In-liquid thermal plasma processing combined with Fenton-like reaction for decomposition of phenol

Dong-Wook Kim [1], Eun Seo Jo [1], and Dong-Wha Park [1]

[1]Inha University, Korea, Republic of

In-liquid thermal plasma processing combined with Fenton-like reaction was conducted to decompose phenol from its aqueous solution. A non-transferred arc plasma torch was located at the bottom of a reactor. Phenol aqueous solution was poured into the reactor and then was treated by discharging arc plasma jet. The experiments were conducted with various solution volumes, phenol concentration and discharge power. In addition, Fenton-like reaction was combined with the in-liquid thermal plasma system for further improvement of phenol decomposition. Fe_3O_4 nanoparticles were used as a heterogeneous Fenton-like catalyst and could be easily removed from the plasma-treated solution using a magnet thanks to its magnetic properties. The decomposition rate of phenol and the oxygen chemical demand (COD) were analyzed to evaluate the decomposition of phenol. The experimental results showed the phenol decomposition rate above 97% when the 500mL aqueous solution with the phenol concentration of 1000mg/L was treated with the plasma jet operating at 2.6kW for 20min without catalyst. When the Fenton-like catalyst was introduced, both the decomposition rate and the COD removal rate increased. In this study, the main reaction for the phenol decomposition is considered to be thermal decomposition occurring at the interface between plasma jet and phenol. Meanwhile, hydroxyl radical is considered to have a limited effect on the phenol decomposition because of its short lifetime and recombination to form hydrogen peroxide. However, the introduction of Fenton-like reaction could improve the use of hydrogen peroxide, leading to the increased phenol decomposition. Herein, this new thermal plasma processing is suggested to be a promising system for wastewater remediation.

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