ABSTRACT

Water pollution caused by dye waste such as methylene blue (MB) poses a serious problem to the environment due to its toxic nature and difficulty in natural degradation. One environmentally friendly method to overcome this problem is a combination of adsorption and photocatalysis. This study aims to synthesize and characterize polyeugenol-TiO_2 membranes using the Non-Imprinted Membrane (NIM) and Molecularly Imprinted Membrane (MIM) methods, as well as to test their effectiveness and selectivity in degrading MB. This study includes the synthesis of polyeugenol using BF3-diethyl ether catalyst, which produces reddish-brown powder with a yield of 98.49%, and the synthesis of TiO_2 using the sol-gel method, which produces white powder with a yield of 88.79%. The formation of hydrogel from polyeugenol-PVA with PEGDE crosslinker and 0.5 M NaOH catalyst was used as the base matrix for the manufacture of NIM/MIM membranes integrated with TiO_2 at variations of (0.01%; 0.05%; 0.1%). Characterization results showed that polyeugenol has characteristic phenolic -OH (3435 cm^{-1}) and aromatic -OCH_3 (1270 cm^{-1}) absorption. The synthesized TiO showed a Ti-O-Ti stretching band (400-800 cm^{-1}) with anatase phase confirmed by XRD at $2\theta = 25.41°$, crystallite size ±38 nm, and band gap value of 3.3 eV. SEM-EDX analysis of the membrane revealed a porous surface with Ti distribution and MB imprint cavities on the MIM membrane. Physical testing showed that MIM had higher porosity, was more hydrophilic, and had greater water uptake and swelling values compared to NIM. Photocatalysis was applied to a 5 ppm MB solution (20 mL) for 30 minutes without irradiation (dark reaction), followed by 60 minutes under UV light. The 0.1% MIM membrane produced the best performance with a degradation efficiency of 82.71%, higher than that of the 0.1% NIM membrane (79.88%). The reaction kinetics followed first-order kinetics, with the rate constant of MIM 0.1% (0.0304 min^{-1}) being higher than that of NIM (0.0275 min^{-1}). Reuse testing of the MIM membrane over 3 cycles showed a decrease in efficiency from 80.24% to 72.59%, still suitable for repeated applications.

Keywords: polyeugenol, anatase TiO_2, NIM/MIM, methylene blue, adsorption-photocatalysis