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Flow Analysis of Air Cleaner and Resonator by Shape

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형상별 에어클리너와 레조네이터의 유동에 관한 연구

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ABSTRACT

In this study, flow analysis results according to different air cleaner and resonator configurations were used to investigate flow and velocity. Among models A, B, and C, model B had the higher speed and pressure. Model B is therefore considered suitable as an air cleaner. This study aims to design optimal shapes of air cleaners and resonators without noise sources.

Keywords : Air Cleaner(에어클리너), Resonator(레조네이터), Flow Analysis(유동해석), Velocity of Flow(유속), Pressure(압력)

1. Introduction

The wide use and high qualification of cars has led to new environmental needs as well as demand for the performance and function of cars. One of them is the need for ergonomic design through enhanced comfort and it provides safety and convenience. Air cleaners have been used to improve indoor air quality in vehicles in order to provide convenience. An air cleaner is a component that filters the air when it is burned in an engine. Therefore, after filtering the contaminated air, the air enters the combustion chamber. However, the use of air cleaner causes the air duct to make a noise at the joint of the air filter. So, this sound makes the driver to be offended by the noise. Therefore, many studies are being conducted with the installation of a resonator to offset the noise in order to achieve the high quality of vehicle. Because the air intake generated by inhaling air are located forward of the driver, the noise from inhalation of air becomes interior noise in vehicle. However, the design must be designed to improve performance in order to get rid of noise problem. In this study, three common models of air cleaners and resonators were designed as CATIA and the analyses of pressure and flow were carried out with ANSYS program. By applying the results of the study to air cleaner and resonator connections, it is thought to devote the design to

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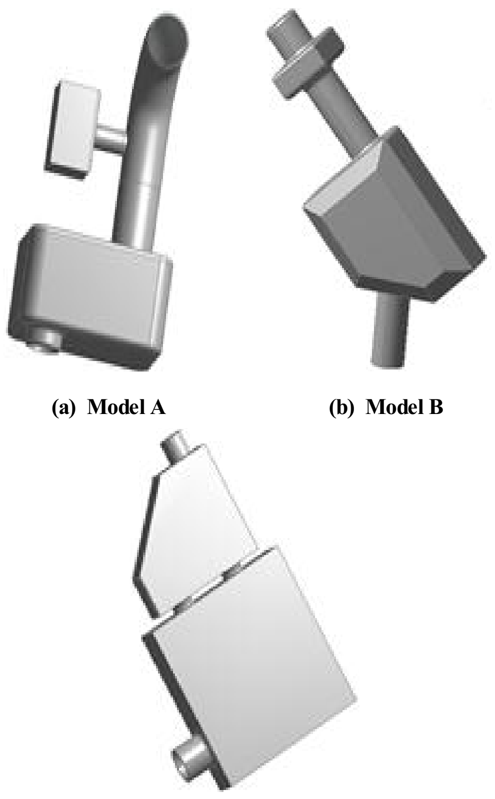
the product whose durability can improve[1~12].

2. Study Models and Analysis Results

2.1 Study models

In this study, the fluid was used as air with the temperature at 25°C as an analysis on the flow characteristics of air cleaner and resonator. In addition, the materials of air cleaners and resonator are used to form materials similar to those of real products using structural steel. The shapes of models are as shown in Fig. 1. Total pressure and velocity were analyzed according to the shapes of three models. The flow inside resonator and air cleaner are analyzed with CFX.



(a) Model A (b) Model B

(c) Model C

Fig. 1 Study models

Table 1 Number of elements and nodes at models A, B and C

Model	Nodes	Elements
Model A	7015	35594
Model B	8084	42601
Model C	8278	38544

In this study, the models of automotive air cleaners and resonators are shown with the number of elements and nodes at models 1, 2 and 3 in Table 1.

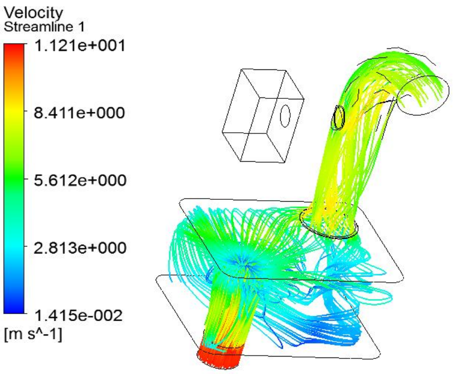
2.2 Flow conditions

The inside flow rate is set at 25°C, the speed of the inlet and the pressure of the outlet were as 11 m/s and 600 pa, respectively. The shapes of the remaining parts except the inlet and exit were considered as walls and the pressure were set as 0pa.

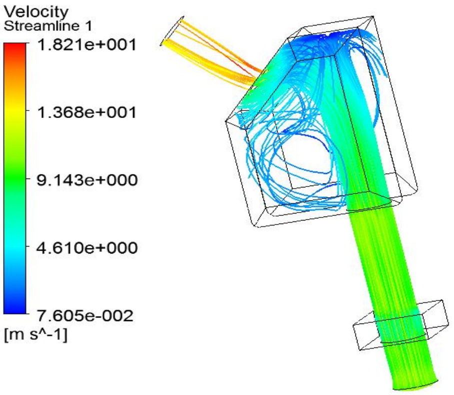
2.3 Flow analysis results

The air cleaner that filters the air entering the engine and the resonator of vehicle that offsets the noise caused by the air flow are analyzed through the flow of air with pressure velocity[13~15]. As seen by the streamline of model 1 in Fig. 2(a), the speed at the inlet of tube is the fastest. However, in case of model 2 at Fig. 2(b), it can be seen that the speed of outlet is the fastest among the overall speeds. In the case of model 3 at Fig. 2(c), the speed of tube perpendicular to the inlet and inlet sections is the fastest.

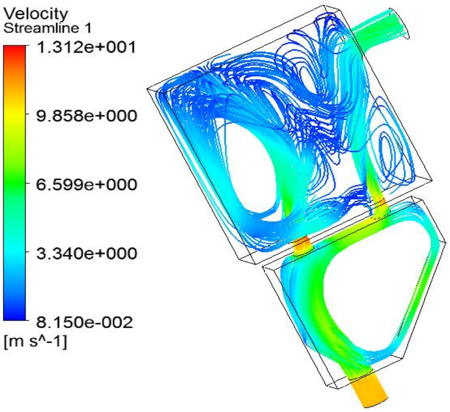
Fig. 3 shows the contours about total pressures of three models. The overall pressure indicates that the pressure of outlet becomes lower than that of the inlet. In addition, the speed and pressure of flow can be checked to determine that the position of resonator seldom has an effect at influencing the air as a result of the lowest pressure among the overall pressures at the part which is the resonator of model A. However, as the pressure at the corner of the air cleaner increases, the source of noise was proved to be the corner through the analysis data.



(a) Model A

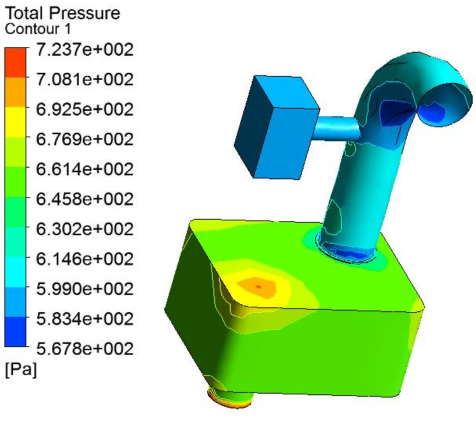


(b) Model B

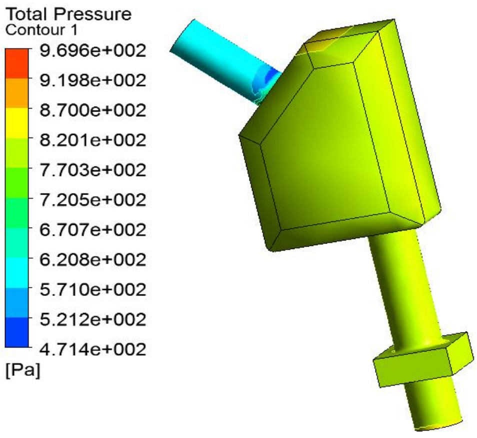


(c) Model C

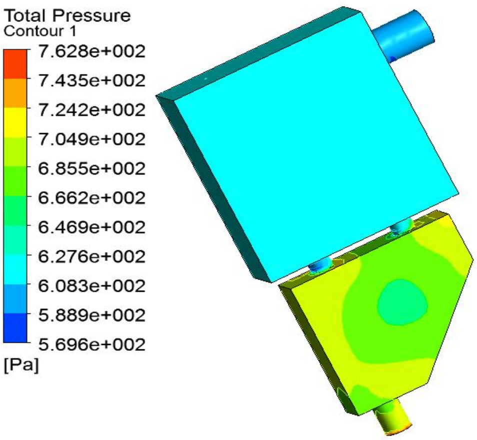
Fig. 2 Streamlines of models A, B and C



(a) Model A

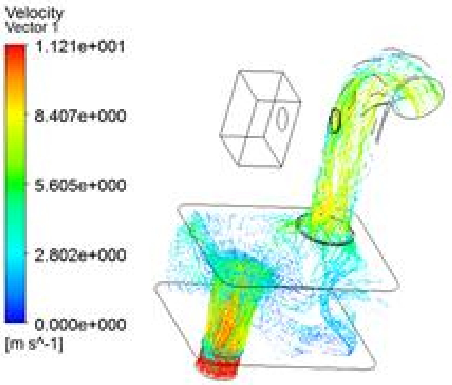


(b) Model B

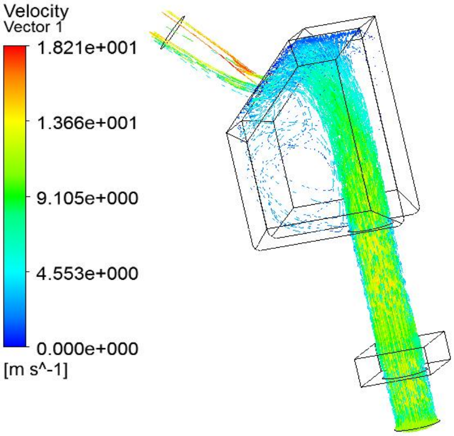


(c) Model C

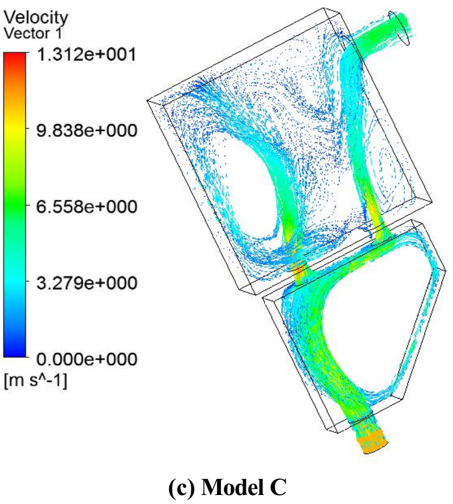
Fig. 3 Pressure contours of models A, B and C



(a) Model A

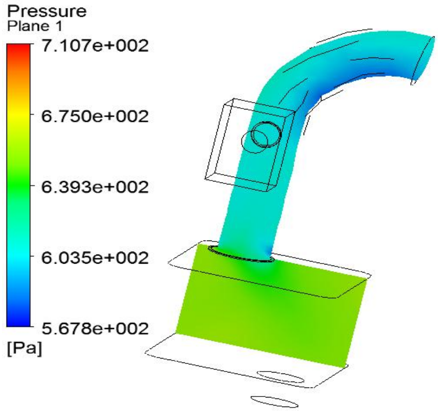


(b) Model B

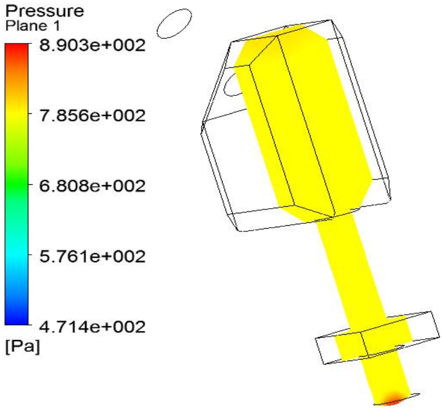


(c) Model C

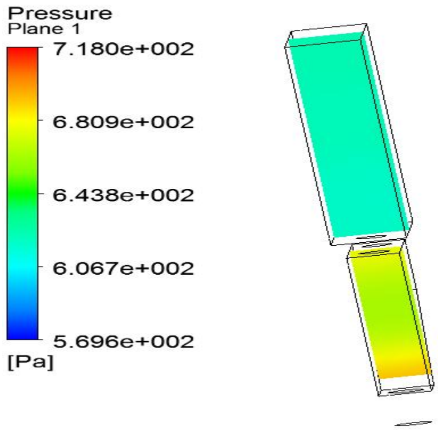
Fig. 4 Vector velocities of models A, B and C



(a) Model A



(b) Model B



(c) Model C

Fig. 5 Internal pressure by flow plane at models A, B and C

Fig. 4 shows the vector velocities about total pressures of three models. Fig. 4 shows that air is not allowed into the resonator of model A. So, it is necessary to change the position to the side of air cleaner or the tube installation of the outlet. In addition, in cases of the front parts of model B and model C, it can be seen that a central space of flow happens. Therefore, it is possible to determine the position of the resonator. In addition, the differences in flow flows in two tubes which influence the overall pressure accordingly can be observed through the flow of air in model C. It is found that the inlet position of model C is not aligned with the central part of the connecting tube of the resonator and the air cleaner, which causes the position to be tilted to one side only.

Fig. 5 shows the internal pressure by flow plane at models A, B and C. As seen by the result of internal pressure at Fig 5(a) in case of model A, it can be seen that the flow with the pressure of approximately 650pa flows into a square shape and exits into a circle. And it can be seen that the internal pressure at the Fig 5(b) of model B is higher than that of the other models A and B, and that the pressure in the inlet is also the highest. Fig 5(c) of model C shows that the internal pressure is gradually decreasing. As seen by the comparison of two models, the internal pressure of model A at Fig. 5(a) is on average low and the internal pressure of model B at Fig 5(b) averages the value of 790pa, with the diameter of the tube and the area of the air cleaner being smaller overall than model A at Fig 5(a) and the pressure of model B increases than that model A at Fig 5(a). In case of model C at Fig 5(c), the internal pressure of the initial resonator is higher than the internal pressure of the air cleaner. Also, the relationship between the resonator and the noise becomes greater than that of model A at the Fig 5(a).

3. Conclusion

In cases of three models A, B and C, the average speed and pressure of inlet are set to normal speed of 11 m/s and 600 pa, respectively. In this study, the flow analysis results according to the configuration in the air cleaner and resonator are summarized as follows;

1. As there is no inflow of air at the resonator of model A, it is necessary to place the position of regenerator by the air cleaner or by the tube.
2. It is shown that the average speed and pressure of model B is significantly higher than those of model A and model C.
3. The pressure at the corner of air cleaner is observed to be high, indicating that the source of the noise becomes the corner.
4. The differences in flow flows in two tubes which influence the overall pressure accordingly can be observed through the flow of air in model C. It is found that the inlet position of model C is not aligned with the central part of the connecting tube of the resonator and the air cleaner, which causes the position to be tilted to one side only.

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