

Adsorption: A Decision Maker in the Photocatalytic Degradation of Phenol on Co-Catalysts Doped TiO₂

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Abstract : In the current work, photocatalytic degradation of phenol was carried both in UV and visible light to find the slowest step that is limiting the rate of photo-degradation process. Characterization such as XRD, SEM, FT-IR, TEM, XPS, UV-DRS, PL, BET, UPS, ESR and zeta potential experiments were conducted to assess the credibility of catalysts in boosting the photocatalytic activity. To explore the synergy, TiO₂ was doped with graphene and alumina. The orbital hybridization with alumina doping (mediated by graphene) resulted in higher electron transfer from the conduction band of TiO₂ to alumina surface where oxygen reduction reactions (ORR) occur. Besides, the doping of alumina and graphene introduced defects into Ti lattice and helped in improving the adsorptive properties of modified photo-catalyst. Results showed that these defects promoted the oxygen reduction reactions (ORR) on the catalyst's surface. ORR activity aims at producing reactive oxygen species (ROS). These ROS species oxidizes the phenol molecules which is adsorbed on the surface of photo-catalysts, thereby driving the photocatalytic reactions. Since mass transfer is considered as rate limiting step, various mathematical models were applied to the experimental data to probe the best fit. By varying the parameters, it was found that intra-particle diffusion was the slowest step in the degradation process. Lagergren model gave the best R² values indicating the nature of rate kinetics. Similarly, different adsorption isotherms were employed and realized that Langmuir isotherm suits the best with tremendous increase in uptake capacity (mg/g) of TiO₂-rGO-Al₂O₃ as compared undoped TiO₂. This further assisted in higher adsorption of phenol molecules. The results obtained from experimental, kinetic modelling and adsorption isotherms; it is concluded that apart from changes in surface, optoelectronic and morphological properties that enhanced the photocatalytic activity, the intra-particle diffusion within the catalyst's pores serve as rate-limiting step in deciding the fate of photo-catalytic degradation of phenol.

Keywords : ORR, phenol degradation, photo-catalyst, rate kinetics

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