Water Disinfection by Photo-Degradation of Microorganisms Using Natural Dye-Sensitized ZnO Catalyst

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Abstract:

Several procedures are commonly used for water purification, such as adding chlorine containing substances, peroxide, bromine, silver-copper, ozone and UV. Photodegradation of microorganisms has also been examined in water disinfection. TiO_2 and ZnO were examined by researchers for inactivation of Escherichia coli and Lactobacillus helveticus using photo-degradation techniques.

Although ZnO is a wide band gap (3.2 ev) semiconductor, with limited photo-catalytic applications to shorter wavelengths only, and demands UV region for excitation; it has attracted attention as an interesting alternative to TiO_2 in dye sensitized solar cells. Both TiO_2 and ZnO have similar band gaps (3.2 ev) and similar electron injection efficiencies from excited dyes. Moreover, ZnO exhibits analogous transport properties as TiO_2. ZnO has other advantages such as improved performance with cheap organic dyes (it absorbs larger fraction of solar UV light than TiO_2 does).

Because only about 4% of the solar spectrum falls in the UV region, ZnO semiconductor is sensitized by dye molecules. Sensitized ZnO catalysts have been investigated for organic pollutant degradation in a safe and simple manner.

In this work, ZnO semiconductor nano-particles, combined with safe low cost sensitizer (the natural dye anthocyanin) was used to disinfect water from bacteria by photodegrading it with solar light .The natural dye sensitizes ZnO to the visible light, the dye has lower band gap and absorbs in the visible region.

Illumination has been constructed by a solar simulator lamp. A pre-contaminated water sample with e-coli bacteria was treated with the catalyst (ZnO/anthocyanin) under halogen spot lamp. A noticeable decline in bacteria concentration was observed. Contaminated samples treated with naked ZnO, anthocyanin dye, and light source (without any additions) separately in control experiments.

Up to 90% degradation was achieved by the ZnO/anthocyanin catalyst system under solar light in 90 minutes.

Effect of different parameters on reaction rate and efficiency, such as temperature, pH, concentration and others will be presented.

Keywords: ZnO, bacteria, photo-degradation, anthocyanin.

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