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Sorption behavior of fluoride ions on iron-magnesium-cerium tri-metal composite

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Weathering of fluoride rich rocks and industrial processes such as electroplating and glass manufacturing result in accumulation of fluoride in natural water bodies. Fluoride is an essential micro nutrient to humans and animals in many aspects namely, strengthening of bones, prevention of tooth decay, and regulating the human growth rate. The acceptable level of fluoride in drinking water is 1.5 mg/L as recommended by the World Health Organization. However, the recommended level of fluoride for tropical countries such as Sri Lanka is 1.0 mg/L. Excess amount of fluoride ions in drinking water causes health risks such as skeletal and dental fluorosis, cancers, infertility and thyroid disorder. In general, the drinking water sources in the intermediate and dry zones in Sri Lanka are rich in Fluoride. Therefore, millions of lives are at the risk of developing fluoride developing diseases. Therefore, removal of fluoride ions from drinking water has gained much attention of the research community.

A wide variety of novel adsorbents have been developed to remove fluoride ions from aqueous medium. In this work 1:1:1 ratio of tri-metal composites of Fe-Mg-Al, Fe-Mg-Zn, Al-Mg-Ce and Fe-Mg-Ce were synthesized using co-precipitation method for the removal of fluoride ions from aqueous solutions with the efficiency (the amount of fluoride ions adsorbed per unit) of 0.275±0.01, 1.496±0.259, 2.016±1.553 and 2.554±0.0079 mg/g, respectively. As reported above, the highest amount of fluoride adsorbed per unit of fluoride ions was observed for the Fe:Mg:Cetri-metallic composite. Therefore, further studies were carried out to improve its efficiency by varying the solution pH, contact time and the molar ratios of metals in the composite. The adsorption process was highly pH-dependent. The maximum amount of fluoride adsorbed per unit of the Fe-Mg-Ce tri-metal composite was determined to be 48.31 mg/g at pH 7. Rapid adsorption of fluoride was observed within the first sixty minutes and equilibrium was established within 5 hours. The fluoride removal efficiencies for Fe:Mg:Ce composites with molar ratios of 1:1:1, 1:1:2, 1:2:1 and 2:1:1 were 2.550 ± 0.008, 48.310 ± 0 .079, 17.230 ± 0.263 and 23.380 ± 0.090 mg/g at pH 7.00 respectively. These composites were further studied using FT-IR techniques and XRD.

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