ABSTRACT

Fly ash is a by-product of coal combustion from steam power plants (PLTU) that is generated in large quantities and contains approximately 32.2% silica (SiO_2). This silica content has the potential to be utilized as a raw material for the synthesis of silica xerogel, which possesses a porous structure, high specific surface area, and excellent adsorption capability toward heavy metal ions. This study aimed to synthesize silica xerogel from fly ash using the sol–gel method, characterize pure silica xerogel, polyethylene glycol (PEG)-modified silica xerogel, and milled silica xerogel, and evaluate the adsorption performance of these materials toward Pb(II) ions. The sol–gel method was selected because it is capable of producing a homogeneous silica structure with controlled porosity. Pure silica xerogel was obtained through oven drying, whereas PEG modification was carried out using polyethylene glycol as a template agent, which was subsequently removed by calcination to produce a more well-defined porous structure. The milling treatment was performed to reduce particle size and increase the active surface area of the material. Characterization was conducted using X-Ray Fluorescence (XRF), Fourier Transform Infrared Spectroscopy (FTIR), and Gas Sorption Analysis (GSA). The Pb(II) adsorption study was carried out at initial concentrations ranging from 20 to 140 mg/L with a contact time of 1 hour, while the final Pb(II) concentrations were determined using an Atomic Absorption Spectrophotometer (AAS). The results showed that all samples were successfully synthesized as white powders containing the characteristic Si–O–Si and O–H functional groups. In the PEG-modified silica xerogel, the Si–OH stretching vibration was not detected, indicating an interaction between PEG and the silica surface. GSA analysis revealed that pure silica xerogel exhibited the highest specific surface area (75.462 m^2/g), followed by PEG-modified silica xerogel (10.682 m^2/g) and milled silica xerogel (3.358 m^2/g). The largest pore volume was also observed for pure silica xerogel (0.194 cm^3/g). The highest Pb(II) adsorption capacity was achieved by pure silica xerogel (34.913 mg/g), followed by milled silica xerogel (34.550 mg/g) and PEG-modified silica xerogel (33.374 mg/g). These findings indicate that structural modification through PEG addition and milling affects the pore characteristics and adsorption performance of the silica xerogel materials.

Keywords: Fly Ash, Silica Xerogel, PEG, Milling, Pb(II) adsorption.