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Interaction of atmospheric dielectric barrier discharge plasma above flowing water with dissolved organic contaminants

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During the last decades, water decontamination has become an increasingly complex challenge, due to the occurrence of new persistent and highly toxic chemicals in industrial effluents. Currently available physico-chemical treatments are not adequate for many industrial processes, since they are unable to efficiently remove recalcitrant xenobiotics in compliance with new European legislation. In this work, a plasma generation above a water surface is proposed as an innovative method for water. If plasma is used there is, in contrast to existing advanced oxidation processes, no need to externally introduce environmentally hazardous species like Ozone, Hydrogen Peroxide or Chlorine, because strongly oxidizing species including UV radiation can be formed directly within the plasma itself. Until now it is not clear in which way an intimate contact of the plasma discharge should be best realized. A unique comparison of literature data is not possible, because widely different chemicals as contaminants have been used and the input of electric energy to generate the plasma is not always clear defined. In many cases the amount of electric energy input, which is necessary for the decolorization of Methylene Blue by 50% (g/kWh) has been reported for different types of plasma discharges. The resulting values of efficiency are varying by much more than one order of magnitude. Assuming that the transfer of reactive species from the plasma zone into the water volume is one of the main parameters determining efficiency, a suitable setup containing a layer of water flowing through a DBD plasma zone is proposed and characterized. With this setup a comparatively high efficiency value of 2 g/kWh could be reached. On this basis the decontamination of herbicidal mixtures is investigated and an upscaling to a technical prototype is proposed.

Keywords
water plasma
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advanced oxidation process