Photocatalytic Membrane Reactors: New Perspective for Persistent Organic Pollutants Removal in Urban Wastewater

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Persistent organic pollutants (POPs) present a significant risk to both human health and the environment due to their chemical stability at low concentrations and their limited biodegradability. However, conventional treatment plants often fail to effectively remove them from wastewater. The photocatalytic degradation of POPs (e.g. pharmaceutical compounds, pesticides or cosmetics) has been deeply studied in the literature using commercial titanium dioxide (TiO_2) in synthetic wastewater, utilizing model recalcitrant contaminants. This work, instead, is based on the degradation and removal of persistent pollutants present in real urban wastewater, recovered by Civil Depurator Plant located in c.da Coda di Volpe in Rende (CS, Italy) by using TiO_2-slurry photocatalytic inorganic membrane reactor (SPMR). At the beginning, two different _batch_ reactor configurations were studied: one with internal UV lamps and one with external UV lamp. The immersed lamp reactor showed the best performance in terms of Chemical Oxygen Demand (COD) reduction and ammonia nitrogen (NH_4^+) oxidation into nitrate (NO_3^-). A finite element model (FEM) was developed to simulate the UV light distribution in each configuration, confirming that the internal lamps provide more efficient UV irradiation and improve catalytic activity. The best configuration was then applied to develop the SPMR. Using an inorganic tubular membrane with a molecular weight cut-off of 1 kDa, the COD removal efficiency was improved by approximately 15%, improving the overall quality of treated water.

Keywords: _Urban wastewater treatment, Persistent Organic pollutants, Titanium dioxide, Photocatalytic degradation, Slurry photocatalytic membrane reactor._