Resistance and Airflow Distribution of Rotary Plate

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Abstract: In this paper, differential pressures and airflow distributions of rotary plates have been respectively computed. The influences of these changes have been analyzed. At the end, we got the law of the influence of rotary plate on resistance and airflow distribution.

Keywords: Rotary Plate, Resistance, Airflow Distribution

1 INTRODUCTION

With the development of the environmental protection and economy, emission standard for flue gas from boiler is demanded less than 80 mg/Nm^3, while particle Emission Standard for Air Pollutants from Iron and Steel Industry (draft) requires less than 50 mg/Nm^3 [1], and less than 30 mg/Nm^3 in some countries. Because of limits of technologies at the time of designing and construction and design requirements, many of existing ESPs have been unable to meet new emission standards and need to be renovated. But with limits of conditions (like space, engineering period, etc.), principles of ESP technological renovation usually are: without increasing specifications (cross-sectional area) length (electrostatic field number) and without changing original size, internal technological innovations were implemented in order to reduce particle emission concentration.

Mobile collection plate technologies such as Hitachi Mobile electrode type ESP[3] and Rotary plate electrostatic field of Xi'an Yuqing environmental engineering and technology company, can effectively trap high specific resistance, ultra-fine particles, and prevent occurrence of anti-corona and re-entrainment; In addition, electric force of charged particles in rotary plate electrostatic field has the same direction with airflow, so that charged particles were more easily trapped. If using rotary plate electrostatic field to renovate ESP, no configuration changes will be induced except installing rotary plates in inlet or outlet of ESP.

2 MODELING

In this paper, an ESP (Table 1) was taken as an example, resistances and airflow distributions of ESP before and after renovation were calculated by FLUENT software in order to analyze influences of rotary plates.

In Fig. 1, there are three-tier airflow distribution plates (opening ratios are52%, 52% and 46%) in inlet and trough plates(equivalent opening rate is 36%) in outlet. Rotary plates are perforated plates. Because it rotates slowly and is presumed to have no effect on airflow distribution, rotary plates are equivalent to two tier airflow distribution plates.

Table 1 ESP specifications

Items	Parameters
configuration	Single chamber / three electrostatic fields
Inlet gas volume(m^3/h)	540000
Distance between collecting electrodes(mm)	450
Electric field length(mm)	12000
Special crossing area(m^2)	145
Gas temperature(℃)	150
Gas velocity(m/s)	1.1
Gas passage number	22

Pressure difference between inlet section and outlet section is considered as ESP resistance, while four sections (Fig. 3) before and after electric fields considered as analysis sections of airflow distribution.

3 ANALYSIS RESULTS

3.1 Resistance Of ESP

In this paper, resistances in three conditions such as original ESP (condition I, the same below), replaced trough plates with rotary plates in outlet(condition II, the same below) and replaced trough plates and last airflow distribution plate with rotary plates (condition III, the same below) were calculated and analyzed. ESP conditions: Gas Temperature 150 □; gas density 0.835 kg/m^3; gas viscosity 2.385×10^{-5} Pa·s; outlet pressure -3000 Pa.

Fig. 2 indicates that the smaller opening rates is and the greater flue gas velocity is, the greater resistances will be. When flue gas velocity did not change, resistance of ESP changes inconspicuously, and it's suggested that ESP resistance were not influenced by rotary plates.

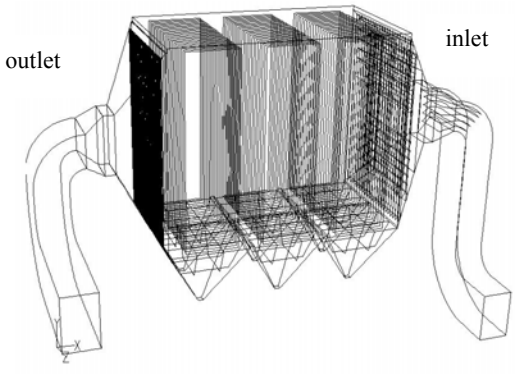


Fig. 1 Modeling

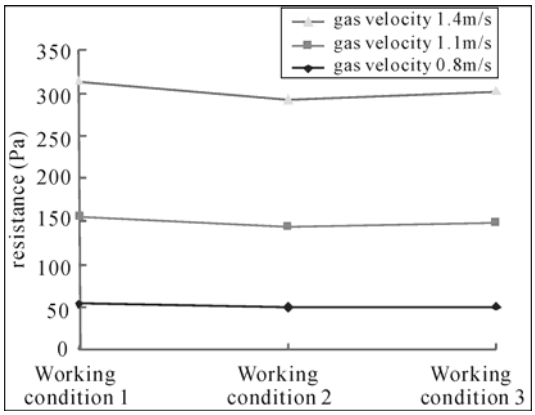
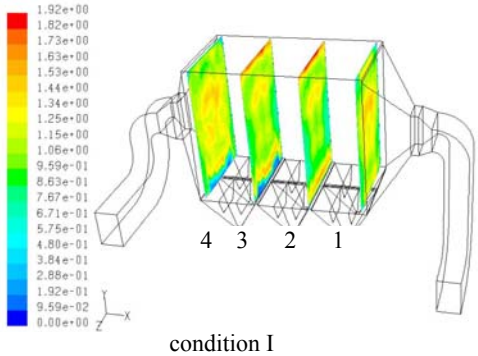


Fig. 2 Resistances

3.2 Airflow Distribution

Many Researches believe that changing internal structures of ESP will influence airflow distribution [2]. In this paper, airflow velocity nephogram calculated by FLUENT is shown in Fig. 3.



condition I

Fig. 3 Flow Velocity Nephogram

Fig. 3 indicates that airflow in original condition is evenly distributed, velocity RMSs of four sections respectively are 0.145, 0.201, 0.245 and 0.21, and meet the airflow distribution requirement. In condition II and condition III, airflow distributions of sections before first and second electric fields are little impacted by rotary plates, while airflow distributions of sections before and after third electric field are more greatly impacted by rotary plate, velocity RMSs of all of them are more than 0.25, max up to 0.326. When installing rotary plates in outlet, airflow distributions are significantly deteriorated, and show as higher flow velocity in centre and smaller in surrounding. The largest flow velocity is increasing from 1.44 m/s before renovation to 1.92 m/s after renovation. These results indicate that replacing trough plates with rotary plates will affect airflow distribution in outlet.

4 CONCLUSIONS

Installing rotary plates in ESP will not influence resistances of ESP and increase load of fan, and original equipments of ESP can be normally running; airflow distributions are influenced by rotary plates, different installation schemes of rotary plates will get different airflow distribution. In industrial application airflow distributors (like opening rate of rotary plates and airflow distribution plates) should be designed depending on required airflow distribution in order to reduce the influence of uneven distribution on collection efficiency.

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