Reduction of pollution of Dyes using TiO$_2$

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OBJECTIVES

1. To determine the adsorption of dye methyl orange on TiO$_2$

2. Determine the degradation of dyes methyl orange and methylene blue on TiO$_2$ using two model dyes (Methyl Orange and Methylene Blue)

3. Investigate the possibility of degrading the dye in wastewaters
Method
Photodegradation of dyes using TiO$_2$
The dyes are carcinogenic i.e. Azo dyes and aromatic amines

Properties of TiO$_2$
- Chemically inert
- Stable with respect to photocorrosion and chemical corrosion
- Cheap/easily available

Disadvantages
- Has a high bandgap energy (3.2 ev)
- Absorbs only wavelengths of below 400nm.
Principles of heterogenous photocatalytic degradation

- Irradiation of photocatalyst with UV source
- Formation of electron acceptors $h^+ + e^-$

$$\text{TiO}_2 \xrightarrow{hv} h^+ + e^-$$

**Reaction on photocatalyst surface**

- $h^+$ - formation $\cdot$OH radicals – oxidation stable organic compounds

$$\text{H}_2\text{O}_{\text{ads}} + h^+ = \cdot\text{OH}_{\text{ads}} + \text{H}^+$$

- electron acceptors $e^-$ - dissolved oxygen

$$\text{O}_2 + e^- = \text{O}_2^{\cdot-}$$
Model Dyes

Methyl Orange

\[
\begin{align*}
\text{N} & \equiv \text{N} \\
\text{OH} & \quad \text{SO}_3\text{H}
\end{align*}
\]

Methylene Blue

\[
\begin{align*}
\text{CH}_3 & \quad \text{N} \\
\text{CH}_3 & \quad \text{N} \quad \text{CH}_3 \quad (+) \quad \text{N} \quad \text{CH}_3
\end{align*}
\]
Monitoring absorbance

UV/VIS spectrum of aqueous solution of Methylene Blue, concentration (1×10^{-5}M).
UV/VIS spectrum of aqueous solution of methyl orange dye different concentrations
Monitoring photodegradation

- UV/VIS spectrophotometer (determining dye concentration in solution)
- AO 7- $\lambda = 485\ nm$  MM – $\lambda = 660\ nm$
- Change in concentrations during irradiation determines degradation rates
Results

Measuring adsorption of Methyl Orange on TiO₂ for different dye concentrations
Dye Photodegradation

**Methyl Orange**

- UV without TiO$_2$
- UV with TiO$_2$

**Methylene Blue**

Dye concentration $c(2.5 \times 10^{-5} \text{M})$
Conclusions

Dyes can be effectively degraded using TiO$_2$ photocatalyst and UV light $\lambda$ (300-400 nm).

Dye adsorption on TiO$_2$ photocatalyst surface influences the rate of dye photodegradation.

In place where we have plenty of sunlight solar radiation can be used for degradation with the use of TiO$_2$. 