Reduction of Nitrate Ions using Aqueous Phase Corona Discharge

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Abstract–**Nitrate, an inorganic drinking water contaminant, is becoming much more ubiquitous in groundwater sources. This is cause for concern particularly to infants and pregnant women as it is easily reduced to nitrite by saliva which causes methemoglobinemia (blue baby syndrome). Nitrate enters drinking water through the nitrogen cycle, which has been more heavily engineered than even the carbon cycle, through the deposition of fertilizers and wastewater treatment. The high solubility of nitrate allows for rapid infiltration and transport into groundwater sources. The current maximum acceptable concentration in both Canada and the USA is 10 ppm NO_3^- -N. The technologies which currently exist for nitrate removal are ion exchange resins, electrodialysis and anaerobic bioreactors. Of these, only the anaerobic bioreactors are destructive, the others are separative . The focus of this work is to explore the use of aqueous phase corona plasma discharges for the removal of nitrate from drinking water. It has been reported in literature that aqueous phase corona aqueous phase corona discharge is capable of producing a number of highly energetic radicals. By applying a pulsed high voltage to submerged electrodes, water molecules are excited under the influence of the electric field and are thermally ionized into hydroxyl radicals and energetic protons. These species interact with other molecules present to generate create secondary reactions, further increasing the radical density, and can cause reactions that are not typical at standard pressures and temperatures due to high energy barriers. Aqueous phase plasma discharges have been well studied for their role as an advanced oxidation process. Examples of these include the degradation of organic dyes and the oxidation of phenol and pharmaceutical products. Additionally, non-thermal plasmas have been employed for the inactivation of bacteria. There has been a limited amount of work done demonstrating the ability of aqueous phase plasmas to chemically reduce compounds. In one instance, chemical reduction was achieved through the use of specific chemical probes from sonochemical studies, which tested for the presence of reductive species generated from aqueous phase non-thermal plasmas. In this study, it is demonstrated that aqueous phase plasmas are capable of chemically reducing a real world contaminant with a water matrix similar to tap water. Using plasma discharges, a reduction in nitrate levels from wastewater effluent concentrations to below drinking water limits is achieved.**