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Optimization of mechanical part design for improving measurement sensitivity of air quality measuring device

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Introduction

Recently, the level of domestic air pollution is rapidly deteriorated by fine dust, and the demand for air quality measurement equipment and reliability of the equipment are also increasing. Although the air quality measuring device has been developed, a problem arises in that the measurement sensitivity rapidly decreases in an environment where the external air flow is low.

In this study, a forced convection environment was developed by installing a fan inside the apparatus, and the flow analysis was performed by optimizing the fan inlet and outlet, and the inlet velocity as design variables. For the analysis, a design optimization model of the air quality measuring device mechanism was conducted to distribute the uniform pressure on each sensor surface.

Experiments and simulations

In the case of the air quality measuring device, a sensor board consisting of eight sensors for measuring fine dust and harmful gas concentration, a control board for power supply and control, and a fan, outlet, and pollution prevention filter Consists of air environment measuring device enclosure.

Fig.1 Atmospheric environment Sensing Device

Two types of models with different inlet / outlet locations were derived to optimize the design of the air chamber as shown in Fig. 2.

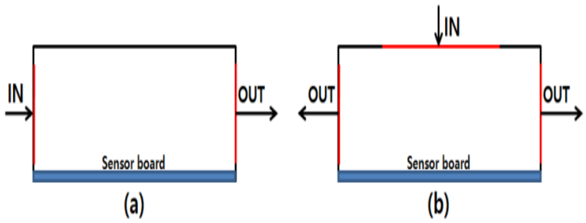

Fig.2 Model type of inflow & outflow

The model for analysis was partially simplified to reduce the analysis time, and the lower part of the sensor board without flow was removed. The boundary conditions were set as inflow and outflow conditions as shown in Fig. 3 and the inflow conditions were set in the range of 1 ~ 5m/s.

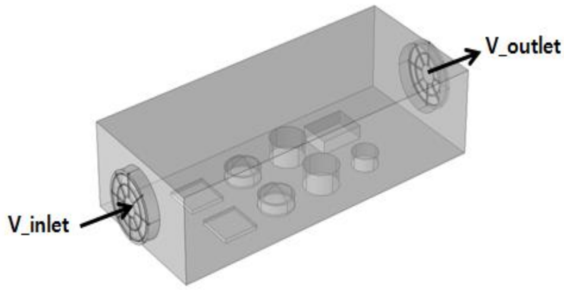

Fig.3 Analysis Model &Boundary Condition

The analysis was performed under the conditions of laminar flow for model (a) and turbulent flow for model (b).

Results

For the analysis of measurement accuracy, the average pressure value applied to each sensor surface was derived after flow analysis, and the pressure uniformity inside the sensor board was analyzed.

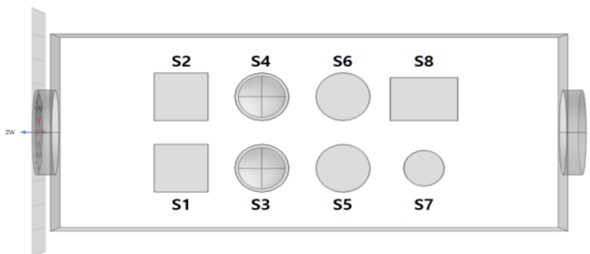

Fig.4 #number of each sensors

As a result, it was analyzed that model (a) is superior to model (b) in terms of pressure uniformity of the sensor surface among the two models presented.

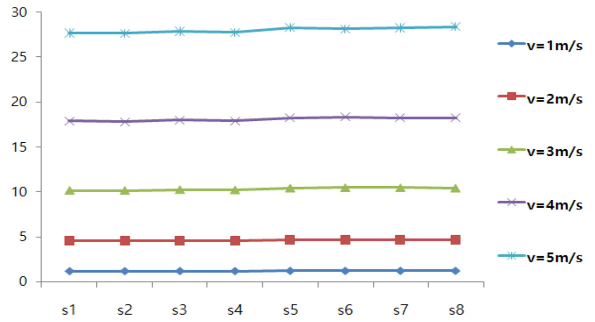

Fig.5 Pressure distribution(a type)

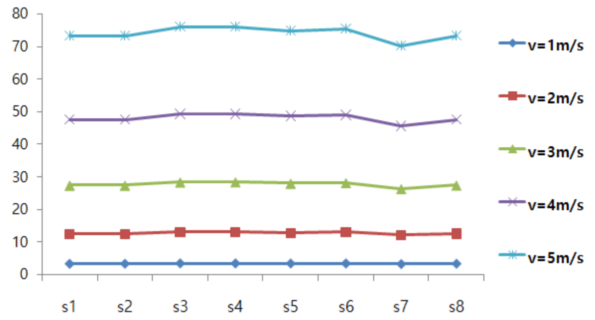

Fig.6 Pressure distribution(b type)

In the case of the pressure acting on the surface of each sensor, the pressure variation also increased as the inflow rate increased in both models.

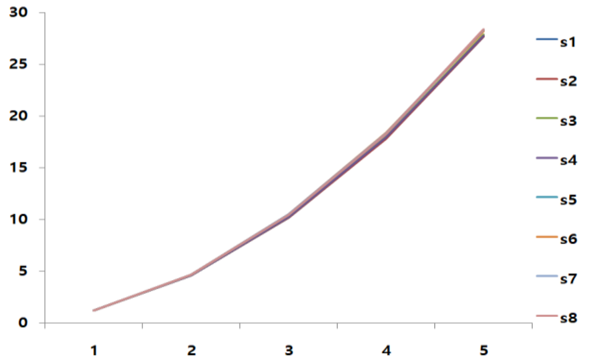

Fig.7 Pressure distribution according to v(a type)

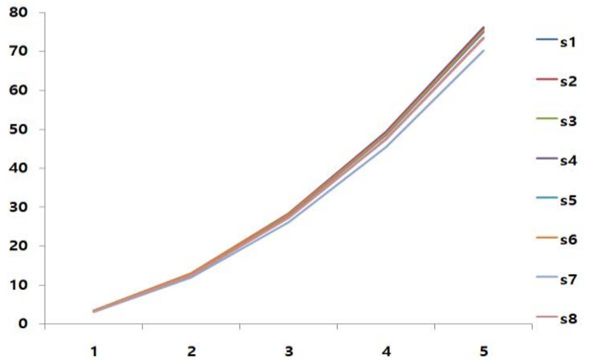

Fig.8 Pressure distribution according to v(b type)

In this study, the flow analysis was performed according to the position of the inlet / outlet and the rotational speed of the fan to optimize the design of the air conditioner enclosure. Based on the results, the optimal design could be derived.

Acknowledgment

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References

[1] J. W. Kim, Y. Y. Chung, Performance and Flow Characteristics of Axial Fan, Korean Journal of Air-Conditioning and Refrigeration Engineering, 12, (11), (2000), 972-981.

[2] K. Selvaraj, S. Kumar, R. Lakshmanan, Analytical expression for concentration and sensitivity of a thin film semiconductor gas sensor, Ain Shams Engineering Journal, 5, (3), (2014), 885-893.