Analysis of Flow Field of Recovery Boiler Flue

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Abstract

The flue is used to connect to the recovery boiler and is the place where the exhaust gas passes first. Due to the uneven flushing of the exhaust gas to the recovery boiler, it is easy to damage the recovery boiler. This damage is a determinant of boiler efficiency and directly affects the economics of the boiler. Through the flue structure speed and velocity vector analysis.

Keywords

Recovery boiler, flue, installation, speed analysis.

1. Flue structure simplification and three-dimensional modeling

The flue is used to connect the recovery boiler and is the place where the exhaust gas passes first. Due to the uneven flushing of the exhaust gas to the recovery boiler, it is easy to damage the recovery boiler. This damage is a determinant of boiler efficiency and directly affects the economics of the boiler. The three-dimensional modeling of the flue duct by UG three-dimensional drawing software is shown in Figure 1.

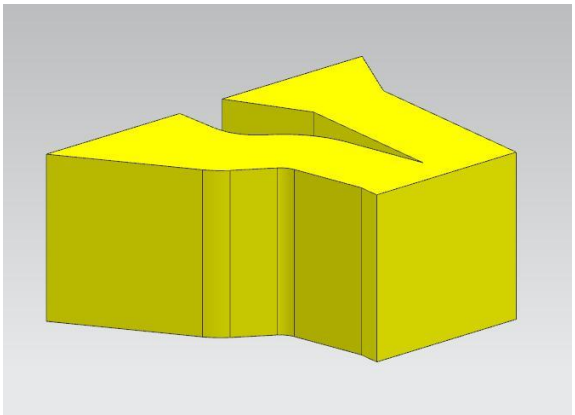
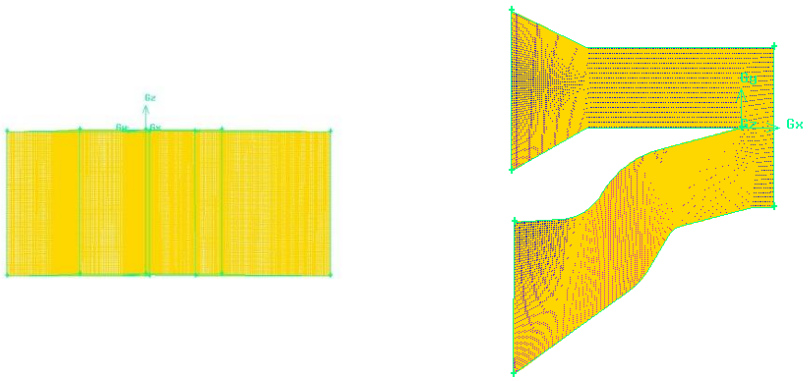


Fig.1 Flue three-dimensional fluid model

2. The grid meshing

GAMBIT pre-processing software was used to mesh the three-dimensional model of the flue gas. In order to ensure the calculation accuracy and keep the calculation volume moderate, the principle of using hexahedral mesh preferentially in the meshing process and the tetrahedral mesh in the irregularly shaped area is adopted. This is because the hexahedral mesh has higher quality and faster convergence than the tetrahedral mesh and can reduce the computational cost. The advantage of the tetrahedral mesh over the hexahedral mesh is its adaptability and ability to fill complex geometric shapes. Due to the relatively simple structure of the flue, the hexahedral grid is used in this flue. Figure 2 shows the cross-section of the flue grid map. The total number of grids generated is 1026480.



(a) Axial section (b) Sectional view

Fig. 2 Grid section sectional view

3. The numerical simulation analysis

The entrance is a 7800mm long square with two pressure outlets. First set the entrance speed to 5m/s. The outlet is set as a pressure outlet and the pressure is a standard atmosphere.

The numerical simulation of the flow velocity cloud of the flue gas flow is shown in Fig. 3. The flow velocity high-speed zone is mainly located in the middle of the flue, and there will be uneven flow velocity near the flue outlet. From the speed cloud diagram we can clearly see that due to the presence of the elbow, the uneven flow velocity of the curved flue gas is more obvious, and the straight flue gas duct also has the phenomenon of uneven flow velocity at the enlarged nozzle, but it is relatively weak.

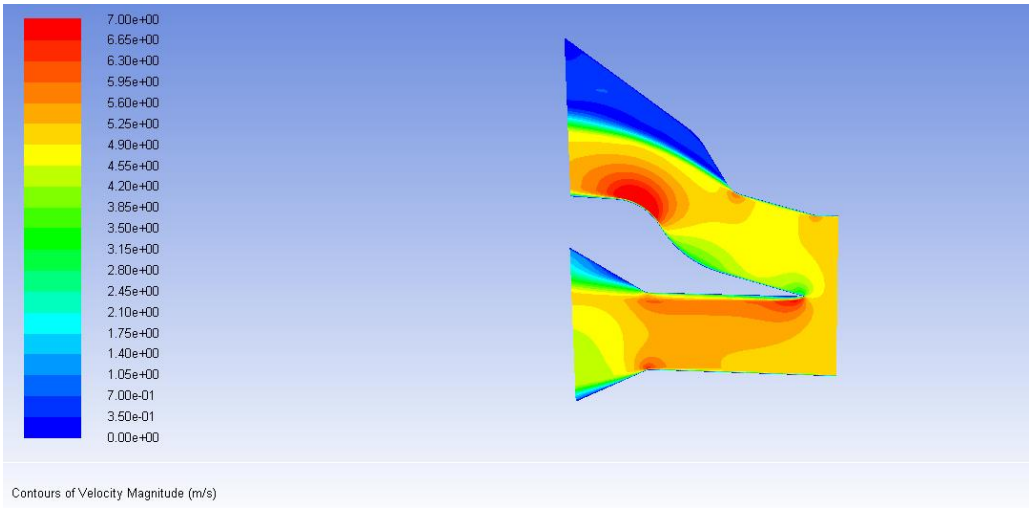


Fig. 3 Speed cloud

Figure 4 shows the speed vector inside the flue. The speed vector can be used to visualize the movement of the flow field. Due to the presence of the elbow and the enlarged diameter of the pipe in the flue, the direction of the speed at the elbow and the diameter of the pipe has changed, and the change of the elbow relative to the pipe diameter of the straight flue pipe has changed significantly.

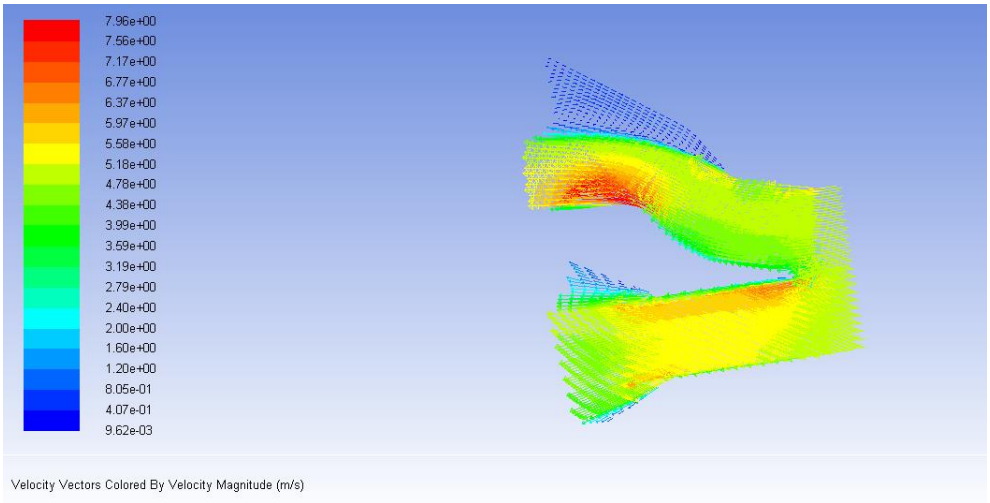


Fig. 4 The speed vector

4. The conclusion

By analyzing the velocity of the flow field of the flue gas structure connecting the boilers, it can be concluded that due to the presence of the elbow and the enlarged pipe diameter in the flue, the direction of the velocity at the elbow and the diameter of the pipe is changed. Relative to the expansion of the diameter of the straight pipe flue, the change is obvious.

References

[1] CHEN Wen, YU Xiangjun. Simulation of wind speed flow field in wind tunnel with FLUENT[J]. Jiangsu Electrical Engineering, 2008, 27(6): 72-75.

[2] Marra M C, Cunha R R, Muñoz R A A, et al. Single‐run capillary electrophoresis method for the fast simultaneous determination of amoxicillin, clavulanate, and potassium[J]. Journal of Separation Science, 2017, 40(17).

[3] P. Fontes, M. Costa, J. L. T. Azevedo. Measurements in and Modeling of a Black Liquor Recovery Boiler[J]. Combustion Science & Technology, 2008, 180(3):494-508.

[4] Wang Fujun. Principles and Applications of Computational Fluid Dynamics Analysis CFD Software [M]. Beijing: Tsinghua University Press, 2004:7-11

[5] Bao G. The design and on-site construction of shenzhen 384 m high level emperor skyscraper in China[J]. Journal of Constructional Steel Research, 1998, 46(1-3):1.