### *ABSTRACT*

*Coal combustion exhaust emissions in the form of NOx, SOx, and COx are major pollutants that adversely affect the environment and health. This research aims to quantify pollutant removal efficiency and analyze chemical reaction mechanisms using a non-catalytic Dielectric Barrier Discharge (DBD) reactor. The reactor geometry utilizes aluminum foil and mesh electrodes with a pyrex dielectric barrier, operated at voltages from 0 to 15 kV. The reactor's electrical characteristics show compliance with Townsend's law with an I-V quadratic correlation of 0.954 and an initial plasma zone at 4 kV. Measurement results using the Exhaust Gas Analyzer ECOM D at a flow rate of 2 lpm show that maximum removal efficiency was achieved at a voltage of 13.98 kV with a CO reduction of 15.54%, SO2 of 13.47%, NO of 6.12%, and CO2 of 4.17%. An anomalous increase in NO2 concentration reached 110.53%, indicating the dominance of recombination reactions within the oxidative plasma regime. Optical Emission Spectroscopy (OES) diagnosis confirms a transition in energy distribution from a radiative excitation pathway to a destructive non-radiative dissociation route at high voltage, evidenced by a decrease in the relative population area of CO2+ by 13.65% and SO species by 20.1%. This research concludes that the DBD reactor effectively triggers the decomposition of pollutant molecules through a direct electron impact mechanism, with an optimal operating point at a combination of 14 kV voltage and 2 lpm flow rate.*



***Keywords:*** *DBD Plasma, Emission Reduction, Coal, ECOM D, OES Spectroscopy.*