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A new approach for rhenium(VII) recovery by using modified brown algae *Laminaria japonica* adsorbent

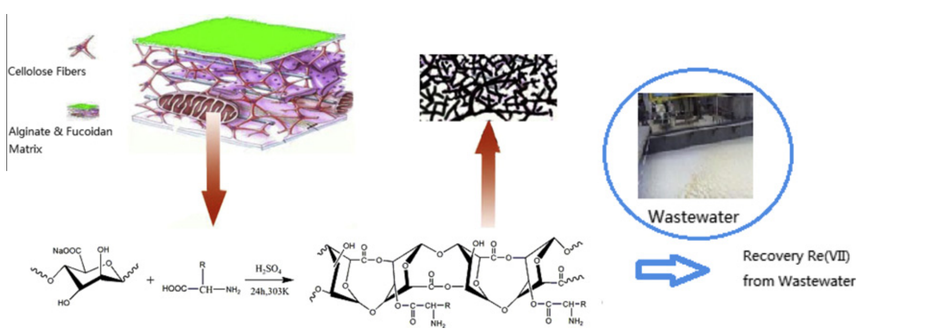
Ying Xiong *, Jia Xu, Weijun Shan *, Zhenning Lou, Dawei Fang, Shuliang Zang, Guangxi Han

College of Chemistry, Key Laboratory of Rare-scattered Elements of Liaoning Province, Liaoning University, Shenyang 110036, PR China

HIGHLIGHTS

- ▶ A low cost brown algae *Laminaria japonica* biosorbent treated by H_2SO_4 was developed.
- ▶ The novel adsorbent exhibited a high affinity for Re(VII) comparing with other biomass gel.
- ▶ Several models were applied to obtain kinetics and equilibrium parameters.
- ▶ The recovery of Re(VII) from Re-containing wastewater was possible.

GRAPHICAL ABSTRACT



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ABSTRACT

Brown algae *Laminaria japonica* was chemically modified with sulfuric acid to obtain a crosslinked brown algae gel (CAS). The CAS gel showed a high affinity for Re(VII) comparing with other biomass gels, and the maximum adsorption capacity was evaluated as 37.20 $mg\,g^{-1}$ in case of pH 6, which could be explained by their different adsorption mechanisms. The adsorption equilibrium, kinetics and thermodynamic study for Re(VII) on the CAS gel was discussed in detail by the several models, such as Langmuir, Freundlich, Temkin and Dubinin–Radushkevich model for kinetics analysis, the pseudo first, the second-order, the Elovich and intraparticle diffusion equation for equilibrium analysis. Reutilization of the CAS gel was confirmed up to three adsorption–elution cycles in column-mode operation with no damage of gel, packed in the column. The result also provides a new approach for the recovery of Re(VII) from Re-containing wastewater by using the modified brown algae gel.

1. Introduction

Rhenium, the rare and valuable metal, has been widely used mainly in oil refinery industries and high temperature alloy productions, for example, platinum–rhenium catalysts and high-temperature superalloys for jet engine components (Magyar, 2006). In addition, rhenium does not occur naturally and no mine-able ore has been found either. It always exists in pegmatites, molybdenites and rocks altered by pneumatolysis (Sutulov, 1970). In general, it is difficult to recovery rhenium from an actual aqueous system, because of its low concentration and coexisting metal ions complexity.

Because of the higher value of rhenium, the recovery of rhenium from the fumes and solution has both economic and environmental benefits. For this purpose, a number of solvent extraction reagents, ion exchange materials and adsorbents have been reported to be developed out of which some are commercially employed at present (Karagiozov and Vasilev, 1979; Lan et al., 2006; Mashkani et al., 2009; Ogata et al., 2009; Xiong et al., 2008; Yamini et al., 2008; Zhang et al., 1993). Recently, low cost adsorbents materials from forestry, fishery and agriculture have attracted much attention to several workers. Some of the reported sorbents include hybrid sludge, wheat straw, sawdust, titanium carbide ceramics, crab shell, cornstarch, coal fly ash, rice husk, orange waste and biological

* Corresponding authors. Tel.: +86 24 62202006.
E-mail addresses: xiongying_1977@hotmail.com (Y. Xiong), shanwj@lnu.edu (W. Shan).

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