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A Study on the Noise Performance of Silencer Fused with Hole-Cavity Resonance Technology and Micro-Sphere Stainless Chip Sintering Technology

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Hole-Cavity 공명기술과 미세공 스테인레스칩 소결 융합 소음기의 소음성능에 관한 연구

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ABSTRACT

In this study, the hole-cavity resonance technology and the micro pore stainless chip sintering technology were fused to develop silencers with excellent noise attenuation performance even at fluid pressures exceeding 30 bar for the first time at home and abroad. As a result of this study, the noise attenuation performance was greatly improved as reflection, loss, and resonance were made to occur thousands of times simultaneously when fluids pass through the sintered micro pore stainless steel chip sound absorber. The noise of the gas emitted from the bomb without the silencer was shown to be 125dB. And noise test conducted after installation of the silencer showed the noise of 67dB. Given the study results, the amount of noise was greatly reduced in the sintered silencer.

Key Words : Sinterd Silencer(소결 소음기), Hole-cavity Roenance(홀-캐비티 공명), Stainless Chip(스테인레스 칩), Noise(소음), Performance(성능)

1. Introduction

Silencers are intended to attenuate the noise propagated through the inside without interfering with the free flow of the fluid. Currently, domestic and overseas studies of silencers are classified into reactive, absorptive, and reactive-absorptive silencer studies according to the principles of motion and such studies have been actively conducted[1,2]. In recent years, due to the development of design technologies, fluid machinery (compressors, blowers, etc.) and engines have been in a trend toward high output / high capacity and accordingly, noises have been gradually increasing[3,4]. In particular, when the fluid pressure is 10 bar or higher, the amount of noise attenuation decreases greatly at the level of

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domestic and foreign technologies leading to difficulties[5]. Unlike automobile exhaust silencers, silencers for reducing exhaust sounds used in South Korea have been mostly foreign products without any design modification[6]. Recently, some silencers for fluid machinery have been supplied mainly by domestic small and medium sized enterprises. However, as fluid machines have become to have high power / high capacity recently, the performance required from silencers has been strengthened so that new research and development is urgently needed[7].

Therefore, this study was conducted to fuse the hole-cavity resonance technology and the micro pore stainless chip sintering technology to develop silencers with excellent noise attenuation performance even at fluid pressures exceeding 30 bar for the first time at home and abroad.

2. Experimental equipment and method

Fig. 1 shows the three types of silencers used in noise performance tests in this study. Fig. 1 (a) shows a silencer appled with the hole-cavity resonance technology, Fig. 1 (b) shows a silencer fused with the hole-cavity resonance technology and the screen mesh technology, and Fig. 1 (c) shows a silencer fused with the hole-cavity resonance technology and the micro pore stainless chip sintering technology. Reactive silencers use impedance mismatch to attenuate noises by reflecting the acoustic energy released by the noise source toward the noise source. Aabsorptive silencers attenuate noises by dissipating the acoustic energy as thermal energy using sound-absorbing materials. In addition, innovative changes in silencer development technologies can be pursued by applying the acoustic resonator technology, which has excellent noise reduction performance. Therefore, in this development project, a sound absorption technology using sintered stainless chips with micro pores was studied as the first source technology at home and abroad. This technology greatly improves the noise attenuation performance using a sintered stainless chip sound absorber with micro pores that simultaneously generates reflection, loss, and resonance when the fluid passes through it. In addition, as shown in Fig. 1, the silencer was studied so that when there is incidence of plane waves in the single resonator installed on the wall of the resonator, interactions occur between the resonator and the external sound fields (reflective waves from the wall, etc.). These interactions appear in the form of radiation impedance at the entrance of the resonator. Therefore, the silencer was studied to improve its sound absorbing performance greatly using the radiation impedance at the entrance of the resonator.

Fig. 2 shows the experimental apparatus for the silencer characteristics experiment. The experimental apparatus was composed of a bomb that supplies high pressure gas to the silencer, a compressor that supplies highpressure gas to the bomb, an electric heater, which is a heat supply device that raises the gas temperature to 400°C, a slidacs that regulate the electric power supply to the gas inside the bomb, a thermometer that measures the internal temperature of the slidacs and bomb, a pressure gauge that measures the internal pressure of the bomb, a silencer that measures the noises of the bomb, and a silencer studied in this study. Three 5-kW band heaters were installed at the outer surface of the bomb to supply heat so that the experiment could be conducted with the temperatures of the gas supplied to the silencer changing in a range of 20 ° C to 400 ° C. The temperature of the gas inside the bomb was controlled by controlling the calorie supplied to the bomb by controlling the electric power energy supplied to the band heater by installing the slidacs. The temperature of the hot compressed

(a) Silencer with hole-cavity resonance

(b) Silencer with hole-cavity resonance and screen

© Silencer with hole-cavity resonance and micro sphere stainless chop

Fig. 1 Silencers of 3 types

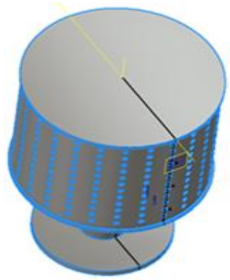
Fig. 2 Sintered silencer noise performance experimental apparatus

air inside the bomb was measured by drilling a hole on the bomb to install a temperature sensor inside the bomb. The pressure of the gas supplied to the silencer produces the compressed air from the compressor. The pressure of the gas supplied to the silencer was achieved by producing compressed air in the compressor, storing the compressed in the compression tank, and supplying the high pressure gas required for the silencer experiment.

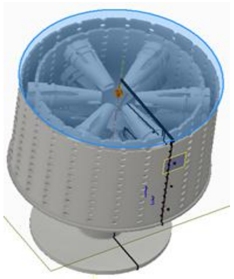
To measure the pressure of the high-temperature and high-pressure gas, a hole was drilled on the bomb using a drill and a pressure sensor was installed in the inner space of the bomb. The experimental apparatus was configured so that changes in the amount of noises in relation to changes in the pressure could be experimented with gas pressures in a range of 1 ~ 30 bar.

3. Results and Discussion

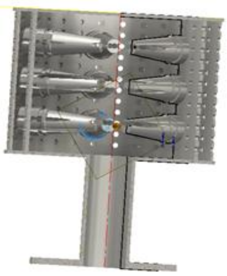
Fig. 2 shows the 3D simulated shape of the noise characteristic study of the sintered silencer. The results of the study obtained indicated that the sintered silencer attenuated noises by reflecting the acoustic energy emitted from the noise source in the direction of the noise source by the impedance mismatch. And the loss type silencer is a technology that attenuates noises by dissipating acoustic energy into thermal energy using sound absorbing materials. In addition, the acoustic resonator technology with excellent noise reduction performance was applied to pursue innovative changes in silencer technology. Therefore, as a result of this study, the noise attenuation performance was greatly improved as reflection, loss, and resonance were made to occur thousands of times simultaneously when fluids pass through the sintered micro pore stainless steel chip sound absorber. Fig. 3 shows the resultant values of the sintered silencer noise amount experiment.



(a) Silencer with hole-cavity resonance



(b) Silencer with hole-cavity resonance



(c) Silencer with hole-cavity resonance

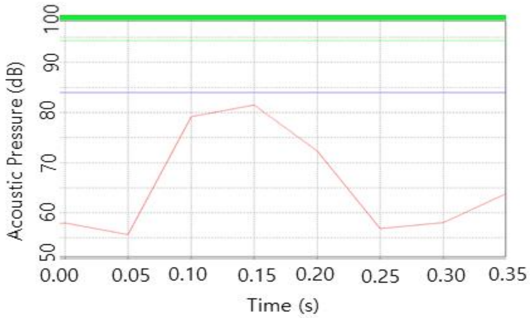
Fig. 3 Three-dimensional simulation of the sintered silencer noise characteristic study

The temperature of the gas supplied to the silencer was changed in a range of 20°C to 400°C in the experiment and three 5 kW capacity band heaters were installed on the outer surface of the bomb to supply heat. The temperature of the gas inside the bomb was controlled by controlling the calorie supplied to the bomb by controlling the electric power energy supplied to the band heater by installing the slidacs. The changes in the amount of noises in relation to changes in the pressure were experimented with gas pressures in a range of 1 ~ 30 bar. The noise of the gas emitted from the bomb without the silencer was 125dB. Fig. As shown in Fig. 4, after the installation of the silencer, noise test results showed 67dB. From the experimental results, it can be seen that the noise amount is greatly reduced in the sintered silencer. As a result of this study, it was found that when the fluid passes through the stainless steel chip sintering absorber, the reflection, disappearance and resonance occur thousands of times simultaneously, resulting in a greatly improved noise attenuation performance Respectively. The temperature of the gas inside the bomb was controlled by controlling the calorie supplied to the bomb by controlling the electric power energy supplied to the band heater by installing the slidacs. The noise of the gas emitted from the bomb without the silencer was shown to be 125dB. As shown in Fig. 3, the noise test conducted after installation of the silencer showed the noise of 67dB. Given the study results, the amount of noise was greatly reduced in the sintered silencer. The results of this study were obtained from a study on sintered stainless steel chip sintered sound absorber with micro pores and it is considered that the noise attenuation performance was greatly improved because as reflection, loss, and resonance were made to occur thousands of times simultaneously when fluids pass through the sintered micro pore stainless steel chip sound absorber.

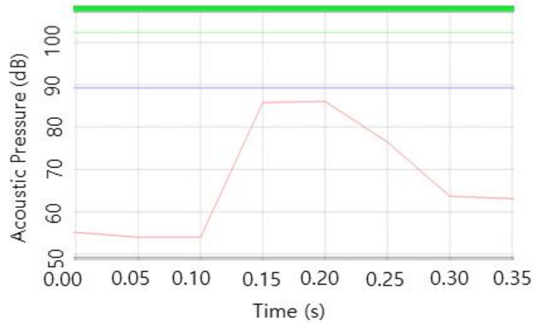
Fig. 4 shows the noise performance of the silencer applied with the hole-cavity resonance technology. The tests were carried out when the temperature of the gas flowing in the silencer was 300 °C. The pressure of the gas was adjusted to three conditions; 10, 20, and 30 bar during the tests. As shown in Fig. 4, the test results indicated that the level of noises increased in proportion to the increase in the gas pressure. This is considered attributable to the fact that as the gas pressure increased, the gas drift velocity increased.

Fig. 5 shows the noise performance of the silencer fused with the hole-cavity resonance technology and the mesh screen technology. The tests were carried out when the temperature of the gas flowing in the silencer was 300 °C. The pressure of the gas was adjusted to three conditions; 10, 20, and 30 bar during the tests. As shown in Fig. 5, the test results indicated that the level of noises increased in proportion to the increase in the gas pressure. The level of noises of the silencer fused with the hole-cavity resonance technology and the mesh screen technology was shown to be 0.91 times of that of the silencer applied with the hole-cavity resonance technology. Therefore, the fusion of the mesh screen technology with the silencer is considered to improve the noise performance.

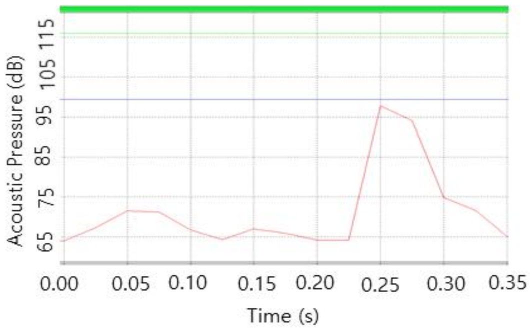
Fig. 6 shows the noise performance of the silencer fused with the hole-cavity resonance technology and the stainless chip sintering technology. The tests were carried out when the temperature of the gas flowing in the silencer was 300 °C. The pressure of the gas was adjusted to three conditions; 10, 20, and 30 bar during the tests. As shown in Fig. 6, the test results indicated that the level of noises increased in proportion to the increase in the gas pressure. The level of noises of the silencer fused with the stainless chip sintering technology was shown to be 0.77 times of that of the silencer applied with the hole-cavity resonance technology. Therefore, the fusion of the stainless chip sintering technology with with the silencer is considered to greatly improve the noise performance.



(a) P = 10 bar

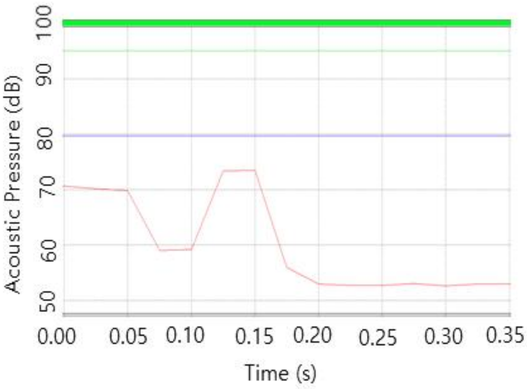


(b) P = 20 bar

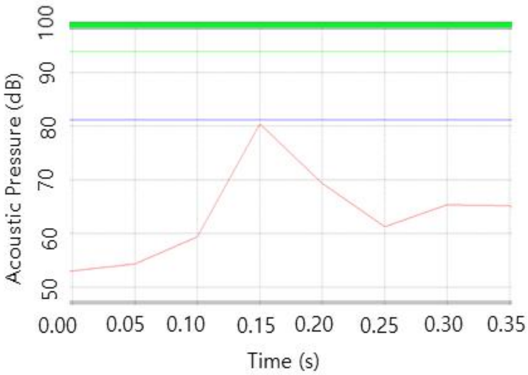


(c) P = 30 bar

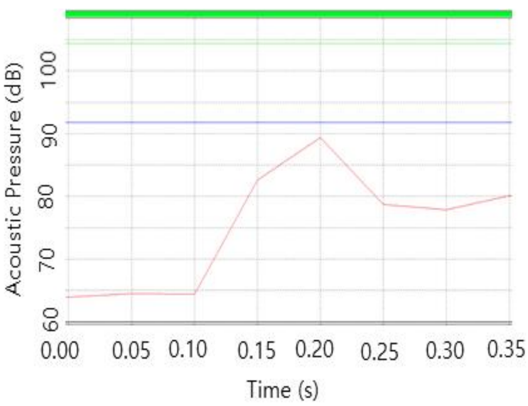
Fig. 4 Sintered silencer noise performance experimental values of silencer with hole-cavity resonance



(a) P = 10 bar

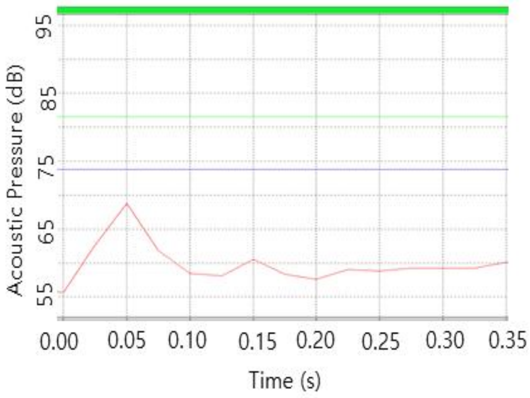


(b) P = 20 bar

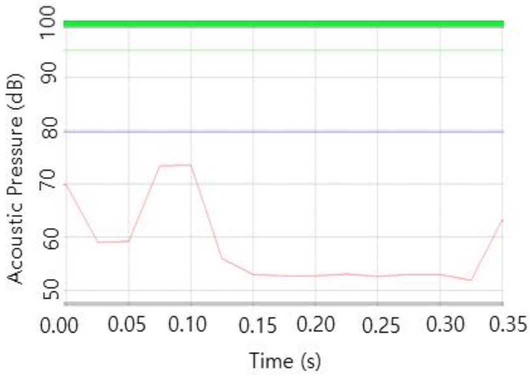


(c) P = 30 bar

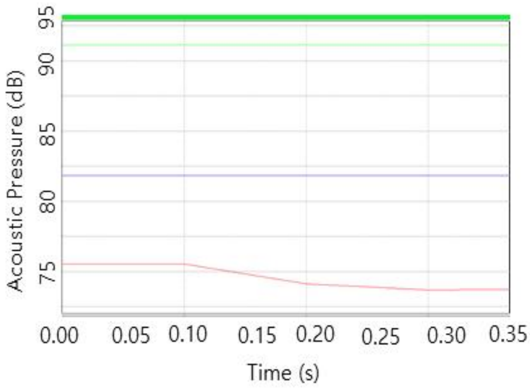
Fig. 5 Sintered silencer noise performance experimental values of silencer with hole-cavity resonance and screen mesh



(a) P = 10 bar



(b) P = 20 bar



(c) P = 30 bar

Fig. 6 Sintered silencer noise performance experimental values of silencer with hole-cavity resonance and micro sphere stainless chip

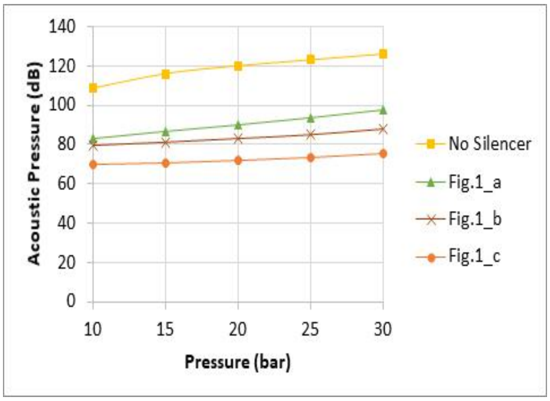


Fig. 7 Sintered silencer noise performance experimental values of silencer for pressure change

Fig. 7 shows the noise level when no silencer has been installed and the noise performances of the silencer applied with the hole-cavity resonance technology, the silencer fused with the hole-cavity resonance technology and the mesh screen technology, and the silencer fused with the hole-cavity resonance technology and the stainless chip sintering technology. The tests were carried out when the temperature of the gas flowing in the silencer was 300 °C.

The pressure of the gas was adjusted to five conditions; 10, 15, 20, 25, and 30 bar. As shown in Fig. 7, the test results indicated that the level of noises increased in proportion to the increase in the gas pressure. This is considered attributable to the fact that as the gas pressure increased, the gas drift velocity increased. When the gas pressure was 30bar, the reduction of noises in the case of the silencer fused with the hole-cavity resonance technology and the stainless chip sintering technology was shown to be 52.8 dB. Therefore, the hole-cavity resonance technology and the stainless chip sintering technology are considered to have greatly reduced the noise level.

4. Conclusion

This study was conducted on a sintered silencer that attenuates noises by reflecting the acoustic energy emitted from the noise source in the direction of the noise source by the impedance mismatch and the following study results were obtained.

1. The noise attenuation performance was greatly improved by making reflection, loss, and resonance occur thousands of times simultaneously when fluids pass through the sintered micro pore stainless steel chip sound absorber.
2. The noise of the gas emitted from the bomb without the silencer was shown to be 125dB. And noise test conducted after installation of the silencer showed the noise of 67dB. Given the study results, the amount of noise was greatly reduced in the sintered silencer.
3. The reduction of noises in the case of the silencer fused with the hole-cavity resonance technology and the stainless chip sintering technology was shown to be 52.8 dB.

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