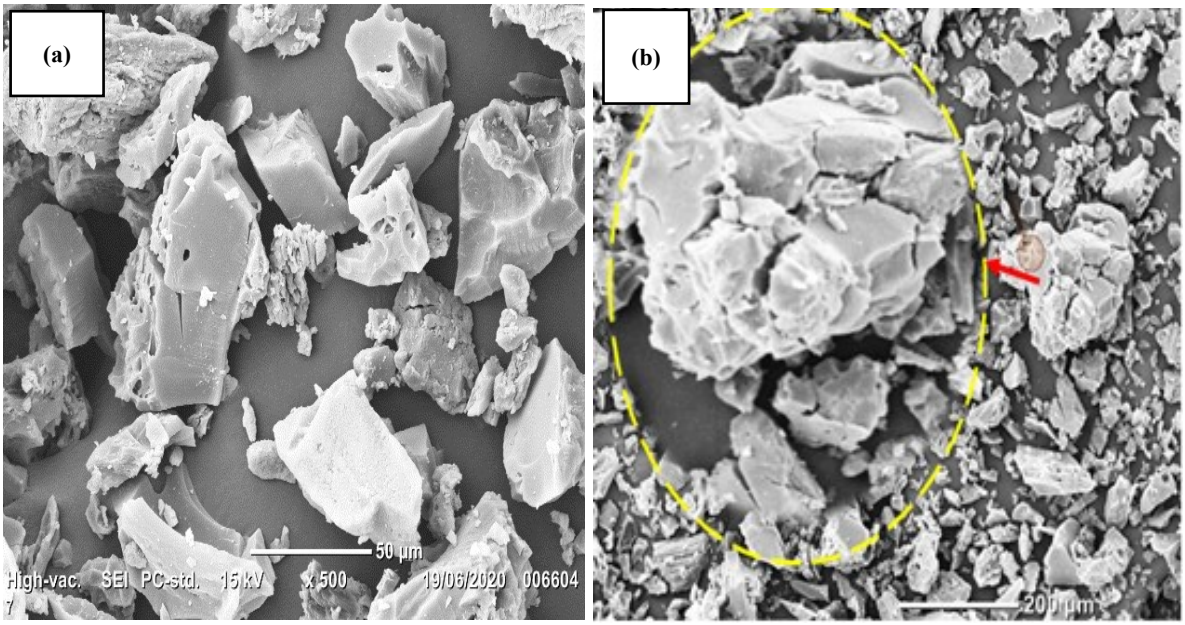

Fig. S1: SEM images of (a) AC-$Al(OH)_3$ and (b) focus on non-uniform cavities and large cracks present at the surface

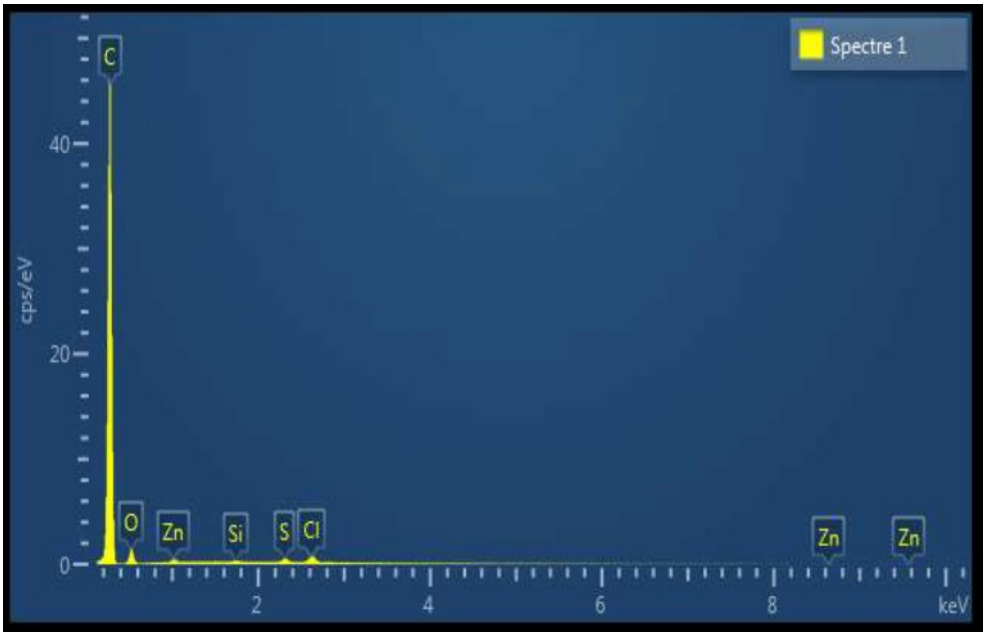

Fig. S2: EDS analysis of AC

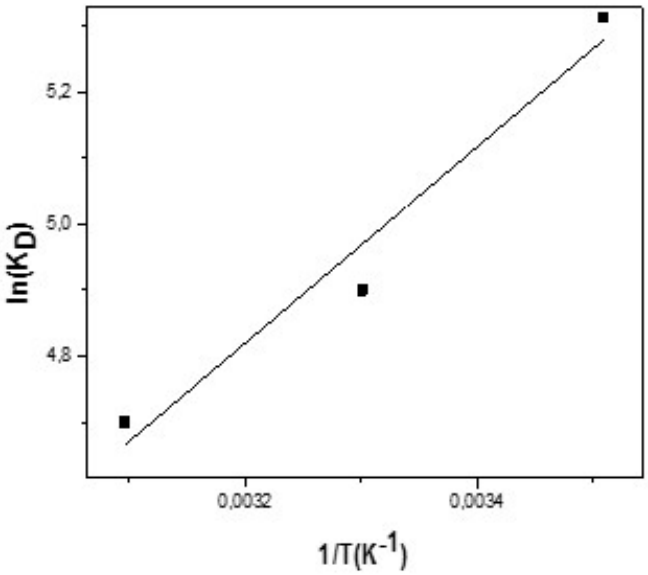

Fig. S3: EDS analysis of AC

Error Functions

There are various error functions in the literature used for the validity evaluation of the Adsorption Isotherm Models. Indeed, it is not sufficient for the analysis of isothermal data to use only the regression coefficient R2, since the results of the experiment can have a high R^2. Therefore, the result for the residue analysis must be diagnosed. In this study, the residual root mean square error (RMSE) and the Reduced Chi-squared (χ^2_{red}) were used to evaluated the fit of the isothermal equations to the experimental results. The calculated error functions have the following expressions:

$$RMSE = \sqrt{(\frac{1}{N-p})\sum_{i=1}^{N}(q_{i,\exp} - q_{i,cal})^2} \qquad (1)$$

$$\chi^2_{red} = \sum_{i=1}^{N} \frac{(q_{i,\exp} - q_{i,cal})^2}{N - P} \quad (2)$$

Where N is the number of data experimental points, p is the number of isotherm model parameters, $q_{i,exp}$ is the q_i experimental value, $q_{i,cal}$, the q_i value estimated by the isotherm model

Thermodynamic Effect of Temperature

Temperature effects on adsorption were tested using four different temperatures, including 12 mechanisms in colder or higher temperature waters. The fluoride removal at 12, 20, 30, 40 and 50 °C were 97%, 97%, 96% and 95%, respectively. Thus, the temperature does not have a significant effect on the removal of fluoride and the material produced can be utilized effectively at large temperature levels. Thermodynamic study was carried out in order to understand the feasibility of fluoride adsorption in AC-$Al(OH)_3$. Experiments were conducted at three different temperatures: 12, 20, 30, 50 °C, and the results were used to calculate the Van't Hoff plot parameters. From the experimental results, the thermodynamic parameters were calculated following the equations:

$$\ln(K_D) = \frac{-\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R} \quad (3)$$

Where ΔH° and ΔS° are enthalpy change and entropy change respectively, and were calculated from the slope and intercept of the Van't Hoff's plot by plotting ln K_D vs. 1/T. (Fig. S3), respectively. R (8.314 J/mol/K) is the universal gas constant, T is the temperature used (K) and K_d (L/g) is a constant of equilibrium calculated from the experimental results under conditions of equilibrium using the equation below:

$$K_d = \frac{q_e}{C_e} \quad (4)$$

q_e is the amount of adsorbate adsorbed on the adsorbent per liter of solution at equilibrium, C_e is the equilibrium concentration of the adsorbate in solution.

In addition,

$$\Delta G° = \Delta H° - T\Delta S° \quad (5)$$

Where $\Delta G°$ (kJ.mol^{-1}) is free energy, change was calculated using Eq. (3). The results of various thermodynamic parameters are summarized in Table S1. Table S1 reveals that $\Delta G°$ is negative for all three temperatures suggest spontaneous adsorption. The negative value of $\Delta H°$ (-3.54 kJ/mol) shows that the process of adsorption is exothermic in nature. This result also allows to include that it is indeed a physical adsorption since the value of $\Delta H°$ is less than 21 kJ/mol. However, the positive value of $\Delta S°$ indicates clearly the affinity of AC-Al(OH)$_3$ for fluoride.

Table S1. Thermodynamic parameters for fluoride adsorption on the AC-Al(OH)$_3$.

ΔS° (kJ.mol^{-1}.K^{-1})	**ΔH°** (kJ/mol)	**ΔG°** (kJ/mol)			
		285 (K)	293 (K)	303 (K)	323 (K)
0.00506	-12.364	-5.25	-13.807	-13.863	-13.899