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Thermal Analysis on 4–1 Tubular Type IC-Engine Exhaust Manifold through Anysis

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ABSTRACT:

The designing of exhaust manifold is a complex procedure and is dependent on many parameters viz. back pressure, exhaust velocity, mechanical efficiency etc. As a part of thermal analysis how the temperature distribution, thermal gradient, heat flux varies from material to material is going to study in both the existing & modified geometries and results were compared by using ANSYS.

Keywords: back pressure, exhaust velocity, heat flux, thermal gradient.

1. 0 INTRODUCTION:

An exhaust manifold is a series of connected pipes that bolt directly onto the engine head. It is an integral part of the exhaust system. Hot exhaust gas from the exhaust ports on the engine’s cylinder head is funneled through the pipes and into a single collector pipe. From there, it is sent to the exhaust pipe. Exhaust manifolds are a necessary component of the exhaust system. Their design is optimized to ensure exhaust gases flow efficiently from the engine combustion chamber without creating any back pressure. A properly functioning exhaust manifold is important to prevent engine vibrations.

2. 0 GEOMETRY:

At low engine speeds the wave pressure within the pipe network is low. A full oscillation of the Helmholtz resonance occurs before the exhaust valve is closed, and to increase low-speed torque, large amplitude exhaust pressure waves are artificially induced. This is achieved by partial closing of an internal valve within the exhaust the EXUP valve at the point where the four primary pipes from the cylinders join. This junction point essentially behaves as an artificial atmosphere; hence the alteration of the pressure at this point controls the behavior of reflected waves at this sudden increase in area discontinuity. Closing the valve increases the local pressure, thus inducing the formation of larger amplitude negative reflected expansion waves. This enhances low speed torque up to a speed at which the loss due to increased back pressure outweighs the EXUP tuning effect. At higher speeds the EXUP valve is fully opened and the exhaust is allowed to flow freely.

3. 0 EXHAUST MANIFOLD:

Exhaust system is designed to evacuate gases from the combustion chamber quickly and efficiently. Exhaust gases are not produced in a smooth stream; exhaust gases originate in pulses. A 4-cylinder motor will have 4 distinct pulses per complete engine cycle a 6 cylinder has 6 pulses and so on. More the pulses produced, the more continuous the exhaust flow. Backpressure can be loosely defined as the resistance to positive flow - in this case, the resistance to positive flow of the exhaust stream. It is a general misconception that wider exhaust gives helps in better scavenging. But actually main factor behind good scavenging is exhaust velocity. The astute exhaust designer knows that flow capacity must be balanced with velocity. The faster an exhaust pulse moves, the better it can scavenge out all of the spent gasses during valve overlap.

4. 0 MATERIAL & MODELLING:

Mild steel or Stainless Steel tubing for the primary tubes along with flat flanges and possibly a larger diameter collector made of a similar material as the primaries. They may be coated with a ceramic-type finish (sometimes both inside and outside), or painted with a heat-resistant finish, or bare. Chrome plated headers are available but they will tend to blue after use. Polished stainless steel will also color (usually a yellow tint), but less than chrome in most cases. This decreases the amount of heat given off into the engine bay, therefore reducing the intake manifold temperature. There are a few types of thermal insulation but three are particularly common. Ceramic paint is sprayed or brushed onto the manifold and then cured in an oven. These are usually thin, so have little insulator properties; however, they reduce engine bay heating by lessening the heat output via radiation. A ceramic mixture is bonded to the manifold via thermal spraying to give a tough ceramic coating with very good thermal insulation.

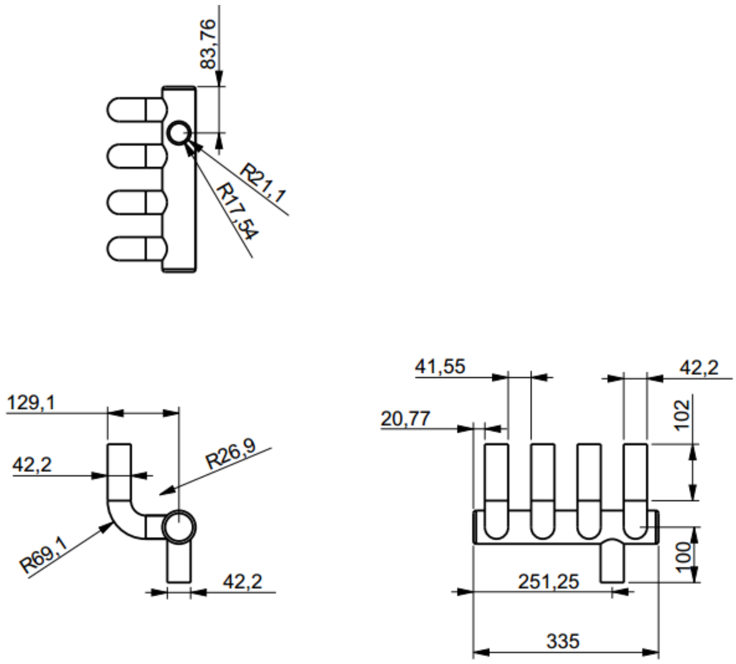


Fig No 4. 1 Existing Model

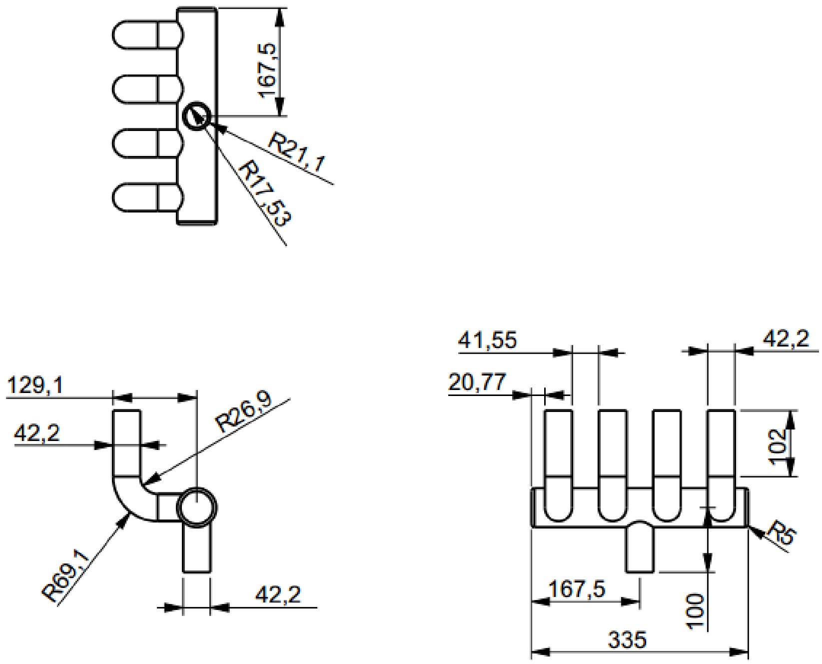


Fig No4. 2 ModifiedModel: 1

Bend Radius 48 mm and Exhaust Valve at Extreme LeftBend Radius 48 mm and Exhaust Valve at Centre

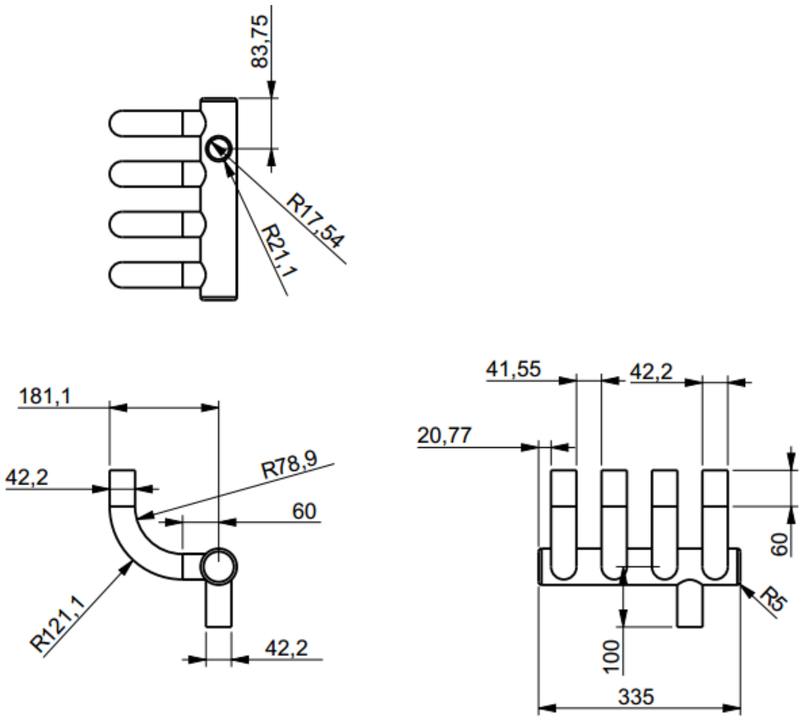
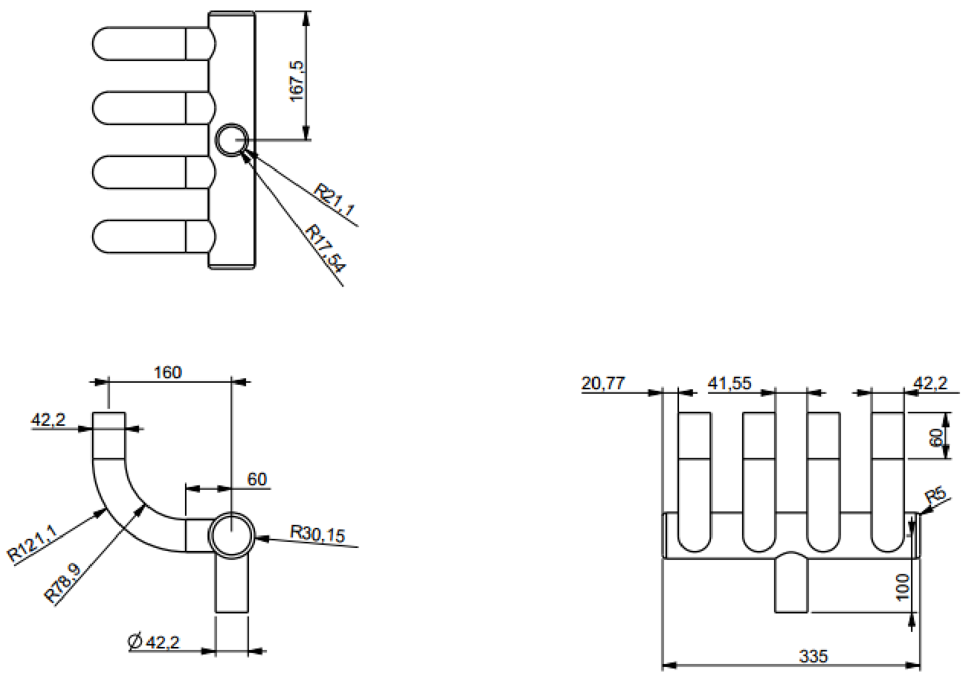


Fig No: 4. 3 Model 2 Radius 100 mm Exhaust Valve Extreme Left



FigNo: 4. 4 Model 3 Radius 100 mm Exhaust Valve at Center

Table No: 1 Temperature (K)

Geometry	Material	
	Aluminum	Cast Iron
Radius 48 mm Exhaust Valve at Extreme Left	553	553
Radius 48 mm Exhaust Vale at Center	553	553
Radius 100 mm Exhaust Valve at Extreme Left	553	553
Radius 100 mm Exhaust Valve at Center	553	553

Table No: 2 HeatFlux (w / mm$^{2)}$

Geometry	Material	
	Aluminum	Cast Iron
Radius 48 mm Exhaust Valve at Extreme Left	13626. 1	110. 838
Radius 48 mm Exhaust Vale at Center	14298. 4	116. 274
Radius 100 mm Exhaust Valve at Extreme Left	13538. 3	110. 152
Radius 100 mm Exhaust Valve at Center	13778. 0	112. 061

Table No: 3 Gradients (K/ mm)

GEOMETRY	ALUMINIUM	CAST IRON
48 mm bend radius and exhaust valve extreme left	57. 4943	110. 838
48 mm bend radius and exhaust valve at center	60	116. 274
100 mm bend radius and exhaust valve extreme left	57. 1235	110. 152
100 mm bend radius and exhaust valve at center	58. 1351	112. 061

5. 0 RESULTS:

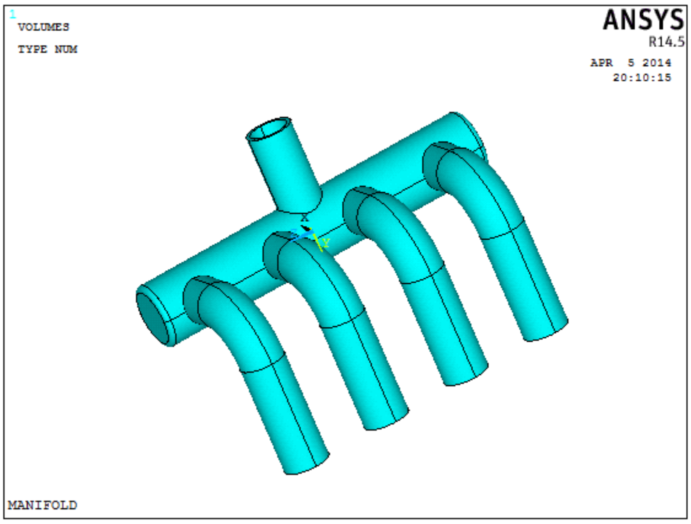


Fig No: 5. 1 3D Model

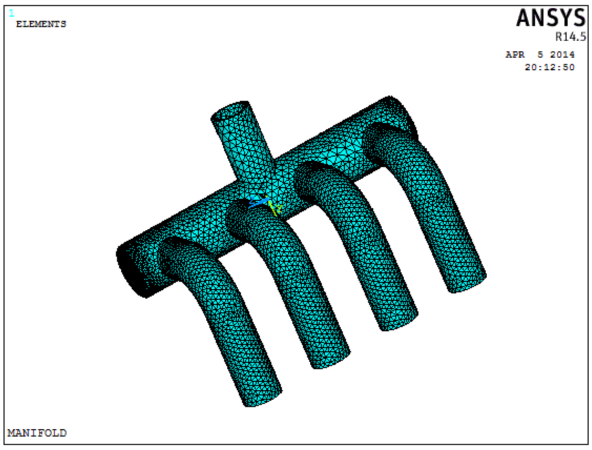


Fig No: 5. 2 Mesh Model

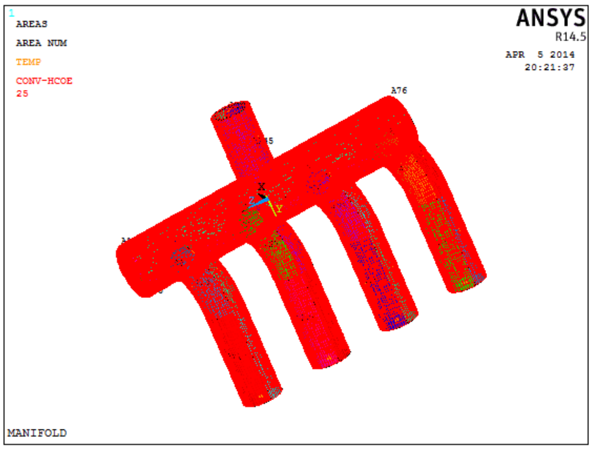


Fig No: 5. 3 Convection Load

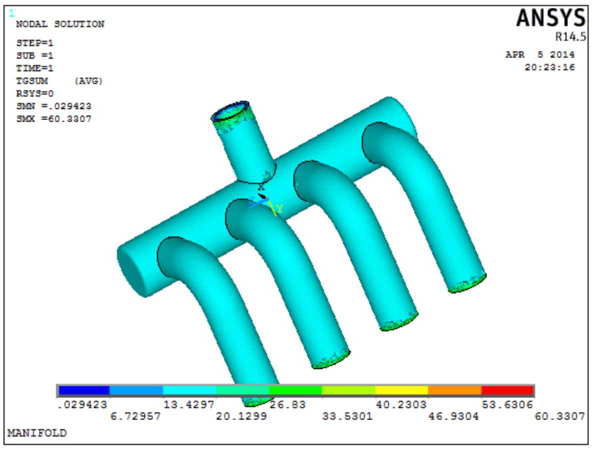


Fig No:5. 4 Heat Flux

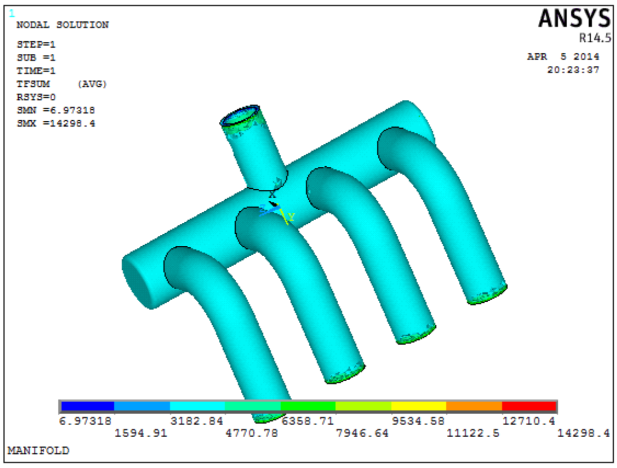


Fig No: 5. 5 Thermal Gradient

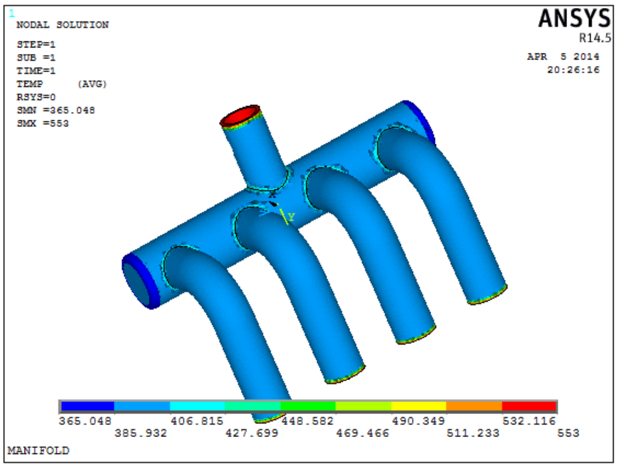


Fig No:5. 6 Temperature

CONCLUSIONS:

Referring all the software results radius of 48 mm when the exhaust valve place at center has shown best heat flux and thermal gradient pressure velocity profiles. The material recommended for the geometry is Aluminum.

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