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Removal of Arsenic from Synthetic Acid Mine Drainage using Mn-Fe Layered Double Hydroxide Adsorbent

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Abstract

The Mn-Fe layered double hydroxide using chloride in the interlayer anion was successfully synthesized using chemical co-precipitation methods. The Mn-Fe LDH was then applied as adsorbent for arsenic removal from synthetic acid mine drainage. The adsorbent characterizations of SEM and XRD analysis showed that the Mn-Fe LDH had many different functional groups and a high specific surface area for the adsorption processes. The morphological structure of Mn-Fe LDH by the SEM-EDS analysis method shows a round shape structure with a particle size of about 1 μm, and the XRF analysis method shows that the Mn and Fe elements dominate more than other components. Batch adsorption experimental conducted using the Mn-Fe LDH with the interlayer anion of chloride as an adsorbent to study the effect of contact time, equilibrium pH, and temperature on the arsenic removal. The Mn-Fe LDH showed high adsorption uptake capacity and selectivity for the arsenic in the synthetic acid mine drainage. The adsorption and ion exchange between interlayer chloride anions in Mn-Fe LDH and As (V) solution was the main adsorption mechanism. Therefore, the Mn-Fe LDH can be used as an adsorbent in water and wastewater treatment. In contrast, this research has the potential to be processed and developed into advanced materials.

Keywords: adsorption, acid mine drainage, co-precipitation, Mn-Fe LDH, wastewater treatment

1. Introduction

Acid mine drainage (AMD) is water generated from mining activities with a deficient pH level due to oxidation of sulfide minerals such as pyrite, which have resulted in a high concentration of dissolved sulfate and heavy metal contamination of surface and groundwater (Acharya and Kharel, 2020, Otgonjargal *et al.,* 2012, Ryu *et al.,* 2020). The AMD has a real impact on mining activities, including runoff and infiltration from mine rock, and it is still a problem that arises in the community due to the high contamination of dissolved sulphate content and heavy metals contamination such as As, Cd, Co, Cu, Ni, Pb, Zn and other metals dissolved in it (Kefeni *et al.,* 2017, Ryu *et al.,* 2020). The AMD has a negative impact on water quality both during mining and post-mining activities. South Kalimantan has many coal and mineral mining activities, which have resulted in the AMD impacts, including polluting community wells living around the mining area. The community's well water is used to meet the needs both for bathing and for consumption as drinking water. The continuous use and consumption of polluted water due to AMD's impact causes these metals to be directly absorbed on the skin and accumulate in the body so that it can cause various health problems such as skin diseases, indigestion, and even the worst-case cause paralysis. In the AMD containing-As, As found as the inorganic oxyanions forms As (III) and As (V), whereas: As (III) is more harmful than As (V), and its removal is more complicated (Liu *et al.*, 2019, Otgonjargal et al., 2012, Suvokhiaw *et al.,* 2016).

The World Health Organization (WHO) devalued the standard for arsenic in drinking water to 0.01 mg/L. As (V) can be easily eliminated by adsorption technology using adsorbents, but it is difficult to remove As (III) by adsorption processes, and therefore, As (III) requires oxidation before adsorption (Liu *et al.*, 2019, Mohan and Pittman, 2007, Otgonjargal *et al.,* 2012, Suvokhiaw *et al.*, 2016). There are many methods of removing As (V); among them, the adsorption method is regarded as high efficiency, relatively cost-effective technology, and minimum generation of toxic sludge for water treatment (Barrera *et al*., 2017, Liu *et al*., 2019, Núñez-Gómez *et al*., 2019, Otgonjargal *et al.*, 2012,