Chapter 6

PHOTO-DEGRADATION OF METHYL ORANGE WITH DIRECT SOLAR LIGHT USING ZnO AND ACTIVATED CARBON-SUPPORTED ZnO

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ABSTRACT

ZnO is a wide band gap (3.2 eV) semiconductor, with limited photo-catalytic applications to shorter wavelengths only. However, it is suitable to use in solar light photo-degradation of different contaminants, due to a number of reasons, taking into account that the reaching-in solar radiation contains only a tail in the near UV region. The high absorptivity of ZnO makes it efficient photo-catalyst under direct solar light. Moreover, it is relatively safe, abundant and non costly. In this chapter, ZnO has been investigated as a potential catalyst for photo-degradation of methyl orange (a known dye) in aqueous solutions with direct natural solar light under different conditions. The major aim was to assess the efficiency and stability of ZnO under photo-electrochemical (PEC) conditions, and to suggest techniques to enhance such features. This will shed light on the future applicability of ZnO as a candidate for economic and friendly processes in water purification.

Recovery of ZnO particles, after reaction completion, has been facilitated by supporting ZnO onto activated carbon, to yield AC/ZnO system. The AC/ZnO was used as catalyst for contaminant photo-degradation in water solutions under direct solar light.

Both catalytic systems, naked ZnO and AC/ZnO, were highly efficient in degrading both contaminants, reaching complete removal in reasonable times. The latter system showed higher efficiency. In both systems, the reaction goes faster with higher catalyst loading, until a maximum efficiency is reached at a certain concentration, after which the catalyst concentration did not show a systematic effect.

In both catalytic systems, the rate of degradation reaction increases with higher contaminant concentrations until a certain limit is used. The contaminant degradation reaction was studied, using both catalysts, at different pH values. The pH value 8.0 gave the highest catalyst efficiency. The tendency of naked ZnO to degrade into soluble zinc ions, under photo-degradation experiments, was studied under different pH values. Catalyst recovery and reuse experiments were conducted on both systems. The catalytic activity of the recovered systems was only slightly lower

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than the fresh system in each case. The fourth time recovered catalysts showed up to 50% efficiency loss in each case, presumably due to ZnO degradation and leaching out. However, fresh and recovered catalyst systems caused complete degradation of contaminants after enough time. Temperature showed a slight effect on rate of reaction, with immeasurably small activation energy value. Details of effects of other parameters on reaction rate and catalyst efficiency are described. Using CdS as sensitizing dye failed to enhance ZnO efficiency under direct solar light. The screening effect and tendency of CdS to leach out limit its use as ZnO sensitizer. Tendency of ZnO to leach out zinc ions into solution is discussed. The naked ZnO and AC/ZnO systems are promising photo-catalysts in future water purification technologies by direct solar light.

Keywords: ZnO , CdS , Activated Carbon, methyl orange, photo-degradation, solar light, zinc oxide, activated carbon, solar, photo-degradation, methyl orange, water