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Valorization of Mineralogical Byproduct TiO_2 Using Photocatalytic Degradation of Organo-Sulfur Industrial Effluent

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Abstract : Industries are growing day to day to increase the economy of the country. The biggest problem with industries is wastewater treatment. Releasing these wastewater directly into the river is more harmful to human life and a threat to aquatic life. These industrial effluents contain many dissolved solids, organic/inorganic compounds, salts, toxic metals, etc. Phenols, pesticides, dioxins, herbicides, pharmaceuticals, and textile dyes were the types of industrial effluents and more challenging to degrade eco-friendly. So many advanced techniques like electrochemical, oxidation process, and valorization have been applied for industrial wastewater treatment, but these are not cost-effective. Industrial effluent degradation is complicated compared to commercially available pollutants (dyes) like methylene blue, methylene orange, rhodamine B, etc. TiO_2 is one of the widely used photocatalysts which can degrade organic compounds using solar light and moisture available in the environment (organic compounds converted to CO_2 and H_2O). TiO_2 is widely studied in photocatalysis because of its low cost, non-toxic, high availability, and chemically and physically stable in the atmosphere. This study mainly focused on valorizing the mineralogical product TiO_2 (IREL, India). This mineralogical graded TiO_2 was characterized and compared with its structural and photocatalytic properties (industrial effluent degradation) with the commercially available Degussa P-25 TiO_2. It was testified that this mineralogical TiO_2 has the best photocatalytic properties (particle shape - spherical, size - 30±5 nm, surface area - 98.19 m^2/g, bandgap - 3.2 eV, phase - 95% anatase, and 5% rutile). The industrial effluent was characterized by TDS (total dissolved solids), ICP-OES (inductively coupled plasma – optical emission spectroscopy), CHNS (Carbon, Hydrogen, Nitrogen, and sulfur) analyzer, and FT-IR (fourier-transform infrared spectroscopy). It was observed that it contains high sulfur (S=11.37±0.15%), organic compounds (C=4±0.1%, H=70.25±0.1%, N=10±0.1%), heavy metals, and other dissolved solids (60 g/L). However, the organo-sulfur industrial effluent was degraded by photocatalysis with the industrial mineralogical product TiO_2. In this study, the industrial effluent pH value (2.5 to 10), catalyst concentration (50 to 150 mg) were varied, and effluent concentration (0.5 Abs) and light exposure time (2 h) were maintained constant. The best degradation is about 80% of industrial effluent was achieved at pH 5 with a concentration of 150 mg - TiO_2. The FT-IR results and CHNS analyzer confirmed that the sulfur and organic compounds were degraded.

Keywords : wastewater treatment, industrial mineralogical product TiO_2, photocatalysis, organo-sulfur industrial effluent
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