Reaction pathway of nitrate and ammonia formation in the plasma electrolysis process with nitrogen and oxygen gas injection

ABSTRACT

The plasma electrolysis method using N_2 and O_2 injection is an effective and environmentally friendly solution for nitrogen fixation into nitrate and ammonia. The reaction pathway, the effect of the N_2 and O_2 gas injection composition are important parameters in understanding the mechanism and effectiveness of these processes. This study aims to determine the formation pathway of nitrate and ammonia by observing the formation and role of reactive species as well as intermediate compounds. Two reaction pathways of NO_x and ammonia formation have been observed. The NO_x compound formed in the solution was oxidized by ·OH to NO_2, followed by the production of a stable nitrate compound. The ammonium produced from the ammonia pathway was generated from nitrogen reacting with ·H from H_2O. The amount of NH_3 formed was lesser compared to the NO_x compounds in the liquid and gas phases. This indicates that the NO_x pathway is more dominant than that of ammonia. The gas injection test with a ratio of N_2/O_2 = 79/21 was the most effective for nitrate formation compared to another ratio. The results of the emission intensity measurement test show that the reactive species ·N, $·N_2*$, $·N_2+$, ·OH, and ·O have a significant role in the nitrate formation through the NOx pathway, while the reactive species ·N and ·H lead to the formation of NH_3. The highest nitrate product was obtained at a ratio of N_2/O_2: 79/21 by 1889 mg L^{-1}, while the highest ammonia product reached 31.5 mg $L{-}1^{-1}$ at 100% N_2 injection.