Optimization of lead ions adsorption on hydrolyzed polyacrylonitrile fibers using central composite design

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Abstract
Optimization of lead ions ($Pb^{2+}$) adsorption on the hydrolyzed polyacrylonitrile (PAN) fibers was reported by using statistical approach. Electrospinning of PAN solutions in dimethylformamide (DMF) was performed with different concentrations. The electrospun fibers, with various diameters, were then hydrolyzed in a sodium hydroxide solution (NaOH) for different reaction times and temperatures. Response surface methodology (RSM) helped optimizing the hydrolysis reaction conditions to maximize the adsorption capacity of the PAN fibers. The maximum value of adsorption capacity was experimentally determined to be 141 mg/g with the optimized values of hydrolysis reaction time, temperature and fiber diameter being 61.6°C, 82.1 min and 280 nm, respectively. The as-prepared electrospun fibers, hydrolyzed fibers and fibers after adsorption process were characterized by scanning electron microscope (SEM). Experimental adsorption data fit very well with the Langmuir isotherm model. It was found that Pb$^{2+}$ ions adsorption on the nanofibers was 20 times higher than that on microfibers under the same conditions. Adsorption kinetics followed the second order kinetics model.

Keywords: Nanofibers; Hydrolysis; Polyacrylonitrile; Central composite design; Adsorption; Lead ion