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Cerium dispersed in carbon (CeDC) and its adsorption behavior: A first example of tailored adsorbent for fluoride removal from drinking water

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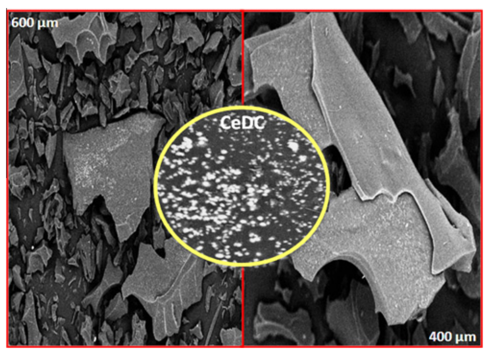
HIGHLIGHTS

- Cerium dispersed in carbon (CeDC) was prepared by carbonization of impregnated starch.
- Sorbent dose, pH and fluoride concentration influence the fluoride removal from water.
- Maximum defluoridation occurred at pH 8.07 with an uptake capacity of 52 mg g^{-1}.
- The successful regeneration of spent CeDC could be achieved.

GRAPHICAL ABSTRACT



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ABSTRACT

The present study is contributed to the removal of excess fluoride in drinking water using cerium dispersed in carbon (CeDC), a hybrid sorbent which was prepared by carbonization of ammonium cerium sulfate impregnated starch. One synthesized CeDC sample with a specific surface area of 685 cm^2 g^{-1} was investigated for its fluoride scavenging ability as the function of pH, fluoride concentration, temperature, co-ions and adsorbent dosage. The verification of various kinetic models *viz.*, Pseudo I, II order; Ritchie II order; Intra-particle diffusion and Elovich gave acceptable results. The isotherm models *viz.*, Langmuir, Freundlich, Temkin and Generalized Langmuir were also checked with the fluoride sorption process. The Langmuir sorption capacity (q_m) was found to be 209 mg g^{-1} with a high R_L value of 0.699. The maximum fluoride uptake capacity of CeDC was determined to be 52 mg g^{-1} at a pH value of 8.07. The FTIR, SEM and XRD characterization studies were carried out for CeDC material. The successful regeneration of spent CeDC was performed by an alkaline washing followed by an acidic activation. This regeneration allows the use of CeDC in a cost-effective removal of fluoride anions in drinking water.

1. Introduction

Fluorine is the most electronegative element and its gaseous form is a very powerful oxidizer. It exists naturally as fluoride ion (F^-) which is environmentally reactive. The natural abundance of fluorine ranges from 0.06% to 0.09% by weight in the earth's crust. Sources of fluoride include natural fluoride in foodstuffs and water, i.e., fluoridated water (usually 1.0 mg L^{-1}), fluoride supplements (as fluoride tablets), fluoride dentifrices (containing on average 1000 mg kg^{-1}), and professionally applied fluoride gel (containing on average mg kg^{-1}). The main source of fluoride for humans is the intake of groundwater contaminated by geological sources.

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