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Development of Low Frequency Dielectric Barrier Discharge using Rotatable Electrodes

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Various non-equilibrium atmospheric pressure plasma generation methods are used for industrial applications such as corona discharge and dielectric barrier discharge (DBD). A DBD is developed for surface treatment of particulate materials using a rotatable electrode at low frequency high-voltage power source. The rotatable electrode dielectric barrier discharge reactor (RE-DBDR) is consisted of a cylindrical dielectric chamber, two fixed cylindrical thin metal electrodes attached on the outside wall of the chamber, and a rotatable rectangular thin metal plate electrode supported by an axial rod located in the chamber center. DBD can be ignited owing to an electrostatic induction effect between the floating electrode and the outside electrodes. Since the rotatable electrode is electrically floating, proposed electrode configuration enables us to enlarge DBD volume by rotating the thin plate electrode at high rotational speed. DBD in flowing air is generated inside a cylindrical discharge device using a sinusoidal voltage pulse of Vpp = 30 kV with frequencies of 60 Hz, 80 Hz, 100 Hz and about 10 kHz with an amplitude modulation. Electrical discharge characteristics depend on ratio of a rotational frequency of the floating electrode fr with the frequency of an applied voltage pulse fp. The measured ozone concentration, which increased with rotational speed, is proportional to the discharge power consumption. At 60 Hz operating frequency and 3 slm air flow rate, the ozone concentration increased from 7.2 ppm at fr =0 to 108.4 ppm at fr =120 Hz.
We observed the emission spectrum and found strong N2 molecular band spectra of second positive system (C-B). N2(C-B) has a maximum fr =120 Hz when measured power consumption of DBD and ozone concentration has a maximum at fr =120 Hz. These results suggest that effective discharge area could be controlled by rotational speed of the floating electrode and applied high-voltage frequency.

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