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SUB-MICROSECOND DISCHARGES FOR THE DEGRADATION OF ORGANIC POLLUTANTS IN WATER*

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Persistent organic pollutants, such as pharmaceutical residues, often withstand treatment by conventional water treatments. Plasmas generated directly in water have shown to effectively decompose these compounds, presenting a promising new approach. Especially corona-discharges that are generated by short high voltage pulses are able to penetrate large volumes of water of different characteristics, including different conductivities and turbidities.
We have therefore compared corona-discharges that are generated by rectangular high voltage pulses of either 100 ns, 300 ns and 650 ns duration and amplitudes of up to 100 kV in defined and comparable coaxial discharge geometries. The positive high voltage pulses were provided by Blumlein line pulse forming lines and networks in stacked configurations. Foremost we investigated degradation efficacies and efficiencies for six recalcitrant pharmaceuticals that are known to accumulate in surface waters, including diclofenac and ethinylestradiol. Shorter pulses result in higher degradation efficiencies despite a reduced plasma volume penetration. Accordingly we investigated plasma development and also associated reaction chemistries using phenol as a model system. Detailed studies of degradation pathways confirmed that OH-radicals are primarily responsible for the degradation of organic compounds. However, in the bulk they are primarily provided by secondary reactions, i.e. not directly by the plasma. Accordingly, in conjunction with plasma processes, Fenton reactions play a significant role. Concurrently, especially reactions with the ground electrode material, which have so far often been neglected, are important. Ground electrode corrosion due to electrochemical processes favors the catalytic decomposition of hydrogen peroxide that was formed as a secondary discharge product to OH-radicals again. Consequently, degradation efficacies of plasmas in water can be significantly enhanced by a combination with dedicated catalytic materials.
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