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# Simulation Study on Noise Reduction Performance of Thickness of Sound Absorber Films in Industrial Gas Turbine Muffler

# Simulation Study on Noise Reduction Performance of Thickness of Sound Absorber Films in Industrial Gas Turbine Muffler

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**Abstract.** The simulated model of industrial gas turbine muffle is established to study the influence of sound absorber films for noise reduction performance. By the analysis of the Finite Element Model, the results show when the thickness of sound absorbing films increases to a certain extent, the flow pressure increases, the flow space decreases, and the flow velocity in the muffler increases, which reduces the distortion parameters and enhances the flow uniformity.

## 1. Introduction

Because of the variation of air density and pressure in industrial gas turbine pipes, it is easy to form larger air noise, which has seriously reduced the efficiency of industrial production and produced obvious noise pollution [1]. In general, it is necessary to install mufflers in industrial gas turbine pipes for noise reduction and environmental protection [2-3]. However, the noise reduction effect of mufflers with different structures used in pipelines is different. Therefore, it is of great significance to carry out the simulation study on the structure parameters and noise reduction performance of industrial gas turbine pipe muffler for understanding the distribution of flow field in the pipe, which is the base of adopting the pertinent structure optimization work.

## 2. Structural Parameters and Finite Element Modeling of Muffle

This paper mainly studies the influence of the thickness of sound absorber films on the flow field in the industrial gas turbine pipe muffler. For this purpose, Fluent is used to simulate the flow field variation under different structural parameters [4-5]. Table 1 is the muffler parameters. The finite element model of flow field is established by ICEM with unstructured grids. The established flow field finite element model of the sheet resistive muffler is shown in Fig. 1.

**Table 1.** The muffler parameters

| Parameters | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| thickness ($mm$) | 300 | 400 | 500 | 600 |
| angle (°) | 180 | 150 | 120 | 90 |
| number | 4 | 5 | 6 | 7 |

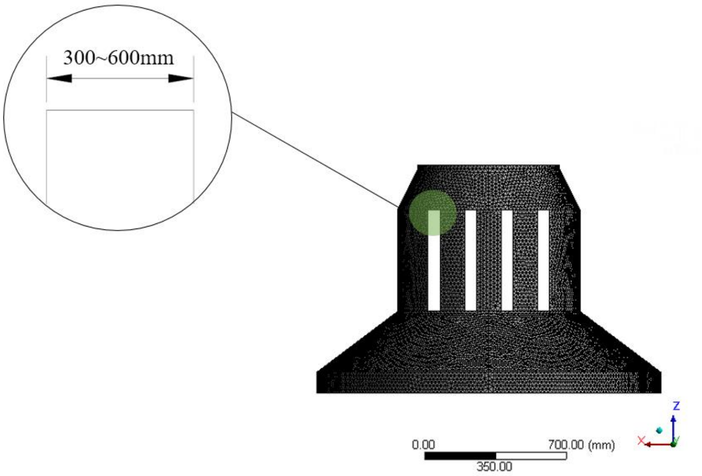
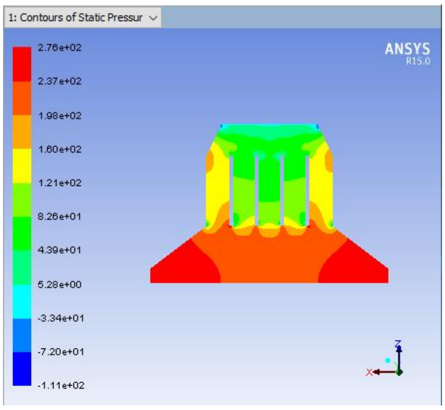


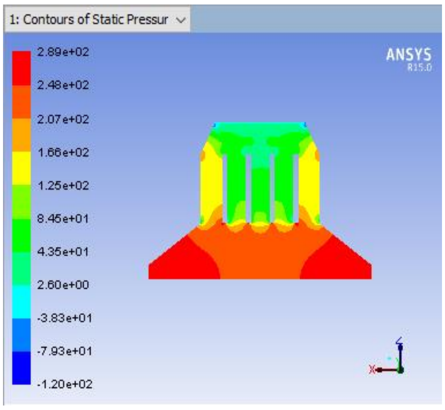

**Figure 1.** Muffle Model

## 3. Simulation Study of Sound Absorbing Films on Flow Field

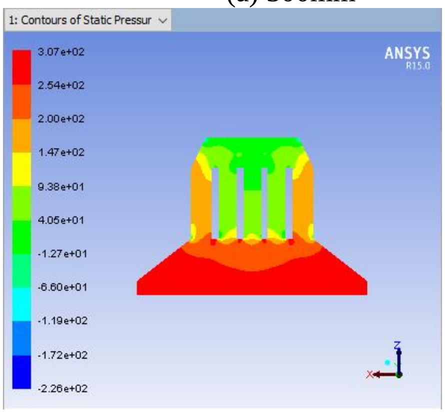
The finite element model of sound absorbing films with different thickness absorber is very complicated. Therefore, the finite element model is divided by unstructured grids to simplify the calculation. The pressure distributions of sound absorbing films with different thickness are shown in Fig. 2, the velocity distributions are shown in Fig. 3, and the turbulence distributions are shown in Fig. 4. The pressure losses are shown in Table 2.



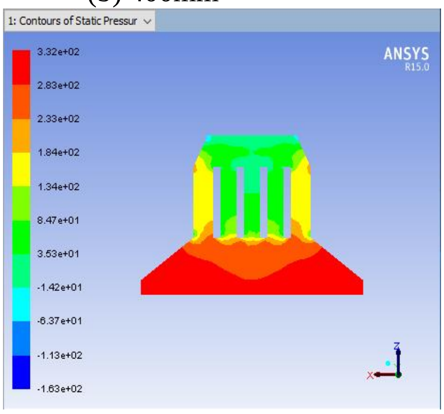

(a) 300mm




(b) 400mm

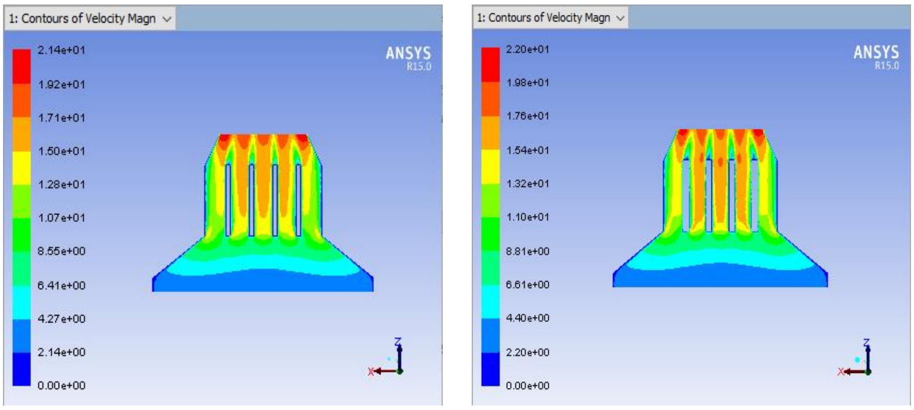



(c) 500mm

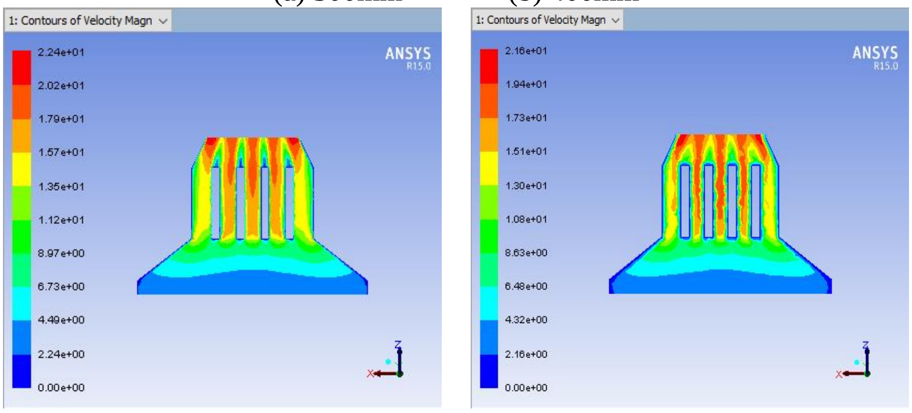



(d) 600mm

**Figure 2.** Pressure Distribution of Sound Absorbing Films with Different Thickness



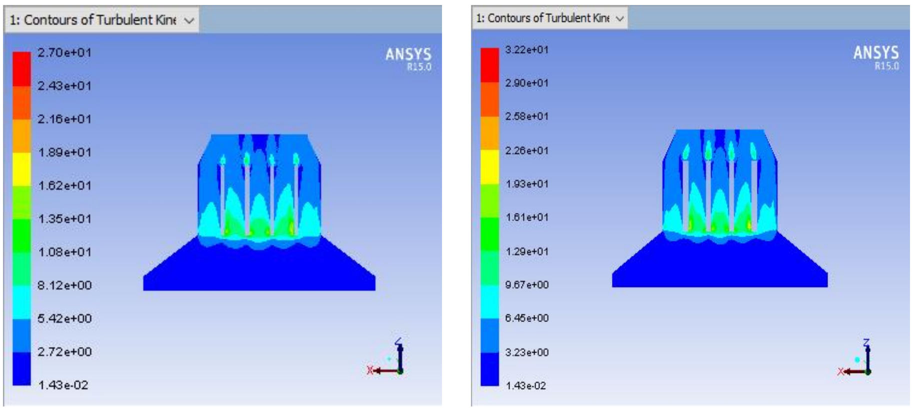

(a) 300mm (b) 400mm



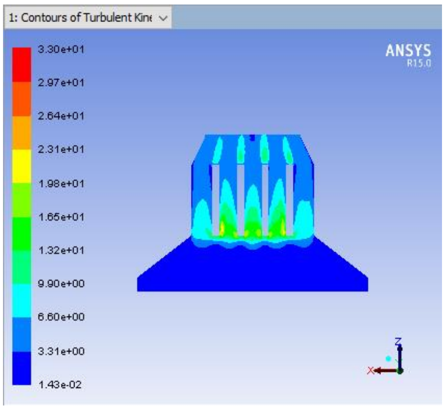

(c) 500mm (d) 600mm

**Figure 3.** Velocity Distribution of Sound Absorbing Films with Different Thickness

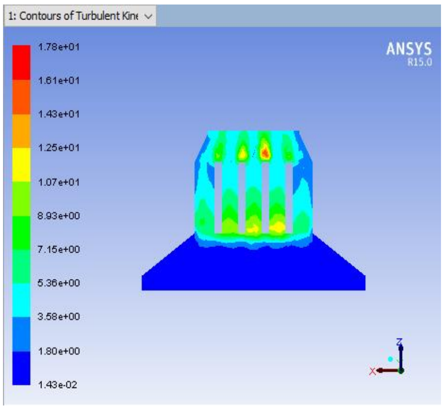
Fig. 3 shows that the velocity of the flow field is increased gradually with the inlet and outlet, and the velocity of the inner space of the muffler is increased obviously. The velocity of the inner space of the muffler is increased with the thickness of the sound absorbing films. Therefore, the increase of the pressure of the flow field and the decrease of the flow space will lead to the increase of the velocity in the flow space.




(a) 300mm (b) 400mm



(c) 500mm



(d) 600mm

**Figure 4.** Turbulence Distribution of Sound Absorbing Films with Different Thickness

Fig. 4 shows that the turbulence intensity at the inlet and outlet of the muffler is higher than that in other regions on the whole. The turbulence intensity and the area of the turbulence region at the inlet and outlet of the muffler increase with the thickness of the sound absorbing films, while the turbulent intensity at the inlet and the area near the inlet of the muffler tube with 600 mm thick sound absorbing films is decreased. Therefore, the overall turbulence intensity and the area with higher turbulence intensity increase with the increase of the thickness of sound absorbing films, but the overall turbulence intensity will decrease when the thickness of sound absorbing films increases to a certain extent.

**Table 2.** Pressure Loss of Sound Absorbing Films with Different Thickness

| Thickness($mm$) | Loss($Pa$) | Distortion |
|---|---|---|
| 300 | 253 | 2.61 |
| 400 | 266 | 2.64 |
| 500 | 284 | 2.64 |
| 600 | 310 | 2.51 |

Table 2 shows that the pressure loss of sound absorbing tube with 300 mm thickness of the absorbing films is up to work. The variation rule is that the pressure loss increases significantly with the increase of the thickness of the absorbing films. The distortion parameters of flow field in tubes with different thickness films do not fit the work standard. The variation rule is that the distortion parameters of flow field increase with the increase of the thickness of the absorbing films at first, but decrease with the increase of the thickness of the absorbing films when they are up to 600mm. Combining with the analysis results of velocity and turbulence distribution, it can be concluded when the thickness of sound absorbing films increases to a certain extent, the flow pressure increases, the flow space decreases, and the flow velocity in the muffler increases, which reduces the distortion parameters and enhances the flow uniformity.

## 4. Conclusion

Through the simulation analysis of the structure parameters of industrial gas turbine muffler, the influence of the thickness, quantity and diversion angle of sound absorbing films on the flow field of the pipeline is studied. It is found that the quantity and thickness of sound absorbing films have great influence on the noise reduction performance of the pipeline, and the noise reduction effect increases with the number and thickness of sound absorbing films. Moreover, the flow field of the pipe decreases with the increase of the number and thickness of the sound absorbing films. On the other hand, the pressure loss and flow uniformity decrease with the increase of the number and thickness of sound absorbing materials. This provides a reference for further optimization of industrial gas turbine muffler structure.

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