Research Paper Technology

Cfd Analysis of Perforated Tube of Aqua Silencer

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ABSTRACT

Perforated tube is one of most important part in Aqua silencer. Perforated tube convert high mass bubble in to low mass bubble. The charcoal layer is putting 5mm from the perforated tube. The charcoal layer has more absorbing capacity because it has more surface area. Exhaust gas is more contact with charcoal layer, in this direction perforated tube is design. Using CFD for validification of perforated tube design because in short time a different design of perforated tube experiment is not possible. So different design is made in software and check it's result from the CFD analysis. CFD analysis of different design of perforated tube is carried out. The effects of different diameter of hole are find out from the CFD analysis.

KEYWORDS perforated tube, aqua silencer, Exhaust Gas, Automobile Engine

INTRODUCTION

An aqua silencer System is designed to replace conventional single unit engine silencers on board structures. With it's light weight and slender design, it offers a minimal 'footprint' while optimizing the entire exhaust system for low noise and reduced backpressure.It is used to control the noise and emission in IC engines. The reason why we go for aqua silencer is, in today life the air pollution causes physical ill effects to the human beings and also the environment. The main contribution of the air pollution is automobile releasing the gases like carbon dioxide and un burnt Hydrocarbon.

Geometry is modeled by varying hole diameter of perforated tube in GAMBIT (2.3.16) then it is exported to Ansys 14.0 (FLUENT) to analyze the contact area between exhaust gas and charcoal layer. Model consists of have 450 mm length, 25.4 mm dia and 8mm, 4mm, and 2mm hole on its periphery at 60o. Exhaust gas max. velocity is 15 m/s and max. temperature is 400 K is taken. And optimize the stream line in gap between the perforated tube and cover of it. And also find result for the changing the hole diameter on periphery of perforated tube and comparison of all result.

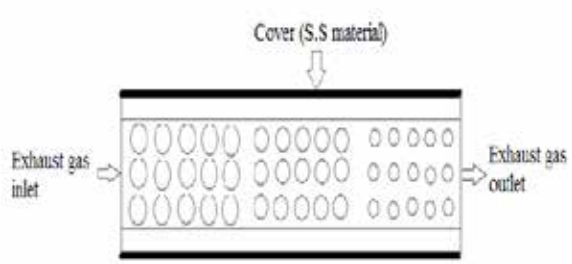

Figure 1: Model Geometry

SIMULATION SETUP

A commercial CFD code Fluent (Ansys 14.0) is used for the numerical solution of the flow. This CFD code is based on a finite volume approach. In this section the various CFD code settings and options are summarized. For all cases, steady and pressure based solver are used. The pressure-velocity coupling is done with the Phase Coupled SIMPLE algorithm.

Overall process

The genetic working process involves the following:

1. Open/Create a project.
2. Create the geometry.
3. Create the mesh.
4. Check/Edit the mesh.
5. Generate the input for the solver.
6. Postprocess the results.

TABLE – 1
TWO-PHASE FLOW SIMULATION SETTINGS IN FLUENT

Solution method	Selection
Simulation type	3D, steady state.
Solver	Double precision, Pressure based explicit scheme.
Model	Turbulence Model, K-epsilon model, (Realizable Model) Energy model.
Pressure-velocity coupling	Simple
Pressure Discretisation	Presto

TABLE 2 BOUNDARY CONDITION

Edge	Types
Air inlet	Velocity
Upper	Wall
Lower	Wall
Outlet	Pressure Outlet

Type of design

Following are different design testing in CFD simulation.

1. Experimental perforated tube.
2. Experimental perforated tube using in reverse direction.
3. 8 mm hole on perforated tube.
4. 4 mm hole on perforated tube.
5. 2 mm hole on perforated tube.

- **Experimental Perforated tube.**

Shown in fig 6.1 This tube is 450 mm length and 25.4 mm

diameter as per the design calculation. And 8mm, 4mm, 2mm diameter hole are made on periphery of this tube from inlet to outlet direction. First 150 mm length from the inlet side, there are 8mm dia. hole after 150 mm length, there are 4mm dia. hole and in last 150 mm length, there are 2 mm dia. hole.

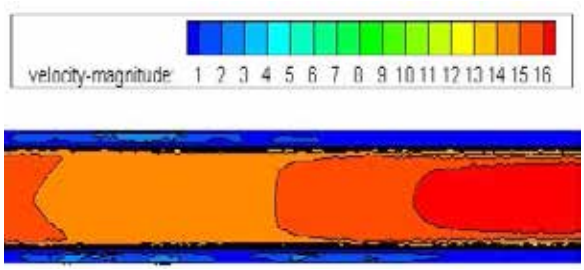

Figure 2: Full frame velocity plane of experimental tube.
Above figure shows velocity stream line in experimental tube. In this tube contour is created in whole tube so exhaust gas come in more time contact with activated carbon. So this perforated tube is using in experiment.

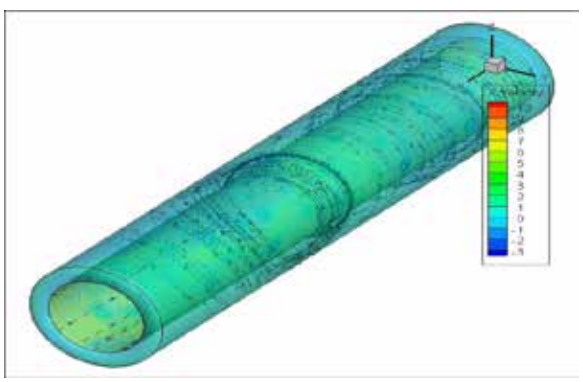

Figure 3:Flow patterns in experiment perforated tube.
Flow diagram is shown in above fig. it is find in steady state condition and exhaust gas inlet from the top side in fig and outlet from the down side. Turbulence flow is generated in gap between perforated tube and charcoal layer.

- **Experimental perforated tube using in reverse direction.**

In this tube 2mm, 4mm, 8mm diameter hole are made on periphery of this tube from inlet to outlet direction. First 150 mm length from the inlet side, there are 2mm dia. hole after 150 mm length, there are 4mm dia. hole and in last 150 mm length, there are 8 mm dia. hole.

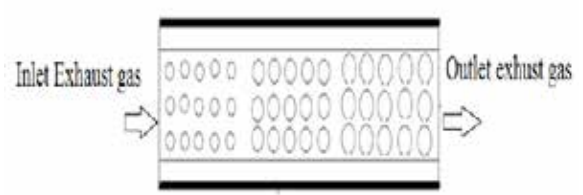

Figure 4: Reverse of experiment tube

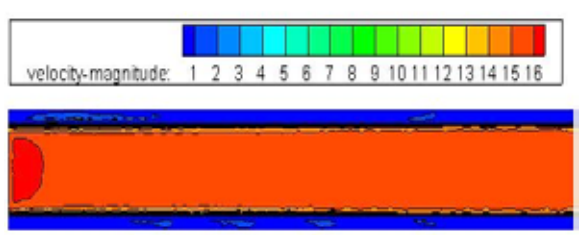

Figure 5: Full frame velocity plane in reverse of experimental tube
If using experimental tube in reverse direction contour is created only at inlet and turbulence is low, so this tube is not better for experiment.

- **8 mm hole on perforated tube.**

In this perforated tube, all holes are 8 mm on tube periphery.

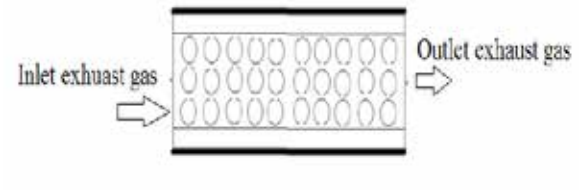

Figure 6: 8 mm hole on perforated tube

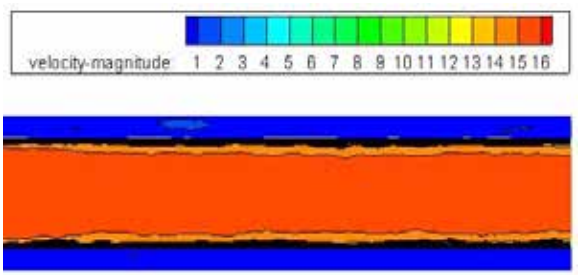

Figure 7: Velocity plane of 8mm tube

Above fig. shows the velocity plane of 8 mm hole on perforated tube. In this tube turbulence is very low and contour is also very less. So this tube is not preferable.

- **4 mm hole on perforated tube.**

In this perforated tube, all holes are 4 mm on tube periphery at same distance.

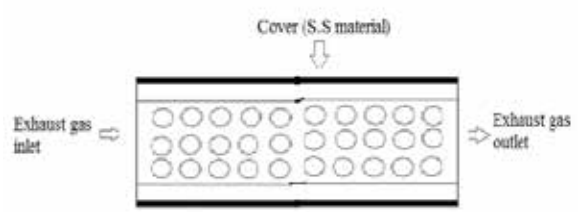

Figure 8: 4 mm hole on perforated tube

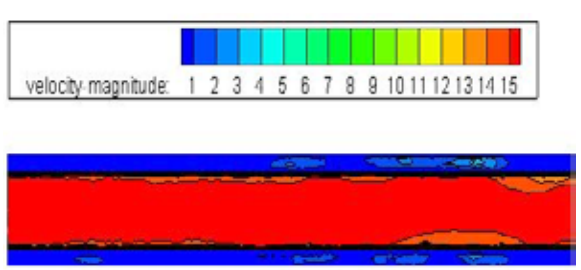

Figure 9: Velocity plane of 4 mm tube

In this tube contour is created at the half of the tube, at the inlet side there is no contour. So gas is not more contact with activated carbon, so this tube is not use.

- **2 mm hole on perforated tube.**

In this perforated tube, all holes are 2 mm on tube periphery.

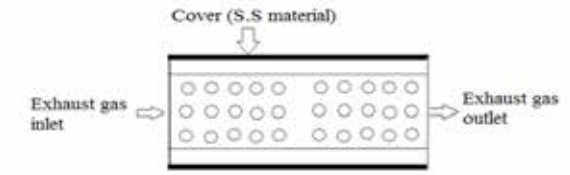

Figure 10: 2 mm hole on perforated tube

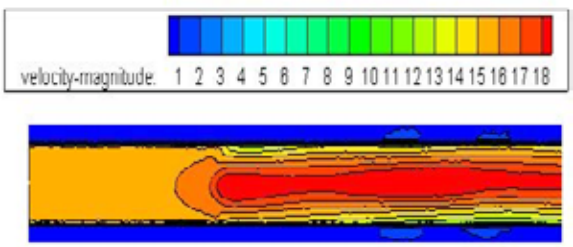

Figure 11: Velocity plane of 2 mm hole

Above fig. contour is not created at inlet and very less number at outlet, so this tube is not good for experiment.

APPLICATIONS OF PERFORATED TUBE

In different type of silencer, there are using perforated tube to reduce sound. Perforated tube convert high mass bubble in to low mass bubble.

APPLICATIONS OF AQUA SILENCER

Aqua silencer is using in automobile engines, DG sets and Industries to reduce the sound as well as pollution.

CONCLUSIONS

Above all design, the experimental perforated tube have good contour, so this design is optimize design from the all. Flow diagram is also shown in fig 2 and fig 3. From that two diagram find that this design is preferable for experiment of aqua silencer. So take this tube used in silencer.

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