



Integration of kinetic modeling and desirability function approach for multi-objective optimization of UASB reactor treating poultry manure wastewater

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HIGHLIGHTS

- ▶ A holistic approach is proposed for multi-objective optimization of mesophilic UASB.
- ▶ Chen–Hashimoto and Stover–Kincannon models are integrated on a composite surface.
- ▶ A bio-economic model including several technical and thermophysical data is derived.
- ▶ Inhibition parameter is derived empirically for the first time for poultry manure.
- ▶ The methodology demonstrated a useful tool with an overall desirability of 0.896.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:

Received 7 March 2012

Received in revised form 17 May 2012

Accepted 18 May 2012

Available online 26 May 2012

Keywords:

Desirability function

Kinetic modeling

Multi-objective optimization

Poultry manure wastewater

Up-flow anaerobic sludge blanket reactor

ABSTRACT

An integrated multi-objective optimization approach within the framework of nonlinear regression-based kinetic modeling and desirability function was proposed to optimize an up-flow anaerobic sludge blanket (UASB) reactor treating poultry manure wastewater (PMW). Chen–Hashimoto and modified Stover–Kincannon models were applied to the UASB reactor for determination of bio-kinetic coefficients. A new empirical formulation of volumetric organic loading rate was derived for the first time for PMW to estimate the dimensionless kinetic parameter (K) in the Chen–Hashimoto model. Maximum substrate utilization rate constant and saturation constant were predicted as 11.83 g COD/L/day and 13.02 g COD/L/day, respectively, for the modified Stover–Kincannon model. Based on four process-related variables, three objective functions including a detailed bio-economic model were derived and optimized by using a LOQO/AMPL algorithm, with a maximum overall desirability of 0.896. The proposed optimization scheme demonstrated a useful tool for the UASB reactor to optimize several responses simultaneously.

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1. Introduction

Poultry manure-related problems are one of the potential sources of many major environmental problems resulting several nuisance consequences (i.e. odor problems, release of pathogens,

eutrophication of surface water resources, groundwater contaminations, surface water runoff, deterioration of biological structure of the earth, etc.) to the environment and human health. The production of a huge amount of poultry wastes, particularly in concentrated areas, has become one of the most critical environmental concerns in recent years (Yetilmezsoy, 2008; Yetilmezsoy and Sakar, 2008a, 2008b). For this reason, urgent treatment and disposal solutions have been investigated to manage improperly

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