

Table 3 — Value of kinetic parameters for Al electrode.

Current density (A/m ²)	$K \times 10^5$ $\left(\left(\frac{m^2}{A}\right)^m \left(\frac{L}{mg}\right)^{n-1}\right) min^{-1}$	m	n
17.36	1.00	0.05	2.05
34.72	1.20	0.05	2.07
52.08	1.32	0.05	2.03
69.44	1.41	0.05	2.00

Fig. 6 — Kinetics plot of F⁻ removal. Starting value of F⁻ = 50 mg/L and pH = 6.5.

kinetic equation for COD reduction from water utilizing electrocoagulation technique. It can be seen from Fig. 2 and Fig. 3 that the fluoride removal rate enhanced quickly up to initial 40 min of treatment time after that it is nearly in equilibrium. This can be attributed to the reason that in the initial 40 minutes of experiment the concentration of aluminium ion (Al³⁺) and fluoride were balanced. Later on the fluoride ion concentration decreased causing the defluoridation process to reach to equilibrium. It is clear from the kinetic plot that order of reaction is not one hence, kinetic data are evaluated by changing reaction order. The values of the kinetic variables k, n and m are calculated with the help of MATLAB toolbox. To achieve the values of different parameter, an optimization function was established by the summation of the square of errors between the model estimated and experimental fluoride concentration for whole data points of a CD. The kinetic data given in Fig. 6 might be potentially modelled by the following equation:

$$\frac{dF^-}{dt} = -kCD^{0.05}(F^-)^n \quad \dots (9)$$

It can be seen from Table 3 that, value of k, for CD (17.36–69.44) are obtained in the range of 1.00×10^{-5} to $1.41 \times 10^{-5} \left(\left(\frac{m^2}{A}\right)^{0.05} \left(\frac{L}{mg}\right)^{n-1}\right) min^{-1}$ and the value of n lied from 2.00 to 2.07. It is found that the model (Eq. 9) the experimental values and predicted values of F⁻ concentration for all CDs fitted well as shown in Fig. 6.

Conclusion

The usage of aluminium as a self sacrificing electrode and its consequence on defluoridation during electrocoagulation treatment has been investigated. The EC technique is found quite fruitful and useful for the defluoridation of the laboratory prepared fluoride solution. The result of various operating parameters such as pH 6.5, CD 34.72 A/m² and treatment time 50 min are found optimum. Maximum F⁻ removal 85.2% is achieved for starting F⁻ concentration of 50 mg/L. The F⁻ concentration can be decreased from its starting concentration of 10 mg/L to 1.5 mg/L, which is acceptable as per WHO norms. Other higher concentrations are not reduced to such limit which entails further treatment. The process could be effective in treating low concentration of fluoride in the water to get it reduced to WHO acceptable limits.

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Conflict of interest

Authors of manuscript entitled, “Defluoridation of water by electrocoagulation using Aluminium electrode,” reveal that there are no clash of interest for this work.

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