PVDF bilayer electrospun nanostructured composite catalytic membranes for dye degradation by hybrid advanced oxidation processes

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Catalytic advanced oxidation processes (AOPs) have gained great attention as a promising solution for environmental pollution, especially for the removal of organic contaminants in wastewater. However, constraints such as high costs, catalyst aggregation in suspension, separation, recovery, and reuse are commonly listed as major drawbacks hindering their widespread employment. This work presents an effort towards the mitigation of such problems by combining their use with PVDF nanostructured electrospun composite catalytic membranes to develop a highly efficient mixed catalytic heterogeneous medium for potential water treatment. To this end, the UV photo-activity of TiO_2 towards the decolorization of methyl orange (MO) was combined with Fe_3O_4 particles synthesized by co-precipitation and employed as a heterogeneous Fenton catalyst. A third system was realized by the combination of such catalysts with graphene oxide (GO) to promote surface absorption and mediate electron-transfer reaction. All the catalytic systems were characterized and deposited on electrospun PVDF nanofibers used both as support, for mechanical and UV resistance, and as catalyst binder. Along with such membranes different AOPs strategies were investigated either alone or in combination using UV radiation, ultrasounds and H_2O_2, evaluating the relative performances using a batch configuration mode. The results revealed that while photocatalysis, sono-photocatalysis, and H_2O_2 photolysis alone have a limited efficiency towards MO decolorization, their proper combination significantly increased the kinetics of the process. The use of such fibrous membranes might be a promising solution for catalytic supported AOPs, thanks to the simple synthesis, no significant loss of catalytic phase and necessity for its recovery combined with good catalytic activity over multiple degradation cycles.

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