Adsorption Potential of Modified Laterite-Based Nanomaterials for Fluoride Removal from Aqueous Solution

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Fluoride (F) is a persistent and non-biodegradable pollutant that accumulates in soil, flora, fauna, and human beings. It is most commonly found in groundwater and is considered to be one of the major environmental toxicological risks globally. Using small amounts of fluoride (<0.5 mg L-1) is good for dental health as it helps prevent tooth decay. However, having too much fluoride (>1.5 mg L-1) can harm teeth and bones, and may lead to other health issues. Globally modified natural minerals have been used for the removal of fluoride. In order to provide an affordable low-tech solution, local deposits of natural rock, such as laterite rich in iron and aluminum oxides, can be a less expensive alternative. Heat treated (HT), chemically treated (CT) and untreated laterite (RL) based nanomaterials have been used with different concentrations viz., 0, 1, 2, 5, 10, 20, 50 and 100 mg L-1 of F in 5 g of the adsorbent in 50 mL of the adsorbate solution. To see the effect of contact time, 5-gram sorbent has been added with 100 mg L-1 of F and then the contents were shaken on a reciprocating shaker for time intervals of 10, 30, 60, 120 and 180 minutes, respectively. Separately, experiments have been carried out at varying pH of 3, 5, 7 and 10 using 5 g of sorbent and 100 mg L-1 of F adsorbate solution. Likewise, effect of adsorbent dose has been tested using multiple doses of adsorbent like 0, 1, 2, 3, 4 and 5g in 50 ml of 100 mg L-1 solution of F. Batch experiment data was fitted to Langmuir and Freundlich adsorption models. Freundlich model fits the data well with adsorption intensity, β values were 0.56 for RL, 0.54 for HT, and 0.322 for CT. The adsorption capacity, Kf values were 878 L Kg-1 for RL, 928 L Kg-1 for HT, and 267011 L

Kg-1 for CT. Treated and untreated laterite showed high removal efficiency (99%) in the pH range 3 to 10. In Case of RL no significant change in removal efficiency was observed with increase in sorbent dose whereas HT and CT showed increase in removal efficiency with increase in dose of sorbent. Result of contact time on adsorption reveals that RL removal efficiency was achieved within the 10 min, while HT and CT showed high removal efficiency when allowed for 180 minutes of a contact time. This study concludes that laterite in raw form and after heat treatment can be used as F sorbent for treating F contaminated water. The efficiency of raw laterite for removing F from contaminated water increases many folds when treated chemically. Thus, this low cost modified sorbent can be an alternative to the expensive filtration systems.