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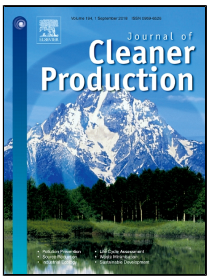

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PII:	S0959-6526(18)31993-0
DOI:	10.1016/j.jclepro.2018.07.026
Reference:	JCLP 13480
To appear in:	*Journal of Cleaner Production*
Received Date:	22 December 2017
Accepted Date:	03 July 2018

Please cite this article as: Zhe Cui, Wende Tian, Hua Qin, Xue Wang, Wenying Zhao, Optimal Design and Control of Eastman Organic Wastewater Treatment Process, *Journal of Cleaner Production* (2018), doi: 10.1016/j.jclepro.2018.07.026

The number of words in this manuscript is 8165.

Optimal Design and Control of Eastman Organic Wastewater Treatment Process

Zhe Cui[a], Wende Tian[a,*], Hua Qin[b], Xue Wang[a], Wenying Zhao[a]

[a] College of Chemical Engineering, Qingdao University of Science & Technology, 266042 Qingdao, China.

[b] Blue Diamond International Co., Ltd, 100016 Beijing, China.

*Corresponding author, Email: tianwd@qust.edu.cn, Tel: 86-532-84022750.

ABSTRACT

The Eastman process discharges a wastewater stream with high organic contents. Its chemical oxygen demand (COD) and flowrate are up to 60000 mg/L and 1011 kg/h, respectively. The ecological environment will be polluted severely in case of an inappropriate disposal of this wastewater. This paper proposes a novel "waste control by waste" strategy to dispose of such a wastewater with a combination of modeling and experiment methods. First, several possible schemes are simulated and evaluated with Aspen Plus software. One scheme that employs internally synthesized 2,2,4-trimethyl-1,3-pentanediol di-isobutyrate (TXIB) to extract organics is chosen because it can alleviate the recovery problems of solvent. The simulation of this scheme shows a mass fraction increase of water in disposed wastewater from 96.941% to 98.572%. Second, experiments concerning extraction and reaction are performed to obtain the requisite parameters for simulation. The optimum operating conditions for extraction column are obtained: room temperature and pressure, the number of trays is 8, the flowrate of extractant is 350 kg/h. The optimum operating conditions for esterification reaction are obtained: reaction time is 3.5 h, catalyst concentration is 8% and reaction temperature is 130 ^{o}C. Finally, the importance of each variable in the wastewater treatment process is evaluated based on complex network theory, and two variables comprised of recycle extractant flow and reactor temperature are selected accordingly. One control scheme is proposed based on selected key variables after its anti-disturbance ability is verified with Aspen Dynamics software.

Keywords: Organic pollutants, Biological degradation, Physical-chemical degradation, Eastman process

1. Introduction

With an increasing development of chemical industry, the discharge of waste gas, water and solid makes the environment polluted seriously (Alwan et al., 2017). Wastewater management faces serious challenges over the last decade due to emerging global threats such as climate change, urbanization, and resource depletion. Without effective wastewater treatment approaches, the water supply service will be seriously challenged by future environment requirements (Butler et al., 2017). At present, more than 420 billion m^3 of sewage is discharged into rivers, lakes and seas in the world every year, polluting 5.5 trillion m^3 of fresh water (Burns et al., 2018). At the same