ADVANCED OXIDATIVE WATER TREATMENT PROCESS USING ANELECTROHYDRAULIC DISCHARGE REACTOR AND NANO TiO_2 IMMOBILIZED ON NANOFIBERS

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ABSTRACT

Over the last decade advanced oxidation process (AOP) has gained interest as one of the alternative to conventional water treatment process due to its high effectiveness, low-cost and environmentally friendly. Electrohydraulic discharges, a type of AOP, utilizes an electrical discharge to produce UV light and highly reactive radicals ($OH^{\bullet}$, $H^{\bullet}$, $O^{\bullet}$) and molecular species (H_2O_2, H_2, O_3) directly in the liquid phase which can targets and attack the contaminants in the drinking water. Electrohydraulic discharges have been studied for several years; however the integration of innovations in nanoscience and nanotechnology has been incorporated into this area of work on a very limited scale. The focus of this project was to design and assemble an electrohydraulic discharge reactor consisting of high voltage multi-unit electrode across the water flow path and ground electrode connected to the contaminant water. Milestones covered in the research activities includes optimisation of the reactor configuration using copper wire electrodes, incorporation of nano TiO_2 immobilized on nanofibers of polyacrylonitrile (PAN) in order to promote the production of the radicals and then replacement of the initial conventional copper electrodes with nano-wire for the reduction of carbon footprint. Characterization was performed by means of XRD, FT-IR, BET, XPS, UV spectroscopy, NMR, LC-MS and microorganism destruction rates. This study has highlighted that chemical probes (e.g. methanol) serves as radical's scavenger in the determination of reactive species. The study shows that hydroxyl radicals and ozone are the key factors at work during the degradation and inactivation process of methylene blue (MB), rhodamine blue (RB), acid orange (AO) and *E. coli* were chosen as target molecules to interrogate the system based on the corona discharge principle. 4-log reduction was achieved after 15 min at water conductivity of 5mS/cm. It was found that the electrical strength of water depends strongly on the polarity of high voltage electrode and the conductivity of the water in the range 5-20 mS/cm. The electrical strength of water decreases, and the time to breakdown the microbes decreases, as water conductivity is increased. The photocatalysis of nano TiO_2 enhanced the active species (OH radicals) determined using ESR to form a cocktails which offers a powerful water treatment solution for the removal of organics and microorganisms from the drinking water without adding chemicals.