CFD Numerical Simulation of ESP Airflow Distribution and Application of Flue Gas Distribution

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Abstract: This paper GUODIAN Bengbu power plant 2×600 MW unit supporting the ESP system for flue study, details of the electrostatic precipitator tail flue contoured layout of the electrostatic precipitator, electric air impacts, as well as how to take the physical model and Mathematical Model of combining CFD numerical simulation study.

Keywords: GUODIAN Bengbu power plant, Electrostatic Precipitator, Flue gas distribution, Electric air distribution

1 INTRODUCTION

Site constraints: GUODIAN Bengbu power plant 2×600 MW supercritical boiler supporting ESP by site constraints, as well as layout of the need ESP to the right track after Fan layout, no direct export of the rear speakers, and vertical also very short. Fan exports exports speakers of the two locations is not symmetrical layout, and two rooms the average gas distribution difficult.

There are many factors affecting performance Electrostatic precipitator including: the nature of soot and dust temperature, and dust components, dust resistivity electrodes form of airflow distribution. Electrostatic precipitator affecting the efficiency of a number of factors, whether the uniform flow distribution of their great impact on the direct impact on the operation of electrostatic precipitator dust resistance and efficiency. Should, as far as possible apart from the addition of the elements of wind, the wind speed uniform.

Therefore, the establishment of a physical model 1:10 physical simulation, and then combine numerical model calculations and to promote a similar situation to do the simulation technology as a way to predict.

2 MODEL DESIGN STRUCTURES

1:10 model on the design, manufacture and installation, and design for the room width, field length, height adjustable electric field structure, GM built the airflow into and out of the flue simulator and simulation test for the future of convenience (see Fig. 1).

Fig. 1 1:10 Model

3 THE PILOT PROGRAMME SET

Option 1: Double room imports speaker layout of the three-tier board, opening rate of 35% of all exports do not stack layout diversion leaves.

Option 2: Double Room imports speaker layout of the three-tier board, opening rate of 35% of all exports of flue layout diversion leaves.

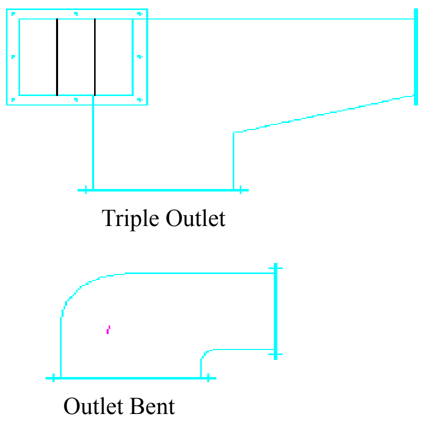
Option 3: Dual-chamber imports speaker layout of the three-tier board, opening rate of 40% of all exports of flue layout diversion leaves.

3 TEST CONDITIONS

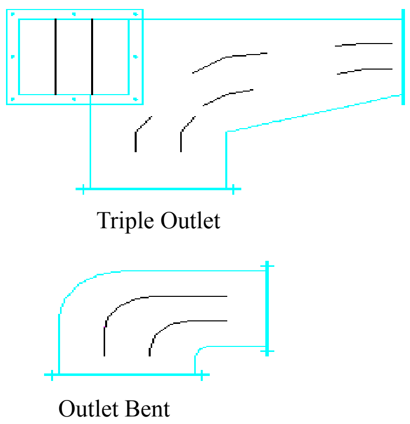
The status of parameters: single Taipower precipitator of imported gas for 450 m^3/s, flue gas temperature to 126□ entrance.

Model parameters: a single tone to the flow of the model 43970 m^3/h, air inlet temperature is 10□. Model ratio: 1:10.

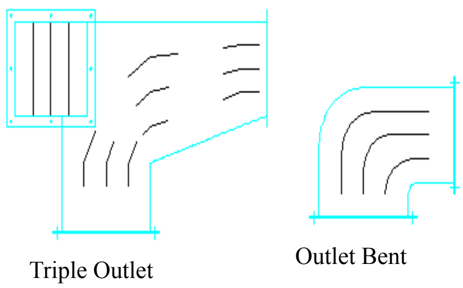
Equipment and detection instruments: simulation test bed simulated flue test fan (9-26-16 D traffic: 58,211 m^3/h, total pressure: 6659Pa), hot-wire anemometer, S-Pitot tube, the U-Gauge (see Fig. 2).



(a) Option 1



(b) Option 2



(c) Option 3

Fig. 2 Three options of airflow

4 TEST METHOD

By uniform airflow measuring points, the first with hot-wire anemometer measurement parameters of the two air horn imports; reuse S-U-Pitot tube manometer measurement and dual-chamber export Speaker exports, the former fan flue pressure parameters under test Data calculated airflow distribution rms value of the relative flow deviation values.

5 TEST PREPARATIONS

1) Completion of the building of experimental model, and to ensure that all relevant dimensions accurate;

2) Test load distribution plate imports of the designated speaker position;

3) Determine measuring point: uniform airflow measuring points in the first field in front of the exit flue resistance balance measuring points in the dual-chamber;

4) Export flue-level speakers, as well as the level of the flue summary;

5) Laboratory equipment be inspected to ensure that the overall experimental model of strength and stability;

6) Check experiment equipment grounding is good;

7) The overall test model of air leakage rate (less than 3%);

8) inspection of the installation plate model is correct, and stability;

9) Check whether it is normal fan switch, and reliable;

10) Check whether it is normal for air volume control, and reliable;

11) Inspection measuring apparatus eligibility, complete;

12) Check whether the experimental lighting equipment;

13) Supplies security checks are complete

6 TEST DATA CONTENT

Measuring points corresponding to detailed data records by the analysis.

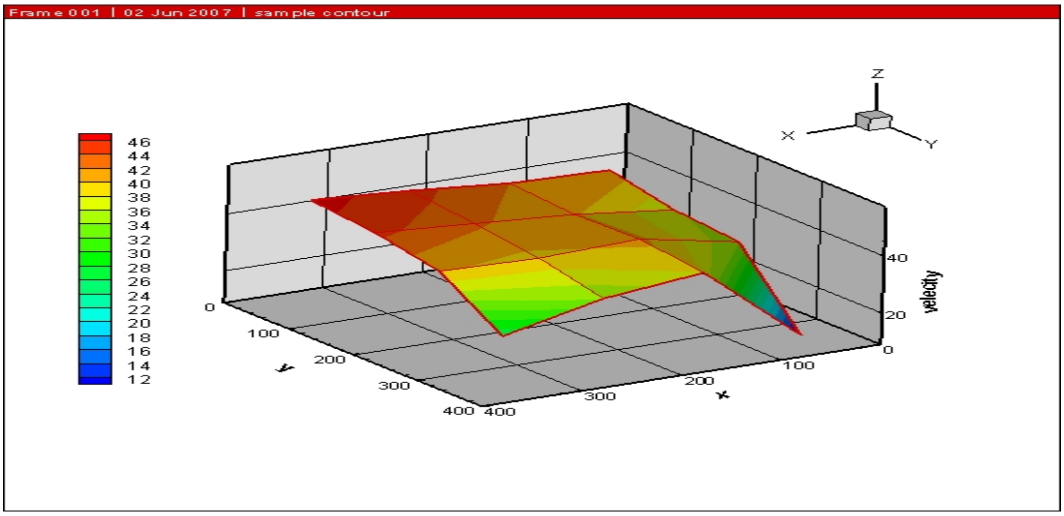
1) Measuring point wind. This calculation of the relative standard deviation, to judge whether the uniform airflow.

2) Measuring points total pressure: the import and export of the flue measure dynamic pressure, to judge whether the average two rooms airflow distribution.

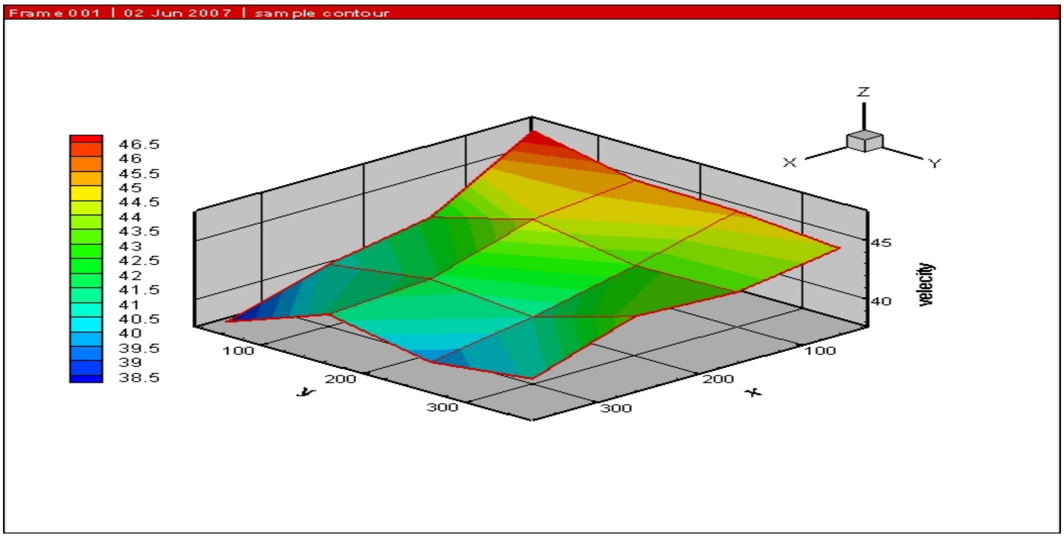
3) The import and export flue resistance losses: to determine what the best plate layout scheme. Least resistance means that the induced draft fan energy consumption at least.

7 THREE EXPERIMENTAL OPTION OF AIRFLOW VELOCITY DISTRIBUTION

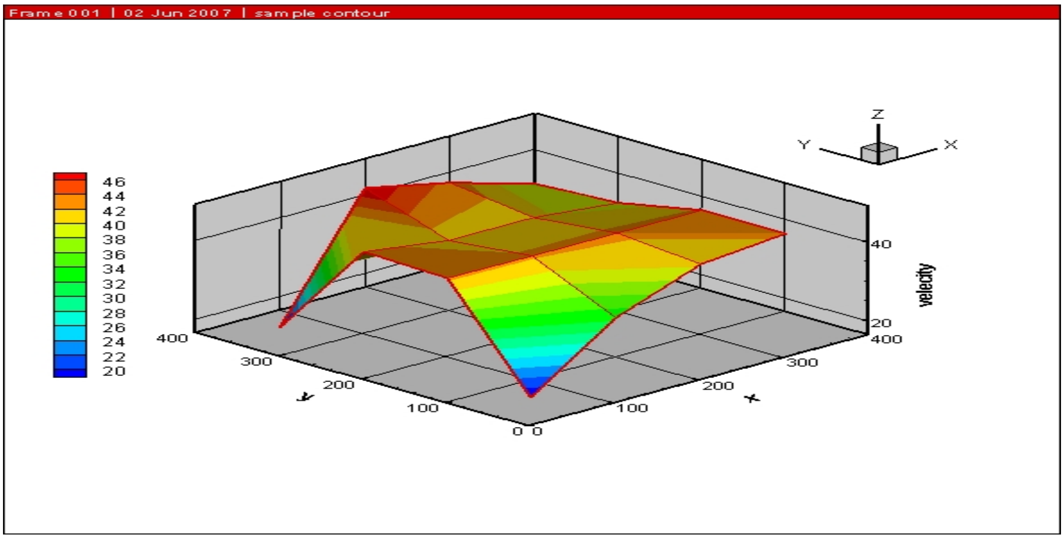
Airflow velocity distribution of three airflow options (see Fig. 3).



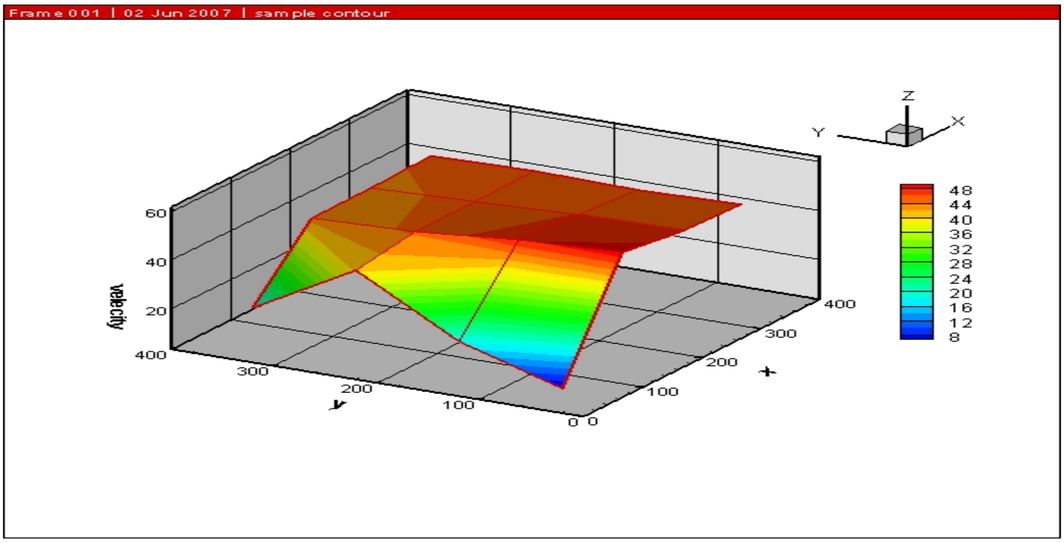
Option 1 Airflow velocity distribution measured of South Room



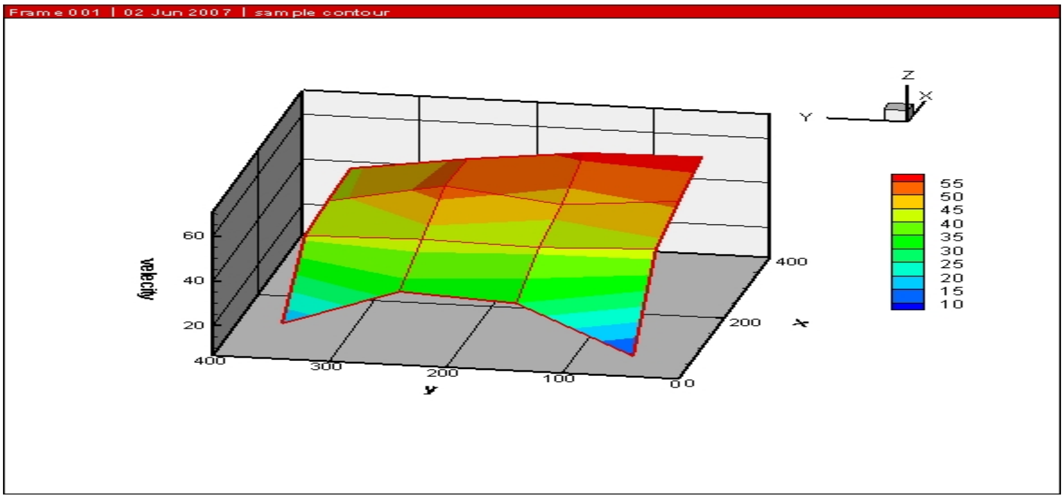
Option 1 Airflow velocity distribution measured of North Room



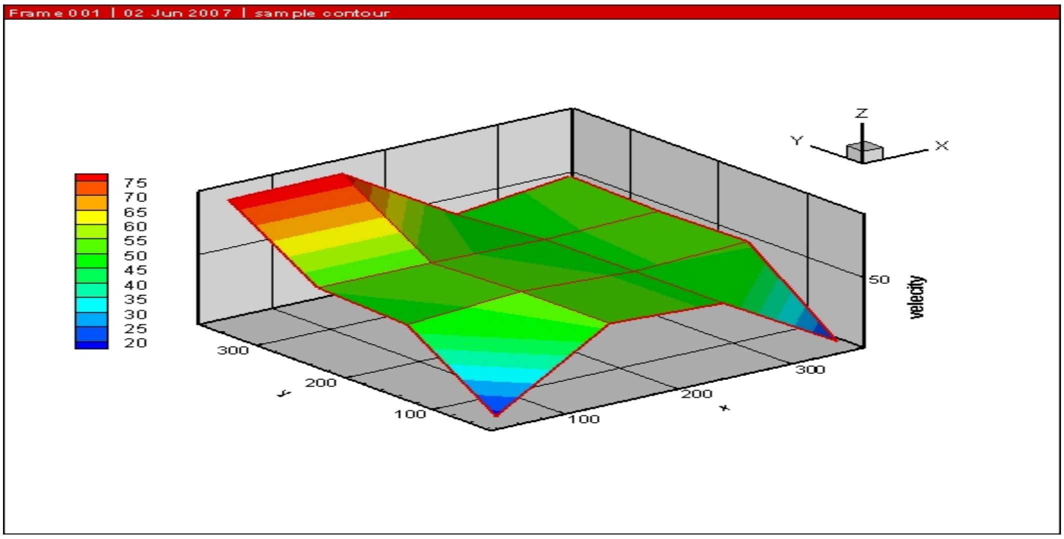
Option 2 Airflow velocity distribution measured of South Room



Option 2 Airflow velocity distribution measured of North Room



Option 3 Airflow velocity distribution measured of South Room



Option 3 Airflow velocity distribution measured of North Room

Fig. 3 Airflow velocity distribution of three airflow options

8 D NUMERICAL SIMULATION OF FLUE

Technical: Select software to identify ideas and the establishment of model geometry, mesh generation, the definition of boundary conditions, the choice of model selection of the control parameters, solving equations and discrete data post-processing.

9 SOFTWARE

Before processing software - Gambit
Use the software process - Fluent
Post-processing software - Tecplot

10 ESTABLISHED GEOMETRIC MODEL(see Fig. 4)

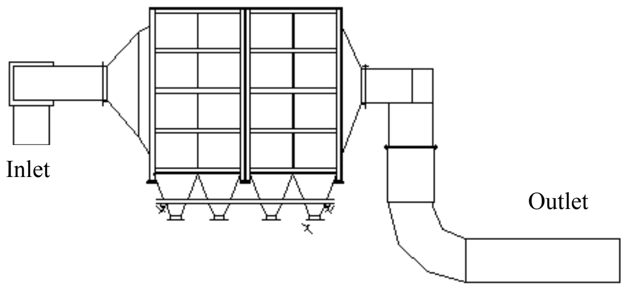


Fig. 4 Geometric Model

11 GRID DIVISION

District adopted the idea of a grid mesh; flue after non-institutional model of a fully tetrahedral mesh generation. Grid scale of 40 mm, its precision and speed can meet the requirements.

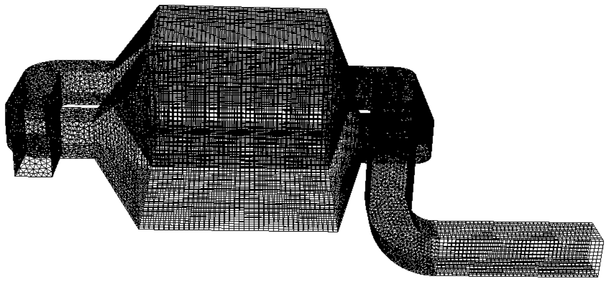


Fig. 5 Grid division

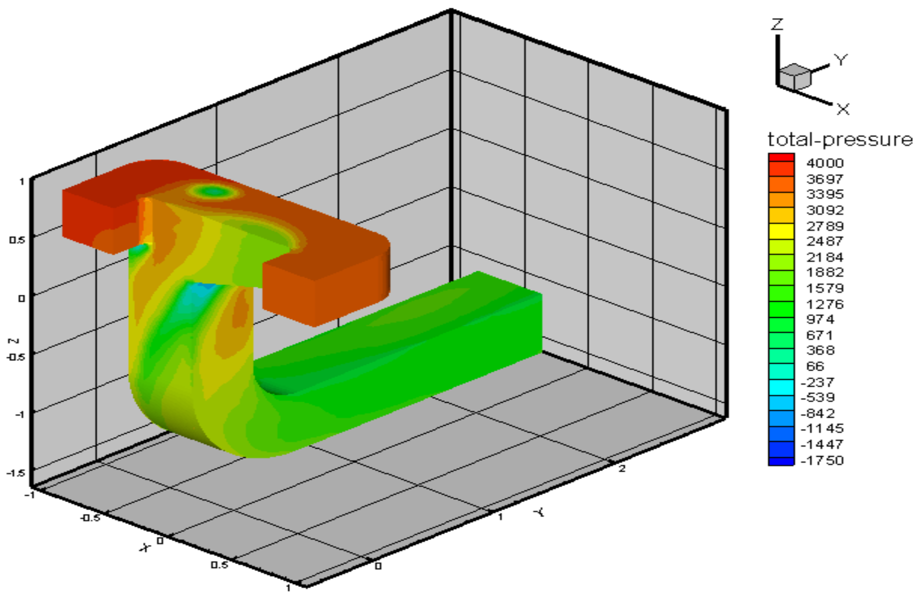
12 DETERMINE THE BOUNDARY CONDITIONS

1) Import boundary conditions
2) A free flow boundary conditions
3) Wall boundary conditions

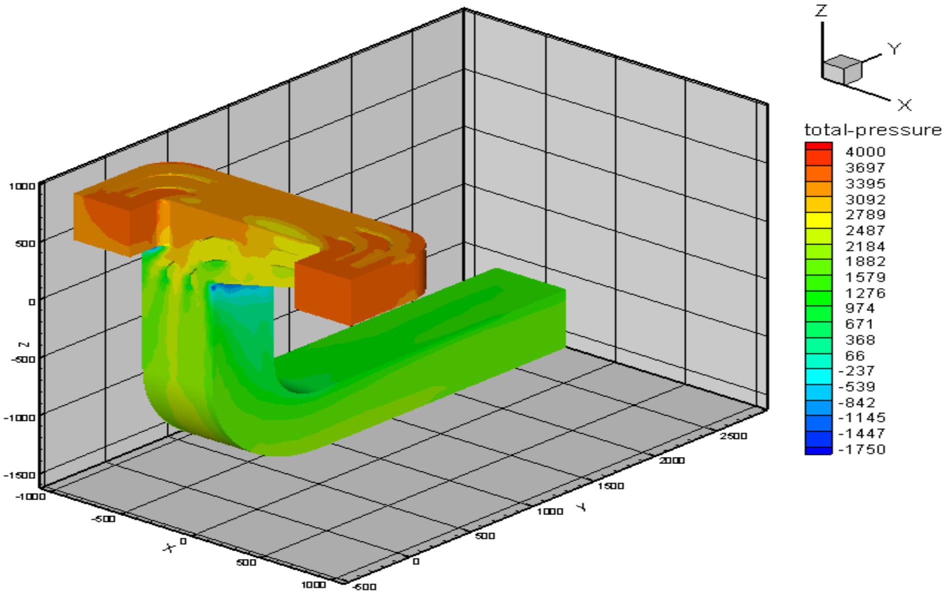
13 CONVERGENCE CONDITIONS

Numerical Calculation of the turbulence model for the use of standard k-ε two-equation model, SIMPLE algorithm, convection of the second order differential format upwind.

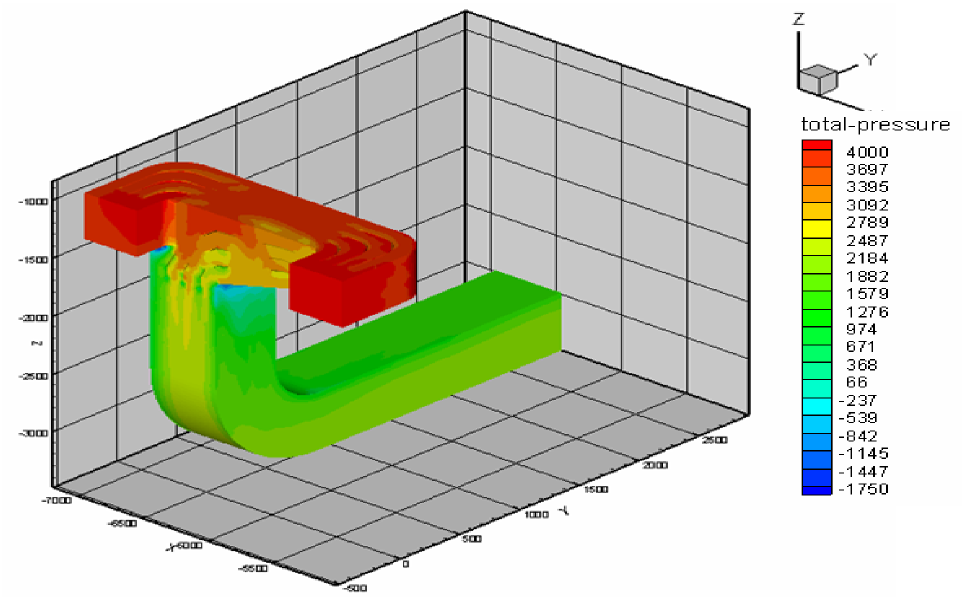
14 NUMERICAL ANALYSIS(see Fig. 6)



Option 1 Exports of flue-wide pressure distribution



Option 2 Exports of flue-wide pressure distribution



Option 3 Exports of flue-wide pressure distribution

Fig. 6 Numerical simulation results of three airflow options

15 NUMERICAL MODEL AND PHYSICAL MODEL TEST DATA ERROR ANALYSIS

1) Simplified numerical model.

2) In test, the actual instantaneous fan with a nominal flow and air volume is not equal. South, North Liangshi the velocity differences also exist.

3) Numerical calculation is also a certain degree of error, affecting the accuracy of numerical factors also mesh type and density, turbulence model has yet to be further improved.

4) Air distribution different manufacturing precision test model, testing equipment error and error of the experimental data can also cause deviations.

16 OPTIMIZATION DESIGN

Verify the validity of numerical model, the computer simulation and optimization on the work of a very convenient, in the nine kinds contrast simulation programme, identified the following optimization than most.

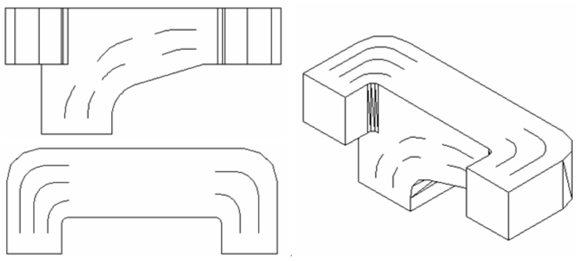


Fig. 7 Flue structures and plate layout after optimized

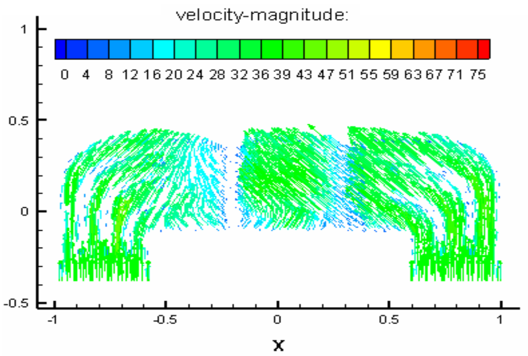


Fig. 8 Section 2 of flue gas velocity vector distribution after optimized

17 THE TEST OF PRACTICE

The equipment is being installed, to be installed, with air distribution test conditions, the actual on-site testing, and further verification and adjustment mode structure, the improvement of the accuracy of model output data.

18 CONCLUSIONS

Internal electric field to the uniformity of the airflow ESP performance of research, and industry has been relatively extensive and in-depth. But Jin, a strange layout of the flue gas distribution or study on the impact of a blank, basic data, a number of die and mould the model, the calculation of customized software development is still not perfect, are currently only borrowed some common software to simplify the reference simulation and experiment.

The development of society, advances in technology, especially computer technology, information technology leap in development, ESP various aspects of technological progress with a lot of opportunities. Computer simulation of the physical simulation research line, it is proved in practice scientific and effective, computer simulation and the simulation brought by the resources of the community savings, improvements in the efficiency of production to the great liberation of the productive forces.

Anhui EE Environmental Equipment Co., Ltd. and Hefei Industrial University of Environmental Resources to jointly set up a technology center, and take industry, academia, research jointly promote technological progress in the line of full cooperation on the project, produced fruitful results. The subject from Hefei University of Technology, Doctor Wang right planning, guidance and acceptance, thanks him for his diligent work.

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