REVIEW OF DESIGN & THERMAL ANALYSIS OF INTAKE MANIFOLD

[1]MS. KETKI SATISH SADHU &[2]MR. SAYYAD A.I.
[1]ME, Dept. of Mechanical, MatoshriPratishthan School Of Engineering ,Vishnupuri ,Nanded,
[2]Assistant professor, Dept. of Mechanical, MatoshriPratishthan School Of Engineering ,Vishnupuri ,Nanded

Abstract

In car technology, an inlet manifold or consumption manifold is the factor of an engine that transports the air-fuel combination to the engine cylinders. The main cause of the intake manifold is to calmly distribute the combustion mixture to each intake port of the engine cylinder. The intake manifold is crucial for the most useful overall performance of an internal combustion engine. The objective of present undertaking is to expect, design and examine the drift via intake manifold of four cylinder spark ignition engine. One of the crucial elements is air drift inside the consumption manifold; the right consumption manifold distributes float calmly to the piston valves. Even distribution is essential to optimize the efficiency of the engine. Hence the waft phenomenon within the consumption manifold need to be fully optimized to produce greater engine power with better combustion and similarly reduces the emission. Firstly Design has been performed to set the thickness and cloth suitability of intake manifold against bursting stress. Three-dimensional inlet manifold is modeled in Catia after which thermal evaluation is completed with the aid of the usage of the commercially available Ansys software program to examine the thermal, velocity and glide characteristics in the manifold.

KEYWORDS: - Nodal Temperature, Temperature Gradient, Thermal Flux, Heat Flow

1. INTRODUCTION

An inlet manifold or intake manifold (in American English) is the a part of an engine that components the gas/air aggregate to the cylinders. The word manifold comes from the Old English phrase manigfeald (from the Anglo-Saxon manig [many] and feald [repeatedly]) and refers to the multiplying of one (pipe) into many. In contrast, an exhaust manifold collects the exhaust gases from more than one cylinders right into a smaller range of pipes – regularly down to one pipe.

The number one characteristic of the consumption manifold is to frivolously distribute the combustion aggregate (or simply air in an instantaneous injection engine) to each intake port in the cylinder head(s). Even distribution is critical to optimize the

performance and performance of the engine. It might also function a mount for the carburetor, throttle frame, gasoline injectors and other components of the engine. Due to the downward movement of the pistons and the restrict resulting from the throttle valve, in a reciprocating spark ignition piston engine, a partial vacuum (decrease than atmospheric stress) exists within the intake manifold. This manifold vacuum can be extensive, and can be used as a supply of vehicle ancillary electricity to drive auxiliary systems: energy assisted brakes, emission control gadgets, cruise manipulate, ignition boost, windshield wipers, power home windows, air flow gadget valves, etc. This vacuum also can be used to attract any piston blow-by means of gases from the engine's crankcase. This is called a high-quality crankcase ventilation device, wherein the gases are burned with the gas/air mixture. The intake manifold has traditionally been fabricated from aluminum or cast iron, but use of composite plastic substances is gaining recognition.

2. RELATED WORK

The goal of this undertaking work is to efficaciously broaden a layout of an Intake Manifold to have the better alignment towards the in ports of the combustion chamber for the ignition system. The mechanism is to be dependable, easy, cost-effective and feasible. The aim of this paper is to provide and to perform a numerical study on a compact Intake Manifold at one-of-a-kind consumption drift fees., so that it will enable brought via editing selected geometrical and waft parameters This system is likewise purported to beautify engines efficiency because the facet pressure felt by an engine temperature is comparatively much less. The technique followed to apply fashionable and presently used element in design in preference to to layout all supportive components from ground up. The advantage of this approach is that, you do now not need to spend ridiculous amount and time in testing the integrity of each element as they have got already proved their really worth in real global packages. Initially the Intake Manifold design become adopted from already present Engine Manifold and minor modifications have been made to suite our motive, the Engine Manifold mechanism first devised changed into primarily based on the usage of energy with the aid of DC Motor and reducing each location of the inlet of the Manifold.

This mechanism became later dropped in checking out section due to following dangers.

1. It has extended by using editing chosen geometrical and go with the flow parameters at the precise temperature for a Vehicle.

2. The machine doesn't have compact size for Inlet Manifold and settings might be based totally at the variables.

Due to these negative aspects, the layout become dropped and a fully new design was defined. The software program for use in layout is Catia V5 and testing of design is Ansys.

3. WORKING MECHANISM

An consumption manifold is a component that promises either air or an air/fuel combination to the cylinders. The layout of those additives varies extensively from one application to some other, but

they all carry out that equal basic feature and they all have a single input and a couple of outputs. In carbureted engines, the consumption manifold connects the carburetor to the consumption ports. In gas-injected engines, the consumption manifold connects the throttle frame to the consumption ports. In addition to the basic functionality of connecting consumption ports to the rest of the consumption system, an intake manifold will frequently function the mounting point for different additives. These manifolds every so often also form an crucial a part of the cylinder head, in that they may serve to "seal" the top of an engine, particularly on inner combustion engines that have a V configuration. In addition to air (and gasoline), consumption manifolds on occasion additionally have coolant skip thru them.

Fuel and Air

The intake manifold is a passage device that lets in the fuel and air to pass even though and from the carburetor and the engine valves. It rests on the midpoint of the carburetor and cylinder head. New age machines have a era that ascertains minimum quantity of condensation of gasoline in the intake manifold. This works out higher for the engine in the long run.

Working of Intake Manifold

Intake manifolds paintings with the aid of frivolously distributing both air and an air/fuel combination from the carburetor or throttle frame to the cylinders. This is done via careful engineering of each the design and orientation of the manifold. If a consumption manifold has too many abrupt changes in orientation or contour, the go with the flow of air may be impeded, which might bring about poor operation. With that during thoughts, aftermarket intake manifolds are regularly designed to be even greater green than OEM components.

The engine's "L" head is attached to the block's side and the "I" head to the cylinder head. The intake manifold that is designed for high performance creates a high amount of vacuum. This vacuum helps to draw in fuel from the carburetor. In turn makes the flow of air and fuel more efficient.

Effects of Intake manifold

In motors with an internal combustion engine (and in spite of the electric automobiles which can be starting to enter the marketplace, most motors (consisting of hybrids) nonetheless have internal combustion engines), what makes movement feasible is a chain of small explosions taking region within the combustion chambers. The gas for those explosions is typically gas, however the explosions would not be feasible without oxygen, which allows combustion to take place. In other phrases, there must be the proper air and gasoline aggregate for your car's cylinders for whatever to occur in any respect. Without air within the cylinders, your car could just sit down there taking on space.

Enter the consumption (or inlet) manifold. If an automobile is like your frame, then the intake manifold is its lungs. (I wager that could make the engine its heart, but it is probably better to offer this metaphor a rest.) The consumption manifold is a sequence of tubes that distributes the air getting into the engine calmly to each of the cylinders, so that the proper amount of air can mix with the proper amount of gasoline. Most inner combustion engines run on a 4-stroke procedure and in the course of the first stroke (called the consumption stroke) air from the consumption manifold is sucked into every cylinder via a valve or valves. These intake valves are then closed for the opposite 3 strokes (compression, combustion and exhaust) and reopen while the cycle starts offevolved all once more. It's the intake manifold it is chargeable for ensuring that there may be enough air available when the valve opens for each consumption stroke and that each cylinder gets the identical amount of air as the others.

Intake Runners and Plenums

Although the only consumption manifold design in reality has to connect the consumption ports to a not unusual inlet, most manifold designs fare substantially greater complicated. A lot of current intake manifolds use a machine of runners that hook up with a imperative "plenum" chamber. When well-engineered, this sort of "resonance Turing" layout can boom volumetric performance above one hundred percent thru Helmholz resonance and the Venturi impact.

Manifold Vacuum

In addition to actually offering a course for air or air and fuel to move between a not unusual intake and the intake ports, consumption manifolds additionally perform some other important function. Due to the way that inner combustion engines paintings, and the way that consumption manifolds are "sealed" by way of the constant go with the flow of air in a single facet and out the opposite, the movement of the pistons inside the engine is able to effectively create a partial vacuum inside the consumption manifold.

When each piston movements downward at the intake stroke, it sucks air (or air and gasoline) out of the consumption manifold. This creates a situation where the strain in the manifold is decrease than the pressure outside of the manifold, which leads to a partial vacuum. This vacuum is then harnessed to perform a spread of different features that variety all of the way from weather controls to break boosters.

Intake Manifold Failure

There are number one assets of intake manifold disasters: awful gaskets and cracked manifolds. Both of these problems bring about additional air entering the intake device, which ends up in drivability problems. In systems that use a carburetor, a cracked intake manifold or a gasket leak will normally result in a bad or hard idle, at the same time as gasoline-injected structures will typically have an incredibly lean fuel mixture and a racing idle. Since vacuum is used to power numerous other structures, leaks in vacuum traces or vacuum-powered components can result in the

equal symptoms that are created by means of a cracked manifold or terrible gasket. That's why it's important to test out the vacuum strains and add-ons instead of just focusing on the manifold itself and the gasket. And for the reason that a few consumption manifolds have coolant ports, it's also viable for an internal or outside coolant leak to broaden due to manifold or gasket problems.

Manifold Vacuum as a Diagnostic Tool

Since manifold vacuum is produced through the normal operation of the engine, the extent of vacuum can also be used to diagnose certain engine issues. For instance, low vacuum might imply a burnt valve, wrong valve or ignition timing, or a diffusion of other troubles.

S.No	Material	Aluminum
1	Young's Modulus (MPa)	7.1×10^5
2	Poison's ratio	0.33
3	Yield strength (N/mm^2)	240
4	Density (kg/m^3)	2710

4. CALCULATION OF INTAKE MANIFOLD

The steps had to perform an evaluation depend upon the take a look at type. You complete a have a look at with the aid of performing the following steps:

S.No	Information	Value
1	Operating Voltage	9V ~ 16V
2	Torque	Min 70Ncm
3	Return spring torque	27 ~ 34Ncm
4	Response time	< 200ms

- Create a look at defining its analysis kind and alternatives. If needed, define parameters of your observe.
- A parameter may be a version measurement, cloth property, pressure value, or another input.
- Define cloth homes.
- Specify restraints and loads.
- The application mechanically creates a mixed mesh while extraordinary geometries (stable, shell, structural members and so on.) exist in the version.
- Define factor touch and call sets.
- Mesh the model to divide the model into many small pieces referred to as elements.
- Fatigue and optimization research use the meshes in referenced research.
- Run the examine and View results.

Analysis Properties:

S.No	Properties	Values
1	Young's Modulus (MPa)	2×10^5
2	Poison's ratio	0.3
3	Analysis Type	Structural
4	Elements	Solid – 20 node 90

Materials properties for Aluminum:

Materials properties for Cast Iron:

S.No	Material	Cast Iron
1	Young's Modulus (MPa)	2.1×10^5
2	Poison's ratio	0.30
3	Yield strength (N/mm^2)	200
4	Density (kg/m^3)	7870

Technical Information:

Analytical Calculations:

S.No	Material	Aluminum
1	Specific Heat	880 C
2	Conductivity	140
3	Temperature Max	500 C
4	Temperature Min	50 C

5. DESIGN RESULTS OF INTAKE MANIFOLD

Part Modeling of Intake Manifold

Sketch: It gives the profile, like outer diameter and inner diameter by intended means of line, rectangle command.

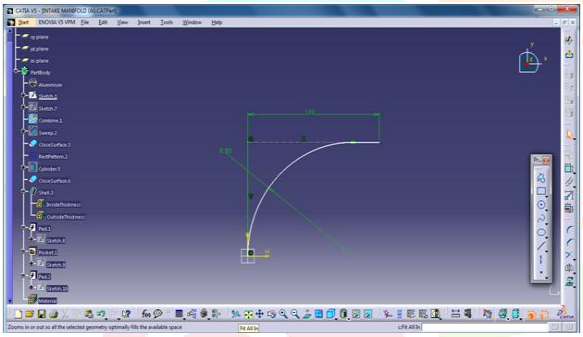

Fig:-3 Using Sketch Command for outer profile

Pad: It gives the required thickness to the component .After the sketch, click on the close workbench icon and then the pad command appears, on clicking on it, the dialog box opens; the required value can be entered.

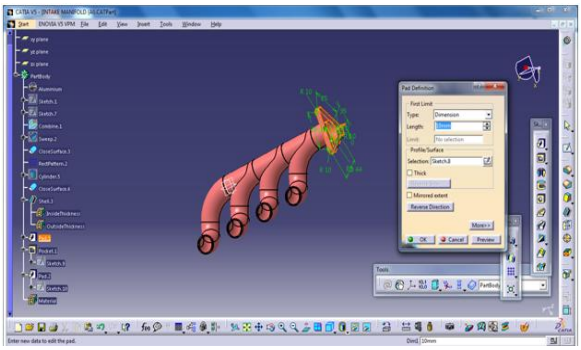

Fig: - 4 Using Pad Command for thickness

Sketch: It gives the profile of the gear teeth, like a inner tooth or outer tooth gear by intended means of circle, arc, trim, reference line commands.

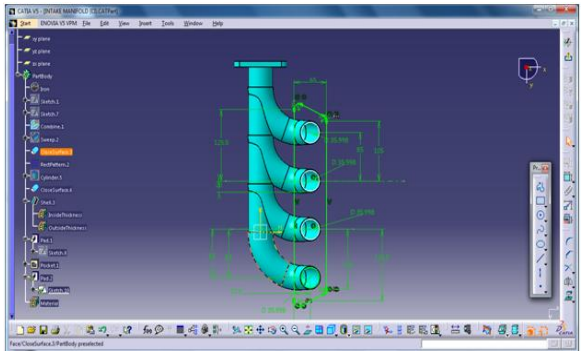

Fig:-4 Window for hook/ circles profile

Pocket: It gives the required pocket / groove / hole to the gear component .After the sketch, click on the close workbench icon and then the pocket command appears, on clicking on it, the dialog box opens; the required value can be entered.

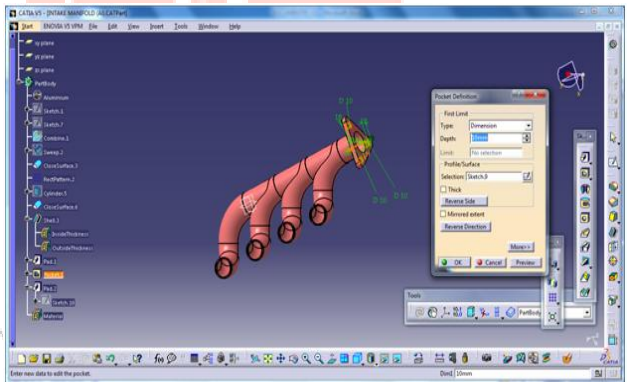

Fig: - 5 Using Pocket Command for removing material/ thickness

Rectr Pattern: This command is used to repeat the profile structure on the total selected workbench. This is the command need to enter the number of profiles are to be repeated on the workbench in the given dialog box.

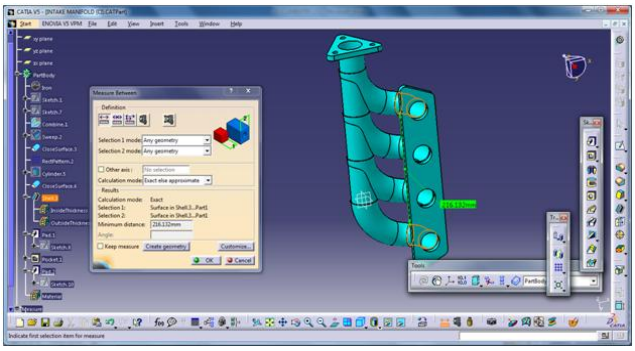

Fig:-6 Using Measure Length

Applying Material properties: Selection of Component and type of material

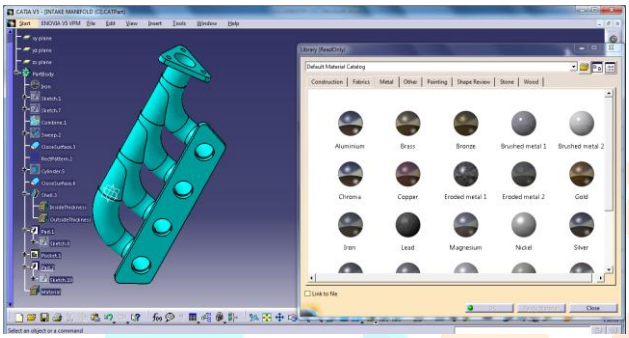

Fig:-7 Applying Material properties

Measure Inertia: Here we get all the values of the material by which the properties were applied; like Mass, Area, Moment of Inertia, Young's Modulus, etc.

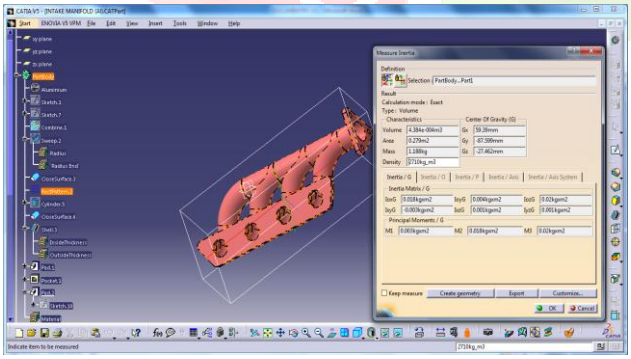

Fig:-8 Using Measure Inertia

Multi View: This is the command in which all the views of the component / model can be displayed on the screen at a same time, they can be edited under the workbench.

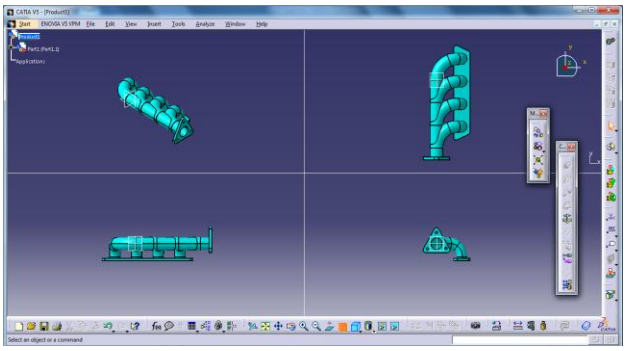

Fig:- 9 Using Multi View Command

DISCUSSION ON ANALYSYS RESULT

Results of Nodal Temperature analysis:

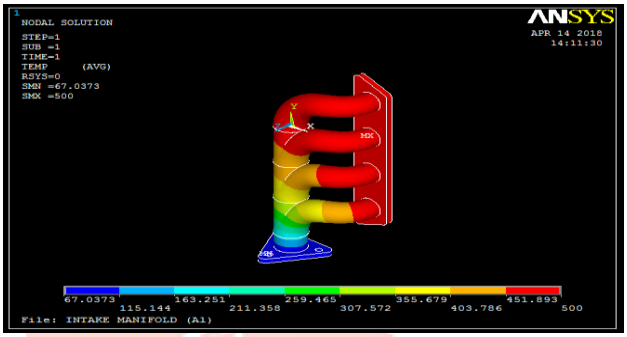

Fig:- 10 Nodal Temperature ofIntake Manifold (Al)

Results of Thermal Gradient analysis:

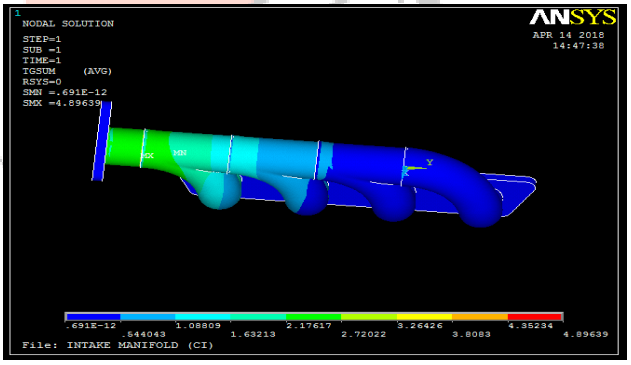

Fig:- 11 Thermal Gradient ofIntake Manifold (CI)

Results of Thermal Flux analysis:

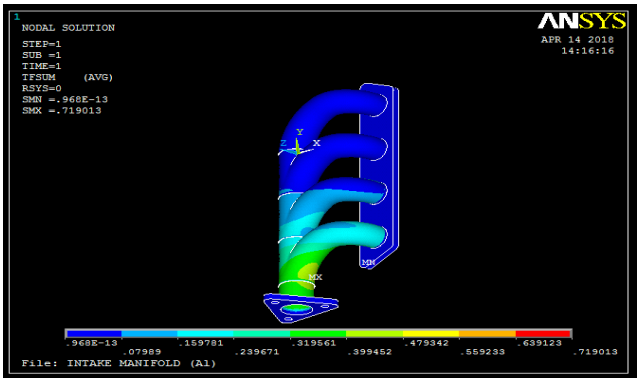

Fig:- 12 Thermal Flux ofIntake Manifold (Al)

Results of Heat Flow analysis:

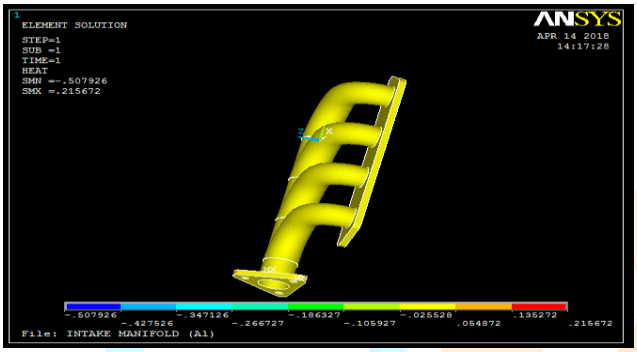

Fig:- 13 Heat Flow ofIntake Manifold (Al)

6. CONCLUSION

In this challenge an Intake Manifold is designed, it has been compared by means of specifying with exceptional materials of Aluminum and Cast Iron. These three-D models are designed in Catia. The evaluation tool Ansys is used to perform thermal evaluation of Intake Manifold at one of kind regions. By observing the evaluation outcomes, the nodal temperature is multiplied by using 67.03 and 88.96; temperature gradient is elevated via 15 and 4.89 for the evaluation version of the Intake Manifold. Heat switch analysis is completed to research the warmth switch fee to decide the thermal flux. The cloth taken is Aluminum and Cast Iron for thermal evaluation. By watching the thermal analysis outcomes, and thermal flux rate is 0.71 and 0.78; the Heat go with the flow charge is 0.21 and 0.17 on the floor medium for the changed model of Intake Manifold.

TABLE FOR RESULTS

S.No	Intake Manifold (Al)	Intake Manifold (CI)
Nodal Temperature	67.03	88.96
Temperature Gradient	5.13	4.89
Thermal Flux	0.71	0.68
Heat Flow	0.21	0.17

Here after design we've got imported it into the Ansys and thermal analysis is carried out on it using the substances Cast Iron and Aluminum. By the usage of these materials the effects are obtained and while they may be compared with every other we are able to finish that solid iron has the satisfactory potential to use up heat but it'll get effected by way of the warmth very soon, despite the fact that Aluminum are bad conductors, we ought to don't forget there insulation property's as whilst manifold receives heated up it's going to act as a heat supply to the cylinder head on which it's miles mounted. So it can be concluded that the Intake Manifold model with contrast of their yields higher effects. Ultimately it is able to be summarized that by imparting hundreds on the Intake Manifold at some stage in the analysis and in reducing with boom in warmth transfer price. This will help in increasing the energy input in line with unit mass in the engine. Hence it is recommended to growth the spacing for the geometry under consideration.

7. FUTURE SCOPE

- To optimize design of convergent- divergent kind restrictor
- To optimize plenum shape for having least glide resistance and maximum air glide pace
- To obtain most useful plenum extent
- To reap most efficient runner diameter
- This layout become based on taking consideration of manufacturing problem and turned into price green. But designed could have been higher if sufficient resources.
- Involvement of ceramic materials in destiny will help in more weight reduction and higher overall performance.

REFERENCES

[1] Ryan I., Christopher B. W., "Design and Manufacture of a Formula SAE Intake System Using Fused Deposition Modeling and Fiber-Reinforced Composite Rapid Prototyping", Journal, Vol. 16 Is: 3, pp.174 – 179.

[2] Heavy Duty Engines – MTZ 6/2005. 4. Jacobs, T., Chatterjee, S., Conway, R., Walker, A., Kramer, J. and K. Mueller-Haas, Development of a PartialFilter Technology for Hdd Retrofit, Sae Technical Paper 2006-01-0213. 56 K. S. Umesh, V. K. Pravin& K. Rajagopal

[4] C. Lahousse, B. Kern, H. Hadrane and L. Faillon, "Backpressure Characteristics of Modern Three-way Catalysts",Benefit on Engine Performance, SAE Paper No. 2006011062,2006 SAE World Congress, Detroit, Michigan ,April 36, 2006

[5] M.B. Beardsley et al.,Thermal Barrier Coatings for Low Emission, High Efficiency Diesel Engine Applications" SAE Technical Paper 1999-01-2255.

[6] Rajesh Biniwale , N.K. Labhsetwar, R. Kumar and M. Z. Hasan, "A non-noble metal based catalytic converter fortwostrokes, two-wheeler applications", SAE Paper No. 2001011303, 2001.

[7] G. Muramatsu, A. Abe, M. Furuyama, "Catalytic Reduction of Nox in Diesel Exhaust", SAE 930135, 1993.

[8] The scientific design of exhaust and intake systems by Philip Hubert Smith, John Cruickshank Morrison, R. Bentley, 1971

[9] The Design and Tuning of Competition Engines by Philip Hubert Smith, BENTLEY ROBERT Incorporated, 1977

[10] Automobile Engines - In Theory, Design, Construction, Operation, Testing and Maintenance by A.W. Judge