Remediation of water by using titanium oxide (TiO₂) as photo-catalyst

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Extensive disposal of dyes from textiles, paper, plastics, leather, food, cosmetics & many others industries to water bodies poses a great threat to environment. The industrial progress causes several severe environmental problems by releasing wide range of toxic compound to the environment. Thousands of hazardous waste locations have been produced worldwide consequential from the accumulation of organic pollutants in soil and water over the years.

Figure 1: Representation of principal mechanism of photocatalysis

Monitoring of environmental pollution is therefore one of the most important needs for selecting pollution controlling option. Among various pollutants, organic dyes are hazardous and toxic pollutants and have adverse effect on living organisms. Semiconducting metal oxide nanostructures play an important role in developing smart materials that are well efficient for destroying harmful chemical contaminants from our environment. Figure 1 represents the principal mechanism of photocatalysis on a semiconductor.

In this contribution, TiO₂ nanoparticles were employed as photocatalyst for the removal of environmental contaminants. Photocatalytic degradation of brilliant cresyl blue (BCB) and cresyl violet (CV) dyes has been carried out using TiO₂ nanoparticles, which showed 92.1% degradation for BCB and 80.7% degradation for CV in 100 min of irradiation time. Figure 2 shows the change in absorption spectrum of crystal violet dye with irradiation time.

Emerging field of nanotechnology leads to improve the interaction of energy and material with the environment. Environmental

application of nanotechnology results less consumption of energy and materials and reduced harm to the environment as well as helps in environmental remediation also [1]. Several semiconducting materials such as TiO₂, ZnO, Fe₂O₃, CdS, ZnS can act as photocatalysts but among them TiO₂ is often studied due to its capability to break down dye or organic pollutants and accomplishes absolute mineralization. Due to high reactivity, low toxicity, chemical stability and low cost make TiO₂ as ideal catalyst to be used in Photocatalysis[2].

Figure 2: Change in absorption spectrum of crystal violet dye with irradiation time

Photocatalysis is an oxidation process in which the organic pollutants are destroyed by the help of a catalyst e.g., TiO₂, ZnO by using an energetic light source, also an oxidizing agent such as oxygen or air. The photons ($h\nu$) having higher energy greater than the band-gap energy (ΔE) creates excitation in valence band (VB) electrons to promote reactions with pollutants.

Keywords: TiO₂ nanoparticle, photocatalysis, water remediation, Brilliant cresyl blue and crystal violet dye

References

1. P. Singh, M.M. Abdullah, S. Ikram, Nano Res. appl. 1(2015)1
2. A. Fujishima, T.N. Rao, D.A. Tryk, J. Photochem. Photobiol C Photochem. Rev. 1 (2000) 1.
3. S. Ahmed, M.G. Rasul, R. Brown, M.A. Hashib (2011) J. Environ Manag. 92(2011)311.