Experimental analysis of corona discharge parameters in nanoparticles electrostatic precipitator

Atmospheric air pollution has become a major environmental issue due to the rapid growth of industrial and technological development that requires significant energy consumption. In the case of fossil energies, this inevitably leads to an increase in the release of gaseous pollutants into the atmosphere by industry, automobiles, and housing, among other things, such as volatile organic compounds (VOCs) and various oxides (NOx, SOx, ozone, etc.). These gaseous pollutants are closely monitored due to their environmental impact (acid rain, global warming, ozone layer destruction) and toxicity (some VOCs have mutagenic effects while some oxides are responsible for respiratory and ocular complications).

For air filtration, various materials and technologies have been developed, including electrostatic precipitators, electrospinning, metal-organic framework based membranes, and melt-blown polymers. Electrostatic precipitators are used to collect fine sub-micron particles from industrial effluents in both manufacturing plants and thermal power plants. The sizing is determined by several factors, including the gas flow rate to be treated, the mass load of the effluent to be cleaned, and the dust characteristics (size, chemical nature, and resistivity).

Electrostatic precipitators are widely used in various fields as environment for boiler and other industrial uses because they can efficiently and economically treat a large volume of exhaust gas. They give electric charges to dust particles in exhaust gas by corona discharge. Electrostatic Precipitators (ESP) are used with success to reduce the emissions of smoke, fumes and dust, playing an important role to maintain a clean environment and to improve the air quality. They are able to remove more than 99 % of the particulates from the flue gas in terms of mass. In these systems, particles are typically charged by the ions produced by a DC corona discharge.

The ESP operates in the three-step process: charging the particles under non-uniform and very high electric field strength, collecting the charged particles on the collecting surface and cleaning the collected particles by rapping or washing the collecting electrode with a liquid. Corona discharge, as applied to electrostatic precipitators, is a gas discharge phenomenon associated with the ionization of gas molecules by high-energy electrons in a region of the strong electric field strength.

Electrostatic precipitator (ESP) with a blade-to-plate configuration was developed in this study to investigate particle migration and collection under spraying conditions. For this ESP, experimental work was done in terms of particle migration, specific collection area, and discharge electrode types. Our research focuses on the experimental investigation of aerosol migration on the behavior of the corona discharge in a blade-to-plane electrostatic precipitator (PES). We will measure the following parameters related to the latter: corona discharge current, applied voltage, threshold voltage, and smoke particle concentration at the PES exit (SO_2; NO and CO). We have shown that the geometric factors such as interelectrode space and physical parameters to have an effect on this corona discharge.