EFFECTS OF ELECTROSPRAY NOZZLE ON THE COLLECTION EFFICIENCY OF ELECTROSTATIC PRECIPITATOR

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ABSTRACT

In this study, the effects on collection efficiency by electrospray nozzle in electrostatic precipitator were investigated. Electrospray is a process that relies on electrostatic forces to break the liquid into fine charged droplets. One of the simplest ways to implement such a process is generally observed by applying a potential difference of several thousand voltages betweena plate and the end of nozzle that supplied with liquid. Since the droplet are highly charged, coulombic repulsion force causes them to self-disperse, which prevents their coalescence and eases their penetration into the gas medium.

To improve collection efficiency of electrostatic precipitator, electrospray nozzle installed at duct in front of the electrostatic precipitator. We performed experiment by changing electric field strength of electro-spray.

In an experiment, collection efficiency was improved, when electric field strength of electro-spray was higher.

1. INTRODUCTION

While a number of strategies have been introduced to air quality management, the national ambient air quality standard (NAAQS) and the standards for emission source have been gradually intensified. It in turn leads industry to use clean energies or to install air pollution control devices with high efficiencies, in order to follow the standards.

Among the control devices, the particulate matters from industrial boilers or production processes contains hazardous air pollutants including heavy-metal components which create human health risk. The fine particles also have light scattering and absorption characteristics which is one of reasons for visibility impairment[5]. Consequently, a high efficiency is required and precipitator are studied to enhance the efficiencies[6].

In general, an electrostatic precipitator shows 99% of total mass efficiency but a low efficiency for fine particle compared to coarse particle[7]. To improve the low efficiencies for fine particle, a number of efforts such as the increase in the size of precipitator, the use of pulse corona or flue gas conditioning, are applied. Recently the agglomeration using electric field, acoustic field, and electrospray has been investigated[3].

The electrospray is the process to charge water droplets as fine liquid droplets using electrostatic force. Generated droplets are highly charged and plenty for the process. The droplets formed by coulomb force are also self-diffused and are capable of maintaining a large amount of ion due to the little agglomeration between droplets[1]. In this study, an electrospray system is designed to generate ions to ESP and studied to improve the efficiency measures.

2. Test setup and testing

To examine the designed electrospray system, a wind tunnel was built based on the previous studies by Davidson, as shown in Fig. 1[2]. The air flow rate was controllable and the front wall was made of a transferent material for eye observation. A HEPA (High Efficiency Particulate Air Filter) was also installed for clean test environment.
The fly ash from B-C oil boiler was used to generate five particle for testing and the aerosol generator was a upward

cyclone type. The diameter was 85mm and the length was 300mm. 4's of 1mm-nozzles were installed to create the upward flow along the wall and the fly ash was supplied for particle generation.

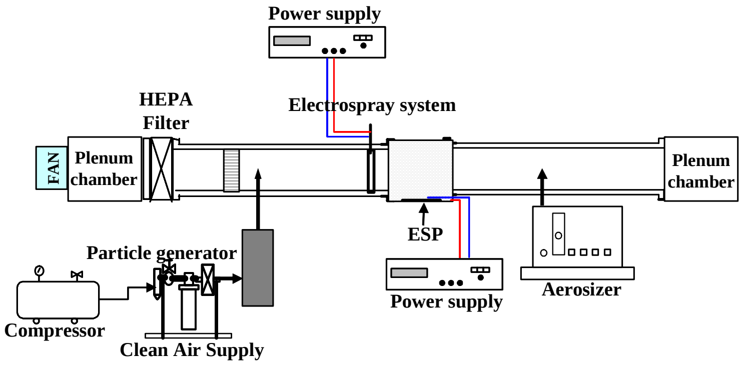

Fig. 1 Schematic diagram for test setup

As displayed in Fig.2, the high voltage was introduced through the water pipe of nozzle. The ESP was composed of 300mm×300mm plate and 1mm-discharge electrode. The gap between the plate and discharge electrode was 50mm. The generated particles were diffused and charged while traveling the electrospray system and collected in the ESP. Aerosizer(Aerodynamic Particle Sizer, API) was used for measurement. The test was proceeded to check the efficiency of patrice removal with the ESP (without the operation of the electrospray system). The electrospray system was then operated to supply ion to the ahead of the ESP. The strength of electrical field tested were 11, 12, 13 kV/cm.

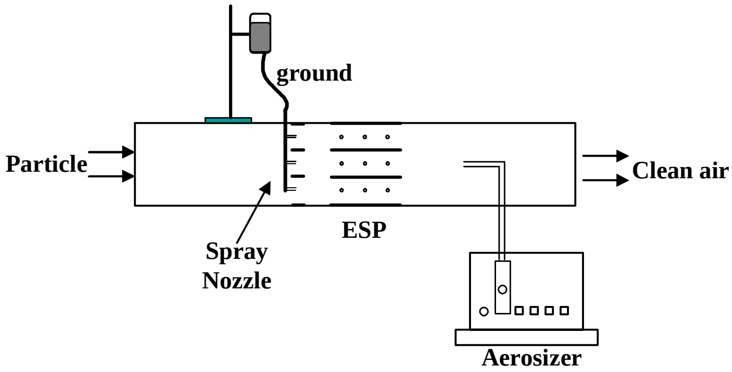

Fig. 2 Schematic diagram for electrospray system and ESP

3. Test results and discussion

The generated particles have the size distribution plotted in Fig.3. The number concentration was $3.3\times10^{9}/m^3$ and the mean size was 1.9 μm as aerodynamic diameter (standard deviation 2.36). It confirms the common characteristics observed in B-C oil combustion as usual.

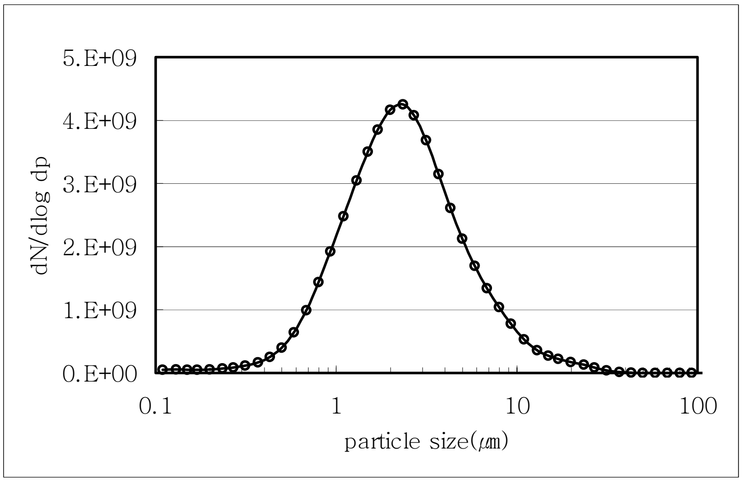

Fig. 3 Size distribution of generating particle

The test conditions of the result in Fig 2 were 4 kV/cm supply power and 0.8 m/s air flow in the ESP. Under this test condition, the corona current was 110 ㎂ when the test particles were supplied and the particle removal efficiency was 79.3%. The efficiency is falling into common range for a single ESP system.

The electrospray system was then operated under the same test condition. The induction power was also varied. The efficiencies were 84.6%, 87.6%, 96.8% for 10, 11, 13 kV/cm respectively. The enhancements by the electrospray system were 5.3%, 8.3%, 17.5% for 10, 11, 13 kV/cm respectively.

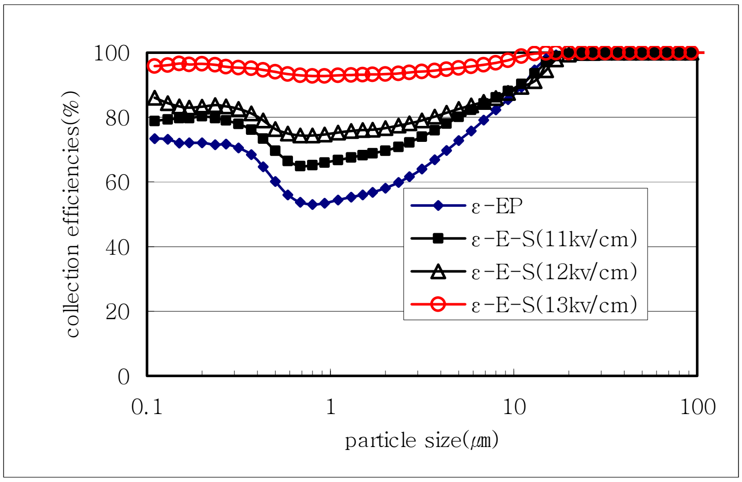

Fig. 4 Collection efficiencies of electrospray system and ESP

Fig. 5 plots the enhanced size distribution. Especially a high collection efficiency was observed in 0.4~3 ㎛ ranged particles. It is because the fine particles were highly charged by electrical field and diffusion. The electrical mobility becomes large, which produces a high collection efficiencies. Collection efficiency for 0.1~1.0 ㎛ in common is low due to the low electrical mobility[4]. In this study the collection efficiency using the electrospray system was higher than the common values by generating plenty amount of ion and charging the particles.

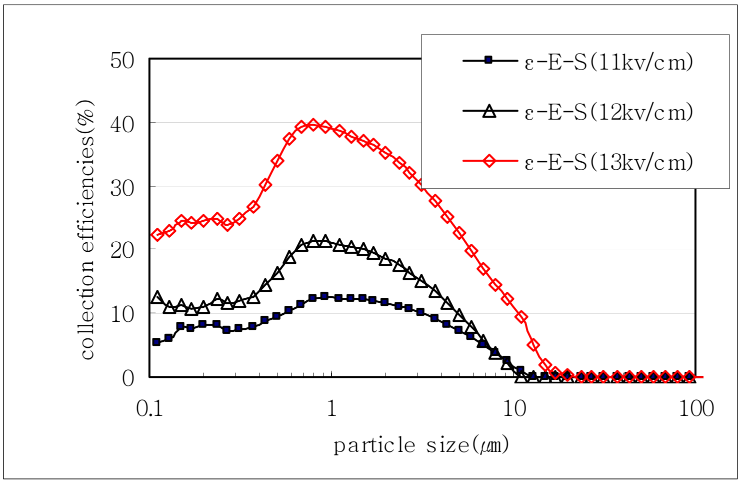

Fig. 5 Net collection efficiencies of electrospray system

4. Remarking conclusion

ESP is commonly introduced to control the emission of particulate matter. ESP has a high collection efficiency in total bu a low efficiency for fine particle. In this study, a conventional ESP was modified by adding the electorspray system to enhance the electrical mobility. It is found that the modified ESP in this study was effective to improve the low collection efficiency for fine particle by

5~17%. It is also beneficial to reduce the human health risk due to the heavy metal-contained particles in the long run.

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