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Electrochemical treatment of industrial wastewater using a novel layer-upon-layer bipolar electrode system (*n*LBPEs)

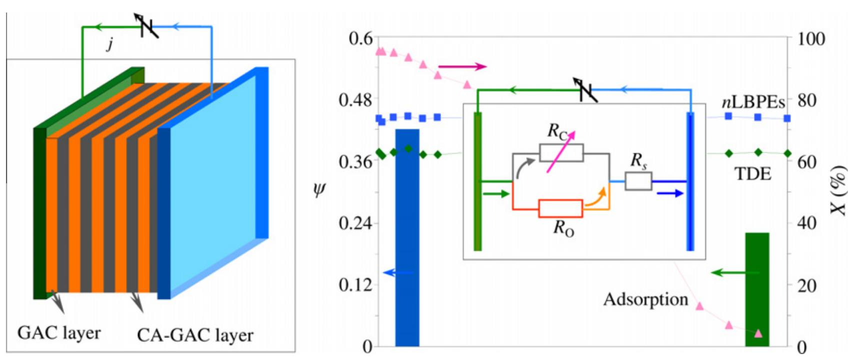
Lizhang Wang [a,*], Yunlong Hu [a], Peng Li [a], Yanle Zhang [a], Qian Yan [a], Yuemin Zhao [b,*]

[a] *School of Environment Science and Spatial Informatics, China University of Mining and Technology, Xuzhou City, Jiangsu 221008, PR China*
[b] *School of Chemical Engineering and Technology, China University of Mining and Technology, Xuzhou City, Jiangsu 221008, PR China*

HIGHLIGHTS

- ▶ A novel layer-upon-layer bipolar electrode system (*n*LBPEs) is developed.
- ▶ The economically prepared CA-GAC as insulating layer can avoid short circuit current.
- ▶ The *n*LBPEs can enhance electrochemical performance compared with traditional TDE.
- ▶ The obtained ψ parameter can guide proper selection of packed materials to OM kinds.
- ▶ The *n*LBPEs shows broad applicability for industrial wastewater treatment.

GRAPHICAL ABSTRACT



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ABSTRACT

A novel layer-upon-layer bipolar electrode system (*n*LBPEs) possessing the ability of increasing space–time yields was developed for efficient treatment of industrial wastewaters. The cellulose acetate coated granular activated carbon (CA-GAC) was used as insulating layer to avoid short circuit current, which could effectively enhance the electro-oxidation. In addition, the excellent performances of the *n*LBPEs are theoretically described by introducing the fraction of current applied to particulate electrode, ψ, which relies on the characteristics of carbon particles, organic matters (OMs) and solutions. The kinetics could provide proper preparation and selection of the filings in accordance with the characteristics of OM. Moreover, the presented *n*LBPEs is superior to the conventional three dimension electrode and shows broad interests and perfect performances in different kinds of industrial wastewater treatment.

1. Introduction

For environmental approaches, several porous materials, such as copper bead, kaolin or carbon are usually packed into electrode gaps to increase space–time yield due to their bipolarity in high gradient electric field [1–3]. This process, so-called three dimension electrode (TDE) proposed in 1960s [4,5] is used for metal recovery (electro-reduction) [6] and removal of organic matter (OM) (electro-oxidation) [7,8]. High removal efficiency and current yield could be achieved yielding this way [9,10]. However, aiming to avoid short circuit current, a membrane arranged between the anodic and cathodic compartments is frequently required [11–13], causing not only the increase of capital investment but also the difficulty in preventing membrane fouling. Although this problem could be eliminated by directly packing these materials into electrode gaps [14,15], low space-time yield, especially carbon saturation (if carbon was used) would commence for the short circuit of the electrodes [16,17]. Many efforts have been devoted to the

* Corresponding authors. Tel.: +86 0516 83591320; fax: +86 0516 83591329 (L. Wang), tel.: +86 516 83590092; fax: +86 516 83885455 (Y. Zhao).
E-mail addresses: wlzh0731@126.com (L. Wang), ymzhao@cumt.edu.cn (Y. Zhao).

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