Chemical Engineering Journal 215–216 (2013) 136–143

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Phosphorus removal and simultaneous sludge reduction in humus soil sequencing batch reactor treating domestic wastewater

Min Wu [a,*], Rui Zhu [b,*], Heguang Zhu [c], Xiaohu Dai [d], Jian Yang [a]

[a] State Key Laboratory of Pollution Control and Resources Reuse, Tongji University, Shanghai 200092, PR China
[b] Shanghai Academy of Environmental Sciences, 508 Qin Zhou Road, Shanghai 200233, PR China
[c] Cestoil Chemical Inc., 251 Consumers Road, Toronto, Ontario, Canada M2J 4R3
[d] National Engineering Research Center for Urban Pollution Control, Tongji University, Shanghai 200092, PR China

HIGHLIGHTS

- The HS-SBR process achieved phosphate removal and simultaneous sludge reduction.
- The percentage of PAOs in the HS-SBR was much higher than that in the cSBR.
- The growth of GAOs was repressed in the HSR.
- The PHAs synthesis in the hsSBR was much lower than that in the cSBR.

ARTICLE INFO

Article history:
Received 24 May 2012
Received in revised form 21 October 2012
Accepted 14 November 2012
Available online 23 November 2012

Keywords:
Humus soil
Sludge reduction
Enhanced biological phosphorus removal
Polyphosphate accumulating organisms
Glycogen accumulating organisms

ABSTRACT

The potential for enhanced biological phosphorus removal (EBPR) and simultaneous sludge reduction in humus soil sequencing batch reactor (HS-SBR) was investigated. The HS-SBR was composed of a humus soil reactor (HSR) and a conventional SBR (designated as hsSBR to differentiate from the conventional SBR used as a control). The observed sludge yield in the HS-SBR process was estimated to be 0.18 mg MLVSS (mixed liquor volatile suspended solid)/mg SCOD (soluble chemical oxygen demand), which represented a 24% reduction of solids production compared to a conventional SBR (cSBR) process. Meanwhile, the phosphorus removal in the HS-SBR remains unchanged compared with that in the cSBR. Intensive monitoring of SBR performance showed that polyhydroxy-alkanoates synthesis in the hsSBR was lower than in the cSBR. FISH analysis showed that the percentage of polyphosphate accumulating organisms (PAOs) in the hsSBR was much higher than that in the cSBR. These observations revealed the mechanism of phosphorus removal and simultaneous sludge reduction in the HS-SBR process. The role played by HSR in this process, especially on the reduction of glycogen-accumulating organisms (GAOs), was also explored and discussed.

1. Introduction

Enhanced biological phosphorus removal (EBPR) is a sustainable process for removing phosphorus from wastewater [1,2]. Like conventional activated sludge process, EBPR produces a large amount of excess sludge. The treatment of excess sludge is expensive and may account for 25–65% of the plant operation cost [3]. Moreover, ultimate disposal of the excess sludge through conventional methods, such as land application and landfill, may be limited by the scarcity of land or the risk to human health due to the hazardous matter contained, i.e. heavy metals, pathogens, and persist organic pollutants. Hence, it is desirable to have treatment methods which can couple the sludge reduction and nutrient removal, such that in EBPR.

During EBPR, the group of polyphosphate accumulating organisms (PAOs) is largely responsible for phosphorus removal. During the anaerobic phase, PAOs use mostly volatile fatty acids (VFAs) as carbon sources, and store them in the form of polyhydroxy alkanoates (PHAs). The energy required is primarily gained from the hydrolysis of their intracellular substances such as poly-phosphate (poly-P) and glycogen (Gly). During the aerobic phase, PAOs utilize the stored PHAs to take up phosphorus and generate intracellular poly-P. In addition, PHAs is also used as energy and carbon sources for storing the Gly pool for biomass growth and maintenance requirements [1].

* Corresponding authors. Tel./fax: +86 21 65984275.
E-mail addresses: wenyaowen@sina.com (M. Wu), zhurui860204@sina.cn (R. Zhu).

1385-8947/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.cej.2012.11.066