Contents lists available at SciVerse ScienceDirect

Chemical Engineering Research and Design

journal homepage: www.elsevier.com/locate/cherd

Photolytic treatment of organic constituents and bacterial pathogens in secondary effluent of synthetic slaughterhouse wastewater

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ABSTRACT

The reduction and degradation of total organic carbon (TOC) and bacteria from a secondary effluent of synthetic slaughterhouse wastewater using vacuum-ultraviolet (VUV) and ultraviolet-C (UV-C) processes and their combination (UV-C/VUV and VUV/UV-C) were investigated. The TOC removal rates under continuous mode operation ranged from 5.5 to 6.2%. In addition, the treatment with the UV-C/H_2O_2 and VUV/H_2O_2 processes under continuous mode operation doubled the TOC removal rates 10.8 and 12.2%, respectively. The optimum molar ratio of H_2O_2/TOC was found to be 2.5 and 1.5 for the UV-C and VUV processes, respectively. It was observed that all photochemical processes were able to totally inactivate different strains of bacteria with concentrations up to 10^5 CFU/mL within 27.6 s. Finally, a kinetic model was developed to simulate the TOC degradation from a secondary effluent of synthetic slaughterhouse wastewater.

Keywords: Slaughterhouse wastewater; Secondary effluent; Advanced oxidation processes; AOP; Vacuum-UV; Total organic carbon; Combined processes

1. Introduction

Human activities such as industrial and agricultural production as well as urbanization are the principal sources of water pollution. Globally, significant amounts of hazardous organic materials and pathogenic microorganisms are discharged into receiving waters daily. With the increased societal awareness of the importance of water, a mandate for clean water sources is being supported by new and more stringent regulations (Oller et al., 2011). Such regulatory pressure is driving the development of new purification technologies in the field of water and wastewater treatment.

Slaughterhouse facilities use vast volumes of fresh water daily for numerous cleaning procedures, including carcass blood washing, equipment sterilization, and work area cleaning (Wang et al., 2006). In fact, more than 65% of the water used in slaughterhouses can be attributed to cleaning, spraying, and rinsing activities. The remaining 35% is associated with the personal hygiene, cooling water scald tank, tool sterilization, and animal handling facilities and vehicles washing (Wang et al., 2005). As a result, high loads of organic content are present in slaughterhouse wastewater effluents. In addition to the high level of organic compounds, pathogenic microorganisms such as *Escherichia coli* O157:H7, *Shigella* spp.,

Abbreviations: AOPs, advanced oxidation processes; COD, chemical oxygen demand; CFU, colony forming unit; CFD, computational fluid dynamics; DBPs, disinfection by-products; GPM, gallons per minute; HAAs, haloaacetic acids; HRT, hydraulic retention time; LPM, liters per minute; LVREA, local volumetric rate of energy absorption; TOC, total organic carbon; THMs, trihalomethanes; U.S. EPA, U.S. Environmental Protection Agency; WHO, World Health Organization.

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Received 1 March 2011; Received in revised form 11 November 2011; Accepted 25 November 2011
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doi:10.1016/j.cherd.2011.11.018