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THE POTENTIAL OF ULTRASONIC MEMBRANE ANAEROBIC SYSTEM (UMAS) IN TREATING SLAUGHTERHOUSE WASTEWATER

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ABSTRACT

In the wake of energy crisis and the drive to reduce CO_2 emissions, the alternative energy sources are much demanded in order to reduce energy consumption, to meet legal requirements on emissions, and for cost reduction and increased quality. The direct discharge of slaughterhouse wastewater causes serious environmental pollution due to its high chemical oxygen demand (COD), Total suspended solids (TSS) and biochemical oxygen demand (BOD). The conventional ways for slaughterhouse wastewater treatment have both economic and environmental disadvantages. In this study, ultrasonic assisted- membrane anaerobic system (UMAS) was used as an alternative, cost effective method for treating slaughterhouse wastewater. Six steady states were conducted as a part of a kinetic study that considered concentration ranges of 7,800 to 13,620 mg/l for mixed liquor suspended solids (MLSS) and 5,359 to 11,424 mg/l for mixed liquor volatile suspended solids (MLVSS). Kinetic equations from Monod, Contois and Chen & Hashimoto were employed to describe the kinetics of slaughterhouse treatment at organic loading rates ranging from 3 to 11 kg COD/m^3/d. The removal efficiency of COD during the experiment was from 94.8 to 96.5% with hydraulic retention time, HRT from 308.6 to 8.7 days. The growth yield coefficient, Y was found to be 0.52gVSS/g COD the specific microorganism decay rate was 0.21 d^{-1} and the methane gas yield production rate was between 0.24 l/g COD/d and 0.56 l/g COD/d. Steady state influent COD concentrations increased from 16,560 mg/l in the first steady state to 40,350 mg/l in the sixth steady state. The minimum solids retention time, $\theta_c^{\min}$ which was obtained from the three kinetic models ranged from 6 to 14.4 days. The k values were in the range of $0.35 - 0.519\ g\ COD / g\ VSS.d$ and $\mu_{\max}$ values were between 0.26 and 0.379 d^{-1}. The solids retention time (SRT) decreased from 600 days to 14.3 days. The complete treatment reduced the COD content to 2279 mg/l equivalent to a reduction of 94.8% reduction from the original.

Keywords: COD reduction, ultrasonic, kinetics, membrane, anaerobic, monod, contois equation.

INTRODUCTION

The slaughterhouse wastewaters arises from different steps of the slaughtering process such as washing of animals, bleeding out, skinning, cleaning of animal bodies, cleaning of rooms, etc. the main pollutant in slaughterhouse effluents is organic matter. The contributions of organic load to these effluents are blood, particles of skin and meat, excrements and other pollutants. Slaughterhouse wastewater is very harmful to the environment; therefore, it must be treated before it discharged. In 2011, more than 36 million tons of food waste was generated in the U.S. (U.S. EPA, 2013). Food waste has higher biochemical methane potential. An aerobic digestion of food waste not only produces methane for energy recovery, but also treats waste for environmental and social benefits (Fuchs and Drosg, 2013; Izumi *et al.* 2010; Zhang *et al.* 2013). In the cited literature, several technologies to treat slaughterhouse wastewater have been proposed; including physico-chemical methods (e.g. dilution, evaporation, sedimentation) and biological methods (e.g. aerobic pretreatment, anaerobic digestion [Paraskeva *et al.* 2006]. Effluent discharge from slaughterhouses has caused the deoxygenation of rivers [Zagklis et al, 2013] and the contamination of groundwater [Sangodoyin *et al.* 1992]. The pollution potential of meat-processing and slaughterhouse plants has been estimated at over 1 million population equivalent in the Netherlands [Sayed, 2005], and 3 million in France. Blood, one of the major dissolved pollutants in slaughterhouse wastewater, has a chemical oxygen demand (COD) of 375000 mg/l [Zhang *et al.* 2013]. Slaughterhouse wastewater also contains high concentrations of suspended solids(SS), including pieces of fat, grease, hair, feathers, flesh, manure, grit, and undigested feed. These insoluble and slowly biodegradable SS represented 50% of the pollution charge in screened (1 mm) slaughterhouse wastewater, while another 25% originated from colloidal solids [Izumi *et al.* 2010]. Typical characteristics of wastewater from slaughterhouse are given in Table-1.

Table-1. Characteristics of the wastewater from the slaughterhouses [Quinn *et al.* 1989].

Parameter	Concentration (g/l)
pH	6.8-7.8
COD	5.2-11.4
TSS	0.57-1.69
Phosphorus	0.007-0.0283
Ammoniacal nitrogen	0.019-0.074
Protein	3.25-7.86

Table-2 summarizes the performance data of digesters used for the treatment of slaughterhouse wastewater. In recent years, considerable attention has