Desalination and Water Treatment 317 (2024) 100181

Contents lists available at ScienceDirect

Desalination and Water Treatment

journal homepage: www.sciencedirect.com/journal/desalination-and-water-treatment/

Removal of eutrophication agents from wastewater using glauconite-based sorbents

Kateryna Stepova[a], Iryna Fediv[a,*], Aušra Mažeikienė[b], Vasyl Kordan[c], Dainius Paliulis[b]

[a] Department of Environmental Safety, Lviv State University of Life Safety, 35 Kleparivska str., 79000 Lviv, Ukraine
[b] Department of Environmental Protection and Water Engineering, Faculty of Environmental Engineering, Vilnius Gediminas Technical University, Saulėtekio al. 11, Vilnius 10223, Lithuania
[c] Department of Inorganic Chemistry, Ivan Franko National University of Lviv, Kyryla i Mefodiya St. 6, 79005 Lviv, Ukraine

ARTICLE INFO

Keywords:
Glauconite
Adsorption
Eutrophication agents
Water pollution
Thermal treatment
Microwave irradiation

ABSTRACT

Excessive phosphorus and nitrogen in water and sediment may cause eutrophication, which poses a potential risk to drinking water safety and the sustainability of aquatic ecosystems. The research focuses on the removal of phosphates and ammonium ions from aqueous solutions using a new thermally and microwave-treated glauconite. The surface morphology of the samples was studied by SEM. BET surface area, pore volume, and pore size distribution were measured. Adsorption studies were carried out in static and dynamic conditions. The best fit for adsorption of both pollutants is given by the Langmuir-Freundlich and BET models. The calcined sample showed the lowest adsorption capacity for phosphate (1.78 mg/g) but the highest capacity for ammonium (20.67 mg/g). For the microwave-irradiated sample, the adsorption capacity for ammonium increases from 0.723 to 4.37 mg/g, while that for phosphate remains almost at the same level (101.21 mg/g). In dynamic conditions, phosphorus was most efficiently retained by natural glauconite (more than 60% retention rate), and ammonium nitrogen by glauconite that was thermally treated in a muffle furnace (more than 80% retention rate after 3 h).

1. Introduction

Water pollution is one of the main environmental issues that has released contaminating substances into freshwater bodies or groundwater [1]. Natural water sources are polluted by untreated or insufficiently treated wastewater [2]. A variety of methods and technologies are developed for wastewater treatment. Usually, wastewater is treated using activated sludge microorganisms or chemical reagents. Conventional methods effectively remove organic matter from wastewater, but it is not possible to remove phosphorus completely [3]. Nitrogen is another threatening biogenic element that escapes into the environment with wastewater [4]. In recent years, there has been a significant focus on the advancement of new technologies for environmental protection [5–8]. Excessive P and N in water and sediment can cause eutrophication, which poses a potential risk to drinking water safety and the sustainability of aquatic ecosystems [5]. Effective removal of phosphorus and nitrogen from wastewater is therefore a key strategy to control eutrophication. The final stage of technological processes should be additional treatment with sorbent materials [9]. Adsorption is the most widely used technology for wastewater treatment [6,10–13]. The simplicity of design, speed, efficiency, and profitability determine the wide use of sorbents [14]. Commercially available sorbents are rather expensive, which significantly limits the range of their application areas [15]. In this context, natural clay mineral adsorbents can be used as an alternative [14]. Natural adsorbents are inexpensive, environmentally friendly, and available in large quantities [7,13]. Natural silicates possessing high adsorption, ion exchange, and catalytic characteristics deserve special attention [15–18]. Often, nitrogen in wastewater is in the ammonium form, so it can be removed by ion exchange. Ammonium ions are effectively removed from water or wastewater by zeolites [19,20]. Most clay minerals produce a net negative surface charge due to the isomorphic substitutions of Si (IV) by Al (III) or Fe (III) [1]. Iron-based materials exhibit high efficiency for P immobilization due to their strong affinity with P [5]. The Fe-rich sorbents can effectively immobilize P in sediment under oxic conditions through adsorption and/or precipitation [8,21]. However, not all natural clays are suitable for wastewater treatment. Bauxite and olivine are not applicable due to the presence of significant amounts of lead and/or nickel [22]. Natural sorbents, which include glauconite, are of great interest for wastewater treatment. It can

* Corresponding author.
E-mail address: ira.arnaut94@gmail.com (I. Fediv).

https://doi.org/10.1016/j.dwt.2024.100181
Received 3 February 2024; Received in revised form 3 February 2024; Accepted 7 February 2024