A GREEN METHOD FOR PREPARING ROBUST AND SUSTAINABLE CELLULOSE-POLYANILINE BASED NANOCOMPOSITE FOR EFFECTIVE REMOVAL OF FLUORIDE FROM WATER AND A PURIFIER THEREOF

IITM Technology Available for Licensing

Problem Statement

- Natural fluoride (F^-) content of water between 1 to 1.5 mg/L is essential for good dental health. However, **higher fluoride content of 1.5-4 mg/L can lead to dental and skeletal fluorosis** which effects over 200 million people across the globe.
- **Conventional methods** of using alumina-based coagulants, membrane technology and electrocoagulation either **leave an unpleasant taste or are too expensive** for public use.
- There is a need for an **eco-friendly polymer based nano-cellulose adsorbent with metallic oxyhydroxides** to get a robust composite for an improved synergistic performance towards F^- removal.

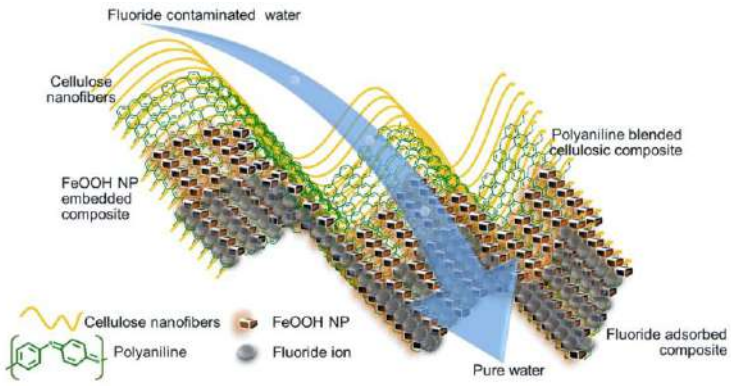


Figure: Illustration of Cellulose Nanofibers-Polyaniline templated Ferrihydrite composite (CNPFH) used for fluoride removal from water.

Intellectual Property

- IITM IDF Ref.**1953**
- **IN 376317 Patent Granted**

TRL (Technology Readiness Level)

TRL 5 Technology Validated in Relevant environment

Technology Category/ Market

Category- Green Technology

Industry Classification:

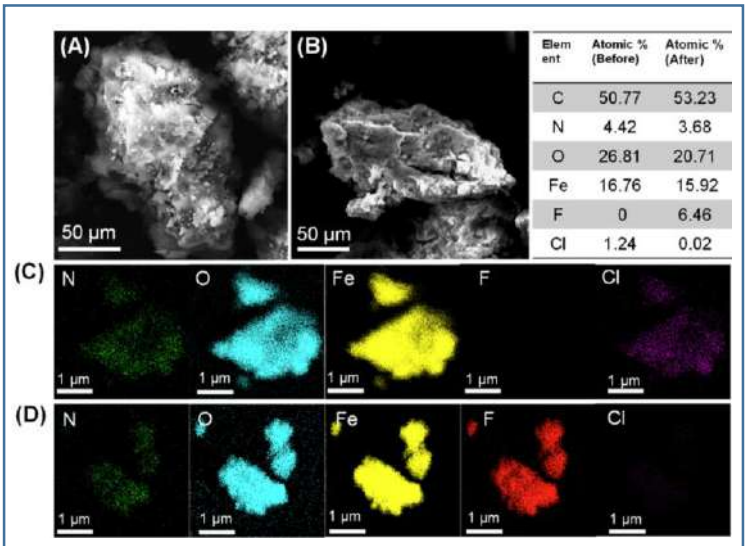
- **NIC (2008)- 28195-** Manufacture of filtering and purifying machinery or apparatus for liquids and gases; **11043-** Manufacture of mineral water; **36000-** Water collection, treatment and supply; **20299**- Manufacture of various other chemical products n.e.c.

Applications:

Water treatment and purification and fluoride removal from groundwater.

Market drivers:

water treatment market size is expected to rise from US$ 69.73 billion in 2024 to US$ 137.17 billion by 2034 with a CAGR of 7%



Element	Atomic % (Before)	Atomic % (After)
C	50.77	53.23
N	4.42	3.68
O	26.81	20.71
Fe	16.76	15.92
F	0	6.46
Cl	1.24	0.02

Figure: (A) and **(B)** show SEM of CNPFH before and after F-adsorption, respectively. **(C)** and **(D)** EDS elemental mapping of N, O, Fe, F and Cl of CNPFH before and after F-adsorption, respectively, along with EDS quantification of elements.

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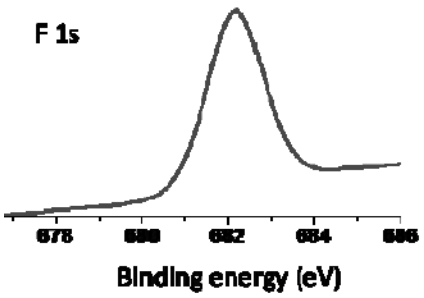

Figure:. When the CNPFH sample was left exposed to high amount of F^- for 3 h, apart from the 687.3 eV, a peak at 682.5 eV emerges which is due to F binding at the FeOOH site. This has been confirmed by analyzing F- adsorbed cellulose-ferrihydrite composite which shows a peak at 682.1 eV

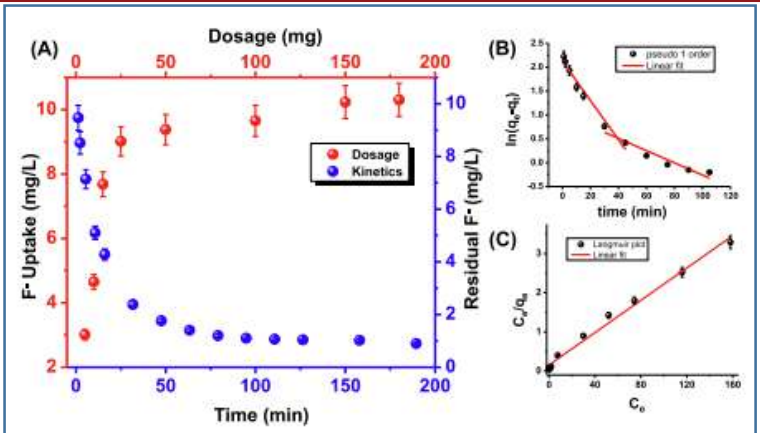

Figure: . Batch studies for the performance of CNPFH **(A)** as a function of dosage and contact time, **(B)** pseudo first order, and **(C)** Langmuir isotherm model for fluoride adsorption from water.

Technology

Cellulose Nanofibers-Polyaniline template Ferrihydrite (CNPFH) nanocomposite was prepared by a green method involving a one pot synthesis process via an in-situ polymerization method.

The ferrihydrite nanoparticles incorporated in the polymeric confinement of cellulose nanofibers and doped N sites of blended PANI function as active sites which operate synergistically for enhanced Fluoride removal

The CNPFH composite exhibited a maximum Fluoride adsorption capacity of 50.8 mg/g

The developed CNPFH composite was also tested for the effect of interfering ions to simulate usage for groundwater applications. CNPFH is able to remove more than 80% of Fluoride in presence of most interfering anions while remaining unaffected by the presence of interfering cations.

Key Features / Value Proposition

- The simple synthesis process yielded a sustainable composite which was used for F^- removal from water by means of adsorption.
- CNPFH composite has maximum F^- adsorption capacity of 50.8 mg/g which is higher than other PANI based composites.
- Though low cost and bio-based adsorbents such as alumina and chitosan are available, they are not completely eco-friendly or effective due to issues such as non-plant based source and high polycrystallinity when compared to cellulose based composites.
- The robustness of the composite keeps it free from leaching. Moreover, CNPFH works efficiently in a wide range of pH with fast adsorption kinetics making it a superior option for an industrially feasible green material for delivering affordable water in Fluoride affected communities worldwide.

materials	uptake capacity (mg/g)	max wt % PANI/PPy
PANI	0.8	100
PANI/chitosan	5.5	8–10
PANI/alumina	6.6	11.6
FeOOH	23.8	0
PPy/Fe_3O_4	17.6–22.3	83
Ppy/TiO_2	33.17	9.3
CNF/PANI/FeOOH	50.8	14.1

Table: The developed CNPFH composite exhibits higher fluorine uptake capacity when compared to conventional adsorbents

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