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Research paper

A Study on the Characteristics of Proportional Control of Roll Screen Dampers' Constant Air Volumes

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Abstract

In the present study, a new damper system using new technologies with a folding roll screen blade system was constructed. In addition, intelligent folding roll screen blades that can control the constant air volume in proportion to damper opening were constructed. Furthermore, an actuator was installed on a slim folding roll screen damper to construct an applied technology so that the constant air volume can be controlled in proportion to damper opening and closing in order to conduct an experimental study. As a result of the present study, the error rate between the theoretical air flow rate and the experimental air flow rate was in a range of ± 3%.The air flow rate increased linearly following the increase in damper opening. The air volume that passed through the roll screen damper increased in proportion to the static pressure and damper opening so that the air volume was controlled in proportion to the constant air volume.The simulation was conducted with damper opening degrees of 40%, 60% and 85 and according to the results, the damper outlet air volume was 158.2 m^3/min when the opening was 40%, 223.7 m^3/min when the opening was 60%, and 302.5m^3/min when the opening was 80%. These simulation results were in good agreement with the experimental values.

Keywords: *Damper. Roll Screen, Constant, Volume, Proportional Control, Screen Blade*

1. Introduction

The dampers used in industrial field facilities have been used thus far for their simple function per se as opening / closing devices to control or block air volumes by adjusting the opening of ducts [1]. In addition, according to the results of domestic and foreign studies of dampers, many study reports were regarding constant air volume control dampers that can control air volumes proportionally to the opening of the dampers at the working pressure, temperature, and static pressure of the fluid flowing in the dampers [2-4]. In addition, to reduce the damper leakage rate, studies to reduce the gap by adjusting the number of wings and dividing the length of wings have been in progress [5-7].In general, large buildings, plants, and industrial facilities are equipped with ducts of predetermined lengths, which serve as fluid passages to enable fluids to flow[8]. These ducts are equipped with dampers that are installed on the lines of the ducts to regulate the direction, velocity, and volume of the fluid circulating inside the ducts.Dampers are divided into diverse types according to their shapes and materials[9]. They are especially frequently applied to the field of controlling the amount of fluids (air). Among damper technologies as such, in the case of normal damper devices consisting of a frame of a certain shape, multiple blades installed inside the frame, and a driving device for opening and closing the blades installed on one side of the frame, study results regarding those with blades having a vacuum hollow section formed inside each of them and fitting pins placed with tension at both end by a tensioning device so that the blades can be easily attached and detached by the insertion and extraction of the fitting pins have been reported[10, 11].However, in the case of the abovementioned damper devices, since the amount of opening is adjusted along the trajectory of multiple blades rotating around the shaft, in cases where the amount of opening is small, the openings formed between different blades cannot but be located above and below the blade rotating directions. Therefore, the fluid (air) collides with the ends of the blades in the process of passing through the damper horizontally so that vortexes are generated and only some of the fluid passes through the damper. Since the fluid cannot flow smoothly as such, the volume of the fluid (air) cannot be accurately controlled.To solve the above mentioned problem, study results have been reported on the structures of dampers of ducts equipped with blades ascending and descending within the frame, in which room members are installed inside the abovementioned frame to be in contact with the outer circumference of the blades on the above, below, left, and right of the blades thereby forming a certain space between the circumference of the room members and the frame and air is blown through this space using an air blower[12, 13].

However, study reports regarding the control of the constant air volume in proportion to damper opening and reduction in damper leakage rates are a little insufficient. Therefore, in the present study, study results were derived on slim dampers with excellent performance that provides not only the convenience of construction but also diverse functions, which can be installed in small spaces in plants in industrial fields and in the field of existing industrial facilities. In addition, study results were derived on folding roll screen blades that can control constant air volumes in narrow spaces.

2. Experimental Equipment and Experimental Method

Fig. 1 shows roll screen damper. As shown in Fig. 1, the roll screen damper consists of a roll screen blade drive unit, a constant air volume proportional control device, a damper jam sealer, a damper opening proportional control actuator device, and folding roll screen blades.

In previous studies, study results were derived regarding dampers in which individual blades are used or integrated blade structure systems are used as with slide dampers and the constant air volume passing through the damper was not controlled in proportion to static pressure and opening. In this study, As shown in Fig. 1, a new technology damper system with folding roll screen blades was constructed. And we constructed intelligent folding roll screen blades that can adjust the constant air volume in proportional to damper opening. In addition, the application technology was constructed so that constant air volume proportional control for damper opening and closing was possible by attaching the actuator to a folding Roll Screen Damper with Slim

In the present study, as shown in Fig. 1, a new damper system using new technologies with a folding roll screen blade system was constructed. In addition, intelligent folding roll screen blades that can control the constant air volume in proportion to damper opening were constructed. Furthermore, an actuator was installed on a slim folding roll screen damper to construct an applied technology so that the constant air volume can be controlled in proportion to damper opening and closing.

In addition, in the present study, to relieve problems and technical prejudices at the current domestic and foreign technology levels, a roll screen damper which can be installedwithout being restricted by places even when the place of installation is small was constructed by ensuring precise control through horizontal movements of the fluid even when the amount of opening is small and minimizing the space where the ascending and descending blades are accommodated. In addition, the screen damper is interposed between the connection sections of the duct, and a pair of connection ducts in which openings for connecting the ducts to each other have been formed; a blade disposed between the pair of connection ducts for selectively controlling the fluid flowing through the connection ducts through ascending and descending; a cover housing, which is connected to the openings of the pair of connection ducts while accommodating blades and equipped with a rolling means for rolling the blade so that the blade can ascend and descend , and an airtightness system, which is installed inside the cover housing connected to the openings of connection ducts and comes into tight contact with ascending blades to enable airtightness between the abovementioned cover housing and the abovementioned blades were constructed. The blades are made through the combination of multiple plates, which are combined so that they can be assembled together. The plates are flat and havea predetermined length and were constructed to form assembly rings on the top and bottom in the length direction so that they can be assembled with each other.

Figure 1:.Roll screen damper

In addition, Fig. 2 shows the screen blade of the roll screen damper**.** As shown in **Fig. 2,** the pitch of the screen blades is 50mm, the number of blades is 25, the thickness of the blades is 2~3.2mm, and the weight of a blade is 46 ~ 55kg. In addition, the driving speed of the folding roll screen blades was set to 50mm/sec, and the blade driving shaft torque was set to 1950 ~ 2,200kg.m. The rolling shaft of the roll screen damper was placed above the cover housing so that it can rotate. The blades were placed laterally to the cover housing while their upper ends were connected to the rolling shaft. In addition, the roll screen damper also comprises a power unit that rotates the rolling shaft in the forward direction and reverse direction so that the blades can be wound or unwound around the abovementioned rolling shaft and a tensile force providing unit, which is placed below the cover housing so that it can rotate and connected to the bottom of the blades with wires to provide tensile force to the blades when the blades are rolling. As a result of the development of the roll screen damper as such, the blades can be made to ascend or descend together with the screen by the system in which the blades are rolled by the driving of the power unit. Therefore, a technology for accurate quantitative control of horizontal movements of the fluid was implemented. This technology has an excellent effect of enabling installation even in small spaces because no separate space is necessary to accommodate blades.

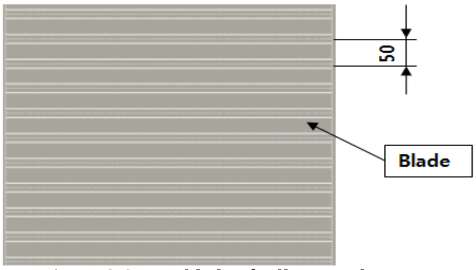


Figure 2. Screen blade of roll screen damper

3. Results and Discussion

3.1. Simulation Results

Figure 3 shows the shape of the damper simulated in the present study. Unnecessary shapes were excluded, and the damper was drawn with planes as the thickness of the damper was considered to have no effect on the air volume. A moving field beginning from a point 2m away from entrance of the damper ending at a point 4m away from the exist of the damper was implemented. The damperheight was divided into five equal intervals and the open percentages were set to 80%, 60% and 40% through the designation of boundary conditions to conduct analysis. The simulation was conducted under normal conditions as analysis conditions and the k-epsilon model was used as a turbulence model.

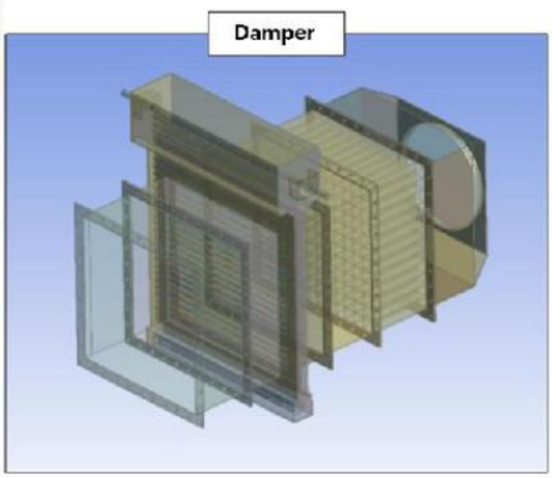


Figure 3.3: Dmodeling of roll screen damper

Fig. 5 shows the results of simulation of the roll screen damper.

The fluid flowing in the roll screen damper is air, and the air density is 1.225 kg / m3. The inlet air volume of the roll screen damper is 420 m3 / min when opened at 100%. The pressure at the inlet of the roll screen damper was set to 33.168 Pa for the simulation. The lattice generation modeling was conducted with 46,000 hexahedron type lattices. The simulation was conducted with damper opening degrees of 40%, 60% and 85 and according to the results, the damper outlet air volume was158.2 m^3/min when the opening was 40%, 223.7 m^3 / min when the opening was 60%, and 302.5 m^3/min when the opening was 80%. These simulation results were in good agreement with the experimental values.

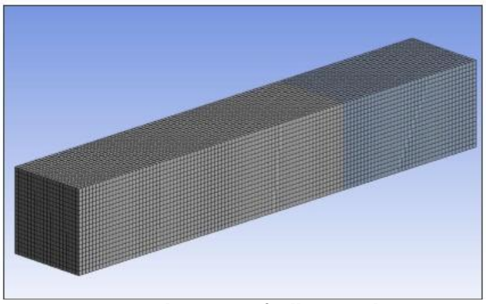
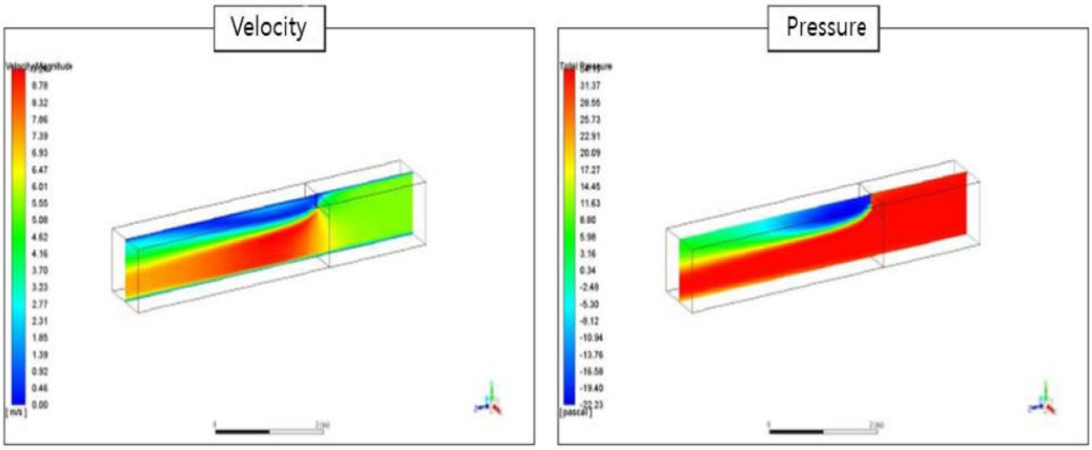
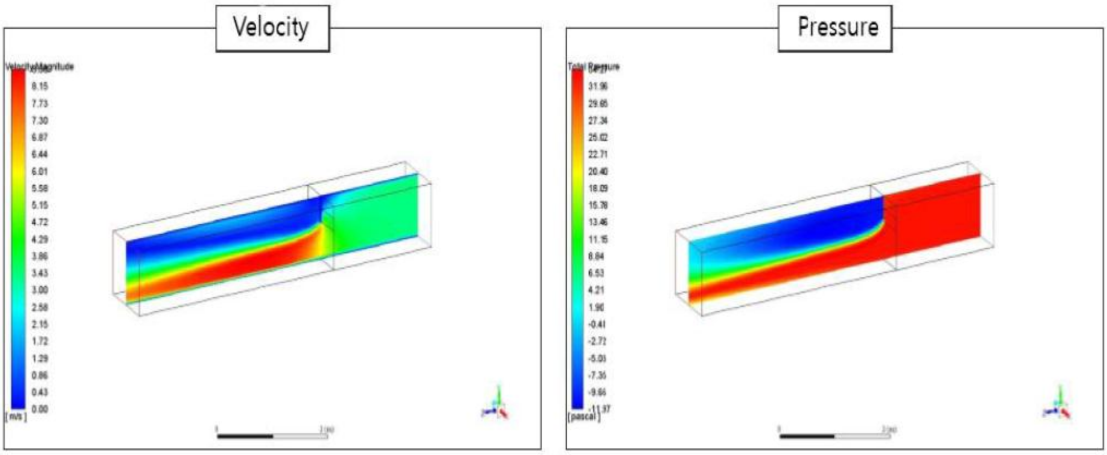


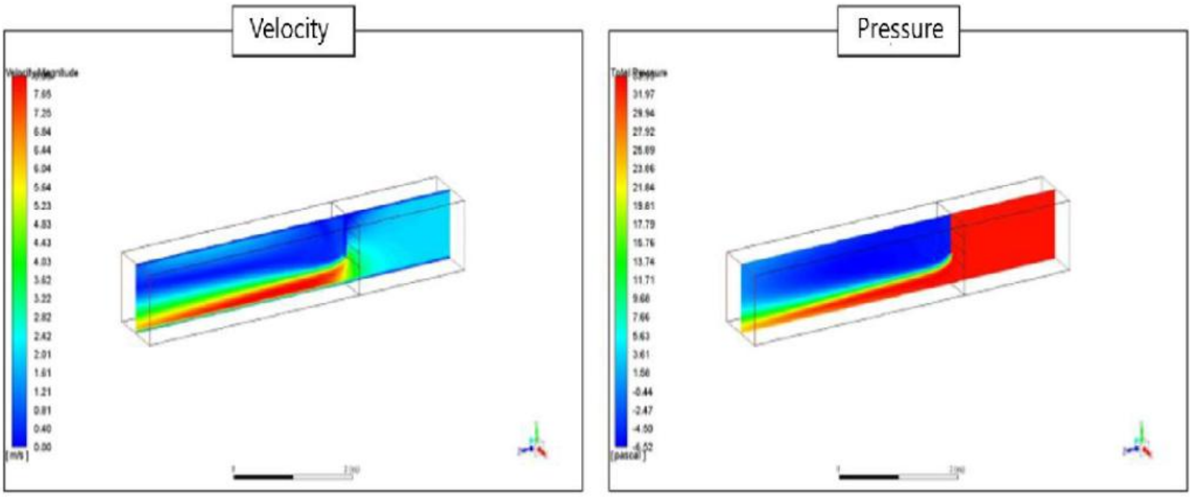
Figure 4:.Grid creation of roll screen damper



(a) The case of 80%



(b) The case of 60%



(c) The case of 40%

Figure 5:. The Velocity anc pressure distribution of roll screen damper

3.2. Experimental Results

Fig. 6 shows the ratios of the theoretical air flow rates to the experimental air flow rates according to changes in the damper opening rate of the roll screen damper. An inverter was installed on the air blower to control the air volume of the air blower. The experiment was conducted with the maximum air volume of the air blower, 50% of the maximum air volume, and 25% of the maximum air volume as experimental conditions. As shown in Fig. 3, the experiment was conducted with the error rates between the theoretical air flow rate and the experimental air flow rate in a range of ± 3%. Therefore, the accuracy of the present experiment was shown to be high and it is considered that reliable experimental results were derived.

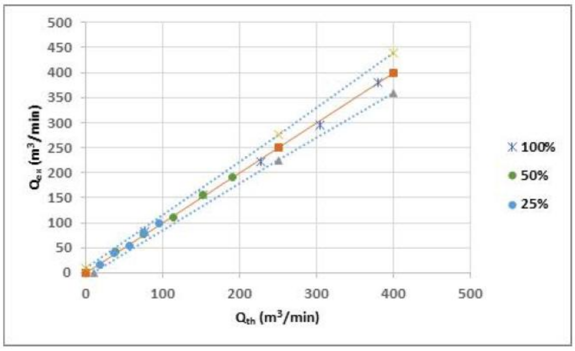


Figure 6:. Accuracy of air flow rate of roll screen damper

Fig. 7 shows the rates of changes in the air flow rate according to changes the damper opening rate of the roll screen damper. The experiment was conducted with the maximum air volume of the air blower, 50% of the maximum air volume, and 25% of the maximum air volume as experimental conditions. In addition, the experiment was conducted under five damper opening conditions; 20%, 40%, 60%, 80%, and 100%. As shown in Fig. 4, under the experimental conditions, the maximum air volume of the air blower, 50% of the maximum air volume, and 25% of the maximum air volume, the air flow rate increased linearly over the changes in damper opening rates into the five rates. Therefore, from the present experimental results, it can be seen that the constant air volume is proportionally controlled because the air volume that passes through the roll screen damper increased in proportion to the static pressure and the damper opening.

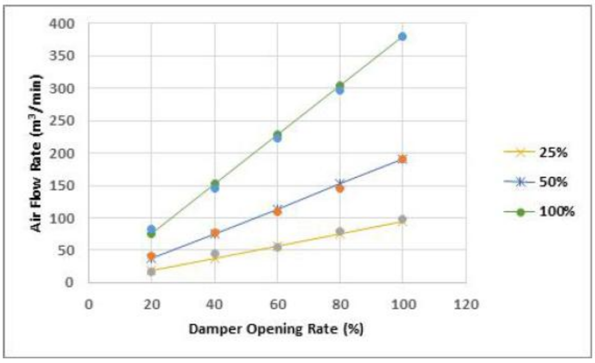


Figure 7:. Air flow rate vs. damper opening rate of roll screen damper

4. Conclusion

In the present study, intelligent folding rollscreen blades that enable the control of the constant air volume in proportion to damper opening were constructed and an experimental study was conducted to derive the following study results. The error rates between theoretical air flow rates and experimental air flow rates were within a range of ±3%. The air flow rate increased linearly following changes in the damper opening. The constant air volume was proportionally controlled because the air volume that passes through the roll screen damper increased in proportion to the static pressure and the damper opening.The simulation was conducted with damper opening degrees of 40%, 60% and 85 and according to the results, the damper outlet air volume was158.2 m^3/min when the opening was 40%, 223.7 m^3 / min when the opening was 60%, and 302.5 m^3/min when the opening was 80%. These simulation results were in good agreement with the experimental values.

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