C. However, environmental and economic requirements will end in higher exhaust gas temperatures, therefore the thermal reliability of the manifold must be improved further. Traditionally, full load air/fuel conditions are operating within the region of lambda = 0.9 for max engine power output and to take care of engine durability. Under these circumstances, excess fuel cools the engine, keeping the exhaust gas temperature below 1,000 °C[7]. Moves towards operating conditions where lambda = 1 will eliminate this fuel cooling effect and exhaust temperatures will go up to 1,050 °C.

Exhaust system contain the ventilation system from the motor, the exhaust system (for petroleum motors), the DPF (for diesel motors), the silencer/suppressor, and the tailpipe. Ventilation systems and silencers are ordinarily made of gentle steel tubing and sheet, which consume dynamically under the activity of hot gases, including water fume. The silencer is by and large the initial segment of the exhaust system to erode through as this is towards the back where it is cooler and where corrosive, shaped from response of NOx with steam, consolidates. When an opening creates in the silencer, the commotion level increments significantly. Erosion of gentle steel is unavoidable and, customarily, exhaust systems have been treated as 'consumables', alongside fuel, oil, batteries and tires. The existence of a silencer is delayed if the mellow steel is aluminized. A few vehicles have been fitted with treated steel exhaust systems, yet these are costly can in any case come up short through breakdown of interior welds in the silencer. Debilitates now last any longer than some time ago since sulfur has been eliminated from the fuel and the heft of the NOx from the exhaust.

Working:

The ventilation system is the initial segment of your vehicle's exhaust system. It is associated with your vehicle's motor and gathers your motor's outflows. The ventilation system gets the air/fuel blend from the different chambers in your vehicles motor. It gathers the fuel/air combination from every chamber, regardless of whether you have four, six, or eight chambers. Not exclusively does the ventilation system get the entirety of the consumed motor gases, yet in addition it totally consumes any unused or deficient consumed gases utilizing its high temperature. The complex likewise houses the main oxygen sensor in your exhaust system to investigate the measure of oxygen entering the system. The oxygen sensor screens the measure of oxygen and will advise the fuel infusion system to increment or reduction the measure of oxygen utilized in the fuel/air blend used to control the motor. Fundamentally, the ventilation system goes about as a channel and is utilized to gather the entirety of the motor's emanations (from anyway numerous chambers your vehicle has). At that point once they are in one spot and totally consumed, the complex sends the outflows into the remainder of the exhaust system.

LITERATURE REVIEW

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The Exhaust manifold of an engine is an important component which has a considerable effect on the performance of the I.C engine. The exhaust manifold operates under high temperature and pressure conditions, which collects exhaust gases from the engine and passes it to the atmosphere[8].

CONCLUSION

In the summary, it are often concluded that the flows are often simplified by using CFD techniques. The flow of exhaust depends on the runner length, bending angle of the pipe thus, by iteration method in ANSYS FLUENT optimized angle will denote the flow with least obstruction. The iteration method is time-consuming therefore the CFD analysis can be through with the assistance of MATLAB software. Further modification of Helmholtz (Runner length of the manifold) i.e. modified runner length are often obtained which is that the indication of a rise in power output. The designed model of the manifold are going to be especially for an application like Formula Student Vehicle.

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