Chemistry of the Electron Beam Process and its Application to Emission Control

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The electron beam (EB) process is well suited to remove small concentrations of gaseous pollutants from large volume flows. The absorption of the electron energy (300 - 800 keV) by the matrix gas leads to the formation of positive ions, radicals, excited state species and secondary electrons. Negative ions are formed from attachment of thermal electrons to neutral species. The positive ions undergo fast reactions with the components of the matrix gas. These positive ion-molecule reactions constitute the major source of radicals in the EB process. Since the radicals do not react with the matrix gas, they are available for the degradation of trace components.

Originally, the EB process was proposed and developed for the simultaneous removal of NO_x and SO_2 from the flue gas of fossile fuelled power plants. In this application, the flue gas is enriched with water vapour and ammonia prior to the irradiation. The EB treatment converts the NO_x and the SO_2 to nitric and sulfuric acids, respectively. Due to the presence of ammonia, the acids are neutralized and transformed into particulate ammonium nitrate and sulfate. The collected product can be used as agricultural fertilizer. The process has been investigated by experiment and model calculation. From the analysis of the results, process modifications were deduced which helped to improve the efficiency to meet the standards of conventional methods.

More recently, novel applications of the EB process have been studied and developed. These include the removal of volatile organic compounds (VOC) from industrial off-gas, the cleaning of automobile tunnel off-gas and the removal of chlorinated hydrocarbons from waste incinerator flue gas or from contaminated ground water.

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