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The Development and Testing of a Small Scale Dry Electrostatic Precipitator for the Removal of Particulate Matter

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Abstract : This paper presents a small tube/wire type electrostatic precipitator (ESP). In the ESPs present form, particle charging and collecting voltages and airflow rates were individually varied throughout 200 ambient temperature test runs ranging from 10 to 30 kV in increments on 5 kV and 0.5 m/s to 1.5 m/s, respectively. It was repeatedly observed that, at input air velocities of between 0.5 and 0.9 m/s and voltage settings of 20 kV to 30 kV, the collection efficiency remained above 95%. The outcomes of preliminary tests at combustion flue temperatures are, at present, inconclusive although indications are that there is little or no drop in comparable performance during ideal test conditions. A limited set of similar tests was carried out during which the collecting electrode was grounded, having been disconnected from the static generator. The collecting efficiency fell significantly, and for that reason, this approach was not pursued further. The collecting efficiencies during ambient temperature tests were determined by mass balance between incoming and outgoing dry PM. The efficiencies of combustion temperature runs are determined by analysing the difference in opacity of the flue gas at inlet and outlet compared to a reference light source. In addition, an array of Leit tabs (carbon coated, electrically conductive adhesive discs) was placed at inlet and outlet for a number of four-day continuous ambient temperature runs. Analysis of the discs’ contamination was carried out using scanning electron microscopy and ImageJ computer software that confirmed collection efficiencies of over 99% which gave unequivocal support to all the previous tests. The average efficiency for these runs was 99.409%. Emissions collected from a woody biomass combustion unit, classified to a diameter of 100 µm, were used in all ambient temperature trials test runs apart from two which collected airborne dust from within the laboratory. Sawdust and wood pellets were chosen for laboratory and field combustion trials. Video recordings were made of three ambient temperature test runs in which the smoke from a wood smoke generator was drawn through the precipitator. Although these runs were visual indicators only, with no objective other than to display, they provided a strong argument for the device’s claimed efficiency, as no emissions were visible at exit when energised. The theoretical performance of ESPs, when applied to the geometry and configuration of the tested model, was compared to the actual performance and was shown to be in good agreement with it.

Keywords : electrostatic precipitators, air quality, particulates emissions, electron microscopy, image j
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