

**RESEARCH GRANT REPORT**

**PREPARATION OF A ZEOLITE SUPPORTED TiO<sub>2</sub> PHOTOCATALYST VIA METAL  
ORGANIC CHEMICAL VAPOR DEPOSITION (MOCVD)  
TO PHOTODEGRADE ORGANIC POLLUTANTS  
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## ABSTRACT

Photodegradation of Indigo Dye (ID) in aqueous solution using anatase  $\text{TiO}_2$  and  $\text{TiO}_2$ /zeolite photocatalyst were studied and presented in this technical report. The photocatalysts were prepared using sol-gel method and subsequently calcined in a furnace at  $450\text{ }^\circ\text{C}$  for 4 hours. The photocatalysts were characterized using SEM and XRD analysis techniques. The XRD analysis was used to identify and confirmed the formation of anatase  $\text{TiO}_2$  crystalline structure while the SEM analysis was used to study the surface morphology of the  $\text{TiO}_2$ /zeolite surface. About 0.4 g of the photocatalysts was used in varied concentration (10-20 mg/L) to photodegrade 500 mL of unbuffered Indigo Dye solution in this photodegradation system. A comparison study was also done using neat anatase  $\text{TiO}_2$  and  $\text{TiO}_2$ /zeolite photocatalyst systems to evaluate the synergistic effect of using a combined adsorbent-photocatalyst system to treat dye contaminated wastewater. UV-Vis spectroscopy was used to determine the concentration of the extracted sample with Indigo Dye's  $\lambda_{\text{max}}$  of 725 nm. The photodegradation experiments were conducted over a 5 hour duration to determine the synergistic effect of the newly synthesized adsorbent-photocatalyst degradation in each experiment. The results showed that photocatalytic behavior of  $\text{TiO}_2$ /zeolite was better as the degree of degradation for  $\text{TiO}_2$ /zeolite was higher as compared with neat  $\text{TiO}_2$ . The percentage degradation achieved by using  $\text{TiO}_2$ /zeolite in 10 mg/L and 20 mg/L were 60.65% and 75.83% respectively. The degradation process followed a pseudo-first-order kinetic reaction with the regression correlation,  $R^2$ , in the range of between 0.8584 and 0.9624. Whereas the rate constant,  $k$ , for the photodegradation of Indigo Dye solution was in the range of between  $0.1207\text{ h}^{-1}$  and  $0.2669\text{ h}^{-1}$ . The highest values obtained for the  $\text{TiO}_2$ /zeolite were  $0.2669\text{ h}^{-1}$  and  $0.1736\text{ h}^{-1}$  respectively, demonstrating the suitability of using this combined adsorbent-photocatalyst treatment system in dye contaminated wastewater.

## ABSTRAK

Pemangkin anatase  $\text{TiO}_2$  dan  $\text{TiO}_2/\text{zeolite}$  digunakan untuk menjalani fotodegradasi bagi pewarna nila telah dikaji. Pemangkin-pemangkin ini telah disediakan dengan menggunakan kaedah sol-gel dan dikalsinasi dengan menggunakan pada suhu  $450^\circ\text{C}$  selama 4 jam. Pemangkin-pemangkin telah dicirikan dengan menggunakan SEM dan XRD. XRD diggunakan untuk mengenalpasti pembentukan anatase  $\text{TiO}_2$  manakala SEM digunakan untuk memerhatikan pengikatan  $\text{TiO}_2$  pada permukaan zeolite. Sebanyak 0.4 g pemangkin digunakan pada setiap set eksperimen yang berbezaan kepekatan iaitu 10 mg/L dan 20 mg/L. 500 mL larutan pewarna nila digunakan dalam sistem photodegradasi ini. Kajian ini dijalankan dengan kehadiran pemangkin  $\text{TiO}_2$  dan  $\text{TiO}_2/\text{zeolite}$ . Kepekatan akhir pewarna boleh dianalisis dengan menggunakan spektrofotometer imbasan UV. Dalam kajian ini, pewarna nila menunjukkan nilai penyerapan pada  $\lambda_{\text{max}} = 725 \text{ nm}$ . Eksperimen ini dijalani dalam tempoh masa selama 5 jam untuk mencari peratusan degradasi bagi setiap eksperimen. Keputusan eksperimen telah menunjukkan fotokatalitik bagi  $\text{TiO}_2/\text{zeolite}$  adalah lebih baik berbanding dengan menggunakan  $\text{TiO}_2$  sahaja. Peratus degradasi yang dicapai bagi  $\text{TiO}_2/\text{zeolite}$  dalam kepekatan 10 mg/L dan 20 mg/L masing-masing ialah 60.65% dan 75.83%. Selain itu, proses degradasi adalah mengikuti first order kinetik dimana pemalar,  $k$  bagi degradasi larutan perwarna nila adalah dalam lingkungan  $0.1207 \text{ j}^{-1}$  dan  $0.2669 \text{ j}^{-1}$ . Nilai tertinggi bagi  $\text{TiO}_2/\text{zeolite}$  adalah  $0.2669 \text{ j}^{-1}$  dan  $0.1736 \text{ j}^{-1}$ . Namun, regresi korelasi,  $R^2$  bagi keempat-empat set eksperimen menunjukkan nilai dalam lingkungan 0.8584 dan 0.9624.