Antibacterial Inactivation of *Escherichia coli after* TiO_2-Fe_3O_4-Bentonite Photocatalytic Treatment

Restu Kartiko Widi, Emma Savitri*, Olivia Angelina, Sherlly Caroline O. J., Arief Budhyantoro

Chemical Engineering Department, University of Surabaya, TG Building 5th floor, Raya Kalirungkut, Surabaya, 60293, Indonesia

*Corresponding Author : savitri_ma@staff.ubaya.ac.id

Abstract

TiO_2-Fe_3O_4–Bentonite photocatalytic material has been developed to inactivate of Escherichia coli. The photocatalytic inactivation of Escherichia coli was conducted in a reactor under ultraviolet (325 nm) exposing. The photocatalytic degradation were observed for 5 hours to determine the optimum initial bacteria concentration, intensity of UV light and also photocatalyst concentration. The inactivation kinetic was approached by Chick-Watson and Hom kinetic models. The colonies calculations were conducted by Total Plate Count. The optimum condition was achieved for 300 minutes process to reach 7 bacterial log reduction units for an average bacterial inoculum size of 3.8×10^4 CFU/ml. The inactivation kinetic of Escherichia coli using TiO_2-Fe_3O_4-Bentonite photocatalytic material system satisfactorily obeyed the Hom kinetic model.

Keywords : TiO_2, photocatalytic disinfection, inactivation kinetics, *E.coli*

1. Introduction

One of the major problems in all countries is water quality problems. The research study on water quality in the East Java found that the rivers in Surabaya contain up to 64,000 cells of *Escherichia coli* per 100 ml of water. The pathogenic microorganisms like Escherichia coli has caused 3.4 million people die each year of waterborne diseases-illness (WWDR, 2014).

The elimination of microorganisms in the wastewater through chemical method such as the addition of chlorine is less effective and may cause harm to human health. As a result, in recent years some continuous efforts have been made to develop the innovative technologies in order to remediate polluted water. Among them, photo catalysis provides a potential method because of its highly efficiency, relatively low cost, non-toxic, chemically and biologically inert and also photo stable (Ubonchonlakate et.al.,2012).

TiO_2-based photocatalysts have much attention for environmental applications such as the degradation of organic pollutants, water purification, CO_2 reduction and antibacterial applications (Li, et.al, 2003; Oveisi, et.al 2010; Pelaez, et.al., 2012; Zhao, J. Yang, X., 2003). On microorganism disinfections, TiO_2-based photocatalysts were used for viruses (Cho, et.al. 2005), bacteria (Rincón, A.G. Pulgarin, C. , 2004), fungi (Maneerat, C. Hayata, Y., 2006), algae (Peller, et.al., 2007), and protozoa (Aruja, 2015). In order to enhance the photocatalytic activity of TiO_2, many different modification methods have been studied, such as coupled of TiO_2 with semiconductor having lower band gap energy (Hirai,T.,et.al., 2001), metal-ion implanted TiO_2 (Stepanov, A.L., 2012), reduced TiOx photo catalysts (Ihara, T. Et.al, 2001), non-metal doped TiO_2 (Di Valentin, C. Pacchioni, G., 2013), and sensitizing of TiO_2 with dyes (Lee, C.Y. Hupp, J.T.,2010).

This study utilized Fe_3O_4 as a dopant that has lower band gap energy and also serves to control the anatase crystal phases of TiO_2. It is responsible for the photo catalyst activity. The material was also modified by addition of bentonite to serve as the support material to help the bacterial adsorption on to the photocatalyst surfaces. It was assessed that the combination of TiO_2-Fe_3O_4-bentonite can generate a better capability of photodegradation of dyes (Widi, et al, 2015). During photocatalysis, the reaction initiates with UV irradiation of the semiconductor. The semiconductor metal oxide can excite an electron from the filled