Ecological Engineering 134 (2019) 26–38

Contents lists available at ScienceDirect

Ecological Engineering

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

Aluminum- and iron-based coagulation for in-situ removal of dissolved organic carbon, disinfection byproducts, mercury and other constituents from agricultural drain water

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ARTICLE INFO

Keywords:
Water quality constituents of concern
Isotherms
Monod equation
Sacramento-San Joaquin Delta
Dissolved organic carbon surrogates
Hybrid wetlands

ABSTRACT

Agricultural production on wetland soils can be significant sources of dissolved organic carbon (DOC), disinfection byproduct precursors, mercury and nutrients to downstream water bodies and accelerate land subsidence. Presented as a potential solution for in-situ water quality improvement and land subsidence mitigation, chemically enhanced treatment wetlands (CETWs) were used to leverage both coagulation and wetland processes. In this study, we evaluated the performance of coagulants ferric sulfate (Fe dosing) and polyaluminum chloride (Al dosing) to remove pollutants from agricultural drain water using the coagulation system designed for CETWs. Both coagulation treatments removed over 70% DOC from source waters, resulting in removal efficiencies (mg-DOC removed per mg-metal dosed) of 1 under Al dosing and 0.5 under Fe dosing. Coagulation by both treatments preferentially removed UV254 active compounds compared to the bulk DOC concentration, suggesting coagulation targeted aromatics more effectively. Phosphates and haloacetic acids were also removed more readily, whereas trihalomethanes, dissolved organic nitrogen and filtered mercury species were removed at similar or lower rates than DOC. Dissolved inorganic nitrogen was not amenable to coagulation and removal was not observed. Freundlich, Langmuir and Monod models explained 33% of the variance in DOC removal for Al dosing and 78–89% of the variance for Fe dosing. All three models indicated Al dosing had higher removal efficiency and affinity for DOC than Fe dosing under study conditions, but when used to predict maximum removal efficiency there was no cohesiveness between the three models due to different model assumptions. Consideration of fluorescence dissolved organic matter and UV254 as surrogates for DOC concentration showed both were equally suitable before coagulant application, but as surrogates after coagulant application, neither could be deemed more fit as a surrogate since both were shown suitable for different treatment scenarios.

1. Introduction

The fertility of peatlands and readily available freshwater make agriculture a prevalent use of delta regions worldwide and within the USA (Dugan, 1990; Wood and van Halsema, 2008). However, agriculture often results in degraded water quality and land subsidence in

Abbreviations: CETW, chemically enhanced treatment wetland; Cl, chloride; Co, control; DAl, dissolved aluminum; DFe, dissolved iron; DIN, dissolved inorganic nitrogen; DOC, dissolved organic carbon; DOM, dissolved organic matter; DON, dissolved organic nitrogen; DBP, disinfection byproduct; DBPP, disinfection byproduct precursor; Delta, Sacramento-San Joaquin Delta; EC, electrical conductivity; FDOM, fluorescent dissolve organic matter; FMeHg, filtered fraction of methylmercury; FTHg, filtered fraction of total mercury; HAA, haloacetic acid; PAC, polyaluminum chloride; PMeHg, particulate fraction of methylmercury; PTHg, particulate fraction of total mercury; Removal efficiency, mg of DOC removed per mg of metal dosed; Removal ratio, WQCC % removal divided by DOC % removal; TAl, total aluminum; TDN, total dissolved nitrogen; TFe, total iron; THg, total mercury; THM, trihalomethane; TMeHg, total methylmercury; TSS, total suspended solids; TTHg, combined fractions of particulate and filtered THg; UV254, absorbance at 254 nm; WQCCs, water quality constituents of concern

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https://doi.org/10.1016/j.ecoleng.2019.02.015
Received 28 August 2018; Received in revised form 14 January 2019; Accepted 15 February 2019
Available online 09 May 2019