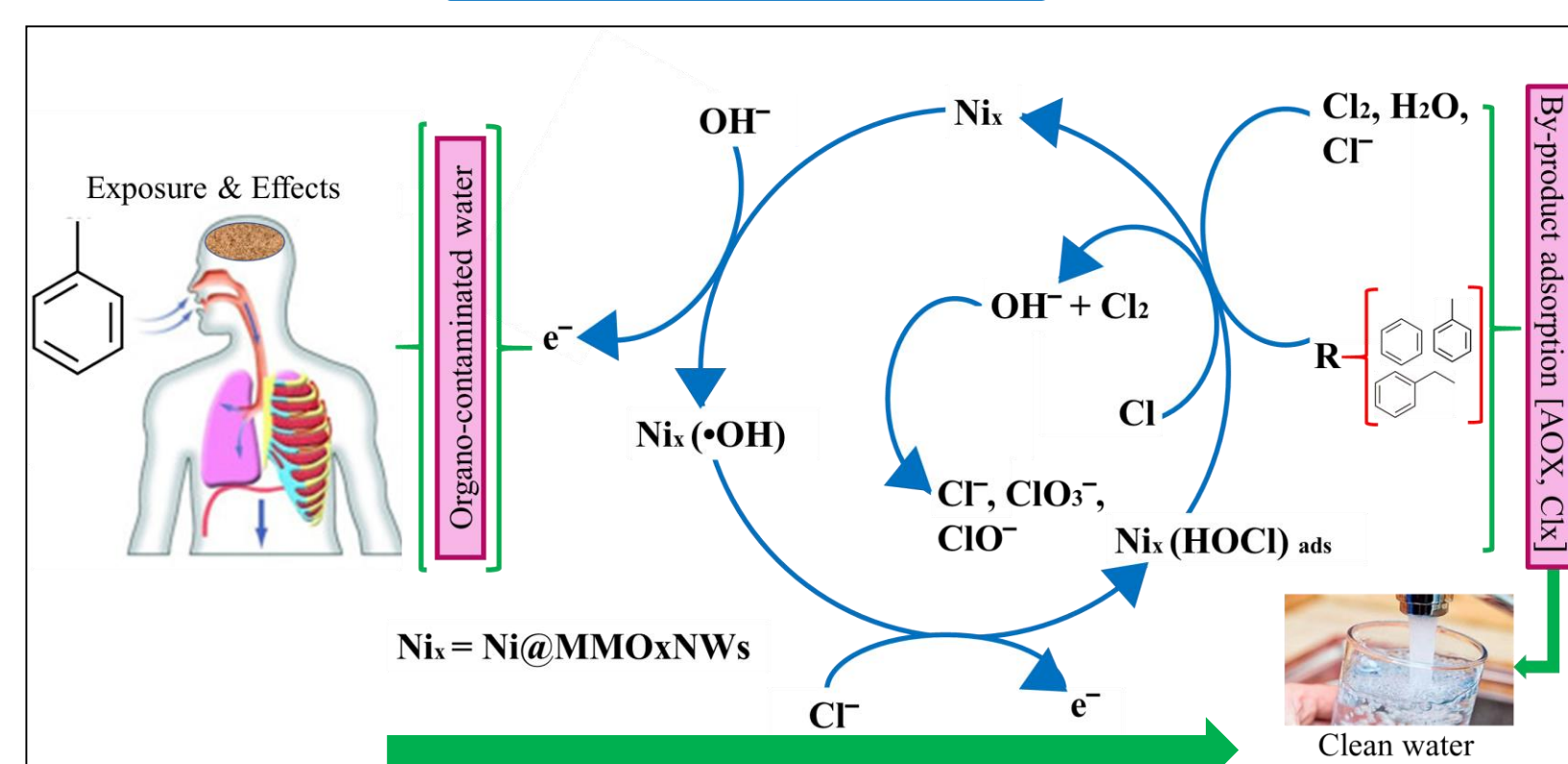


1 ABSTRACT



2 BACKGROUND

- Pollution of the limited freshwater resources is, thus, a course of concern for many governments around the world
- This has emerged as a serious problem that is affecting water bodies and their ecosystem, especially with unaware and incompetent WWTPs in removing organic pollutants (1).
- Furthermore, most biological treatments such as activated carbon, hydrodynamic activation, etc. are inadequate or do not completely remove these solvents because they are miscible or dissolve in water (1,2).
- The combination of EAOPs as primary treatment methods, followed by an adsorption process, is now a very feasible, eco-friendly, and cost-effective in the complete recovery of toxic residual solvents from binary aquatic systems.

3 OBJECTIVES

- The objective of this study was to electrochemically deactivate toxic organic solvents in an electrochemical cell through anodic oxidation as primary treatment followed by column adsorption process as a finishing step for complete removal and recycling of toxic organic solvents from pharmaceutical effluents.

4 METHODS

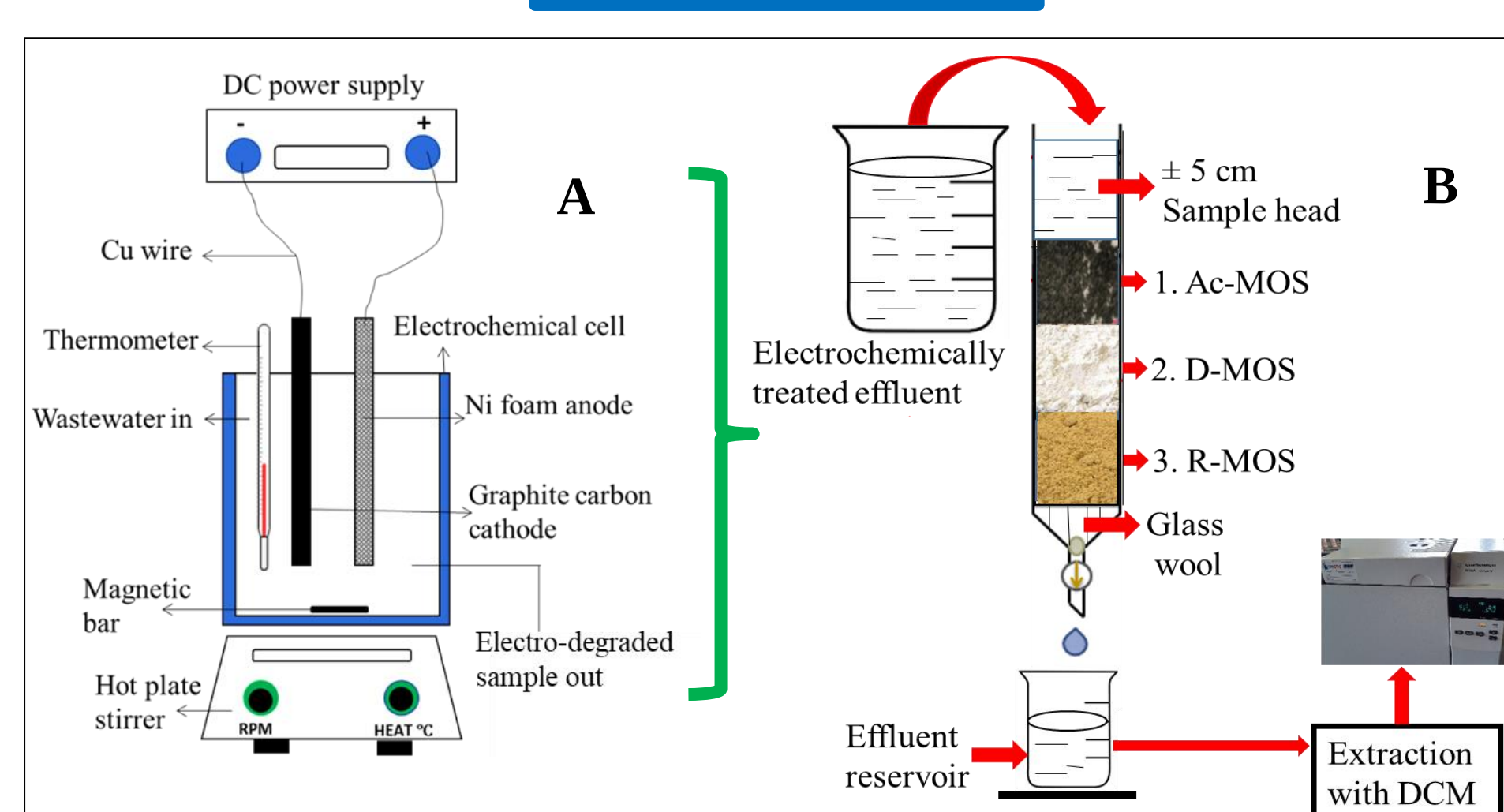


Fig 4.1: (a) Indirect EO of VOCs using Ni@MMOxNWs as anode in the presence of NaCl as electrolyte, (b) Bio-sorption using MOS sorbents

5 RESULTS & DISCUSSION

5.1 GC-FID method development & validation analysis

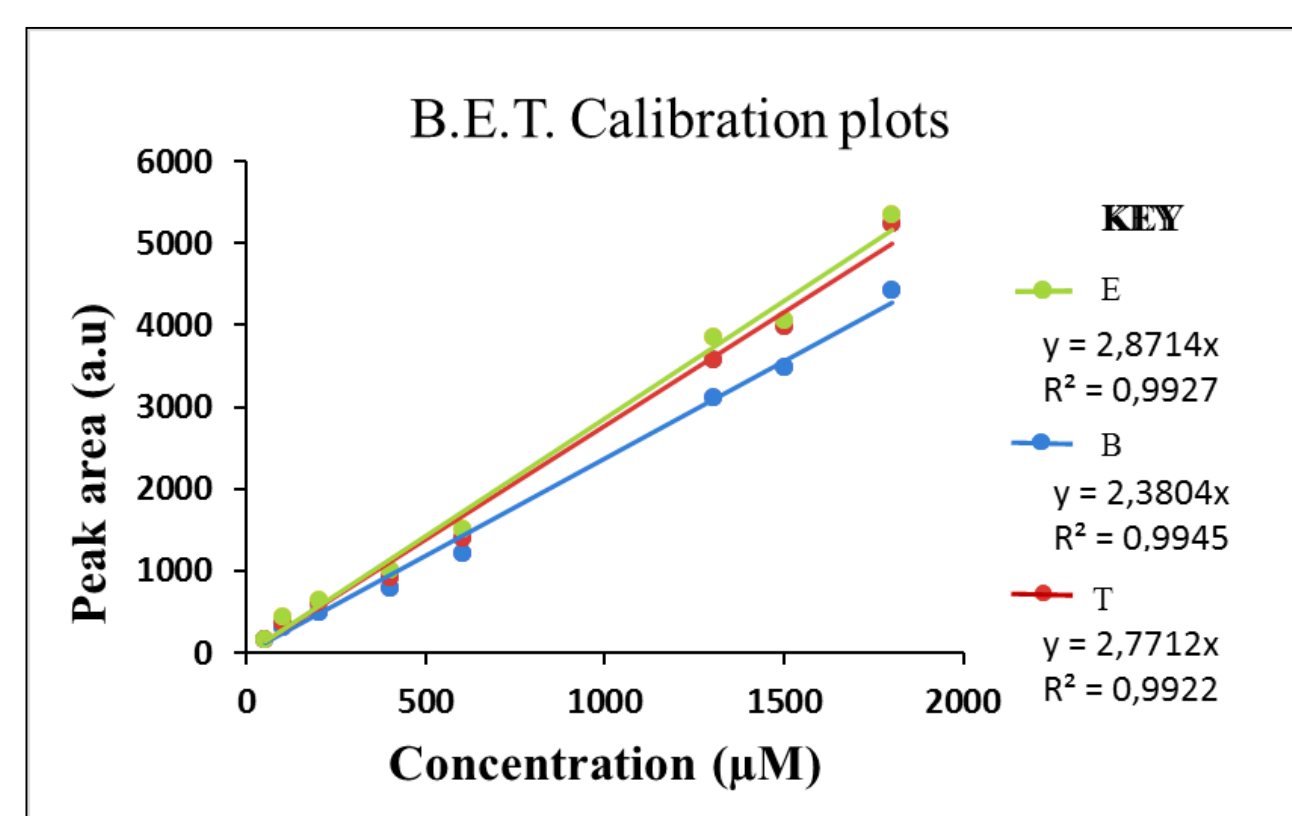


Fig 5.1.1: Calibration plots of VOCs (B.T.E.) with $R^2 = 0.997$ for all VOCs

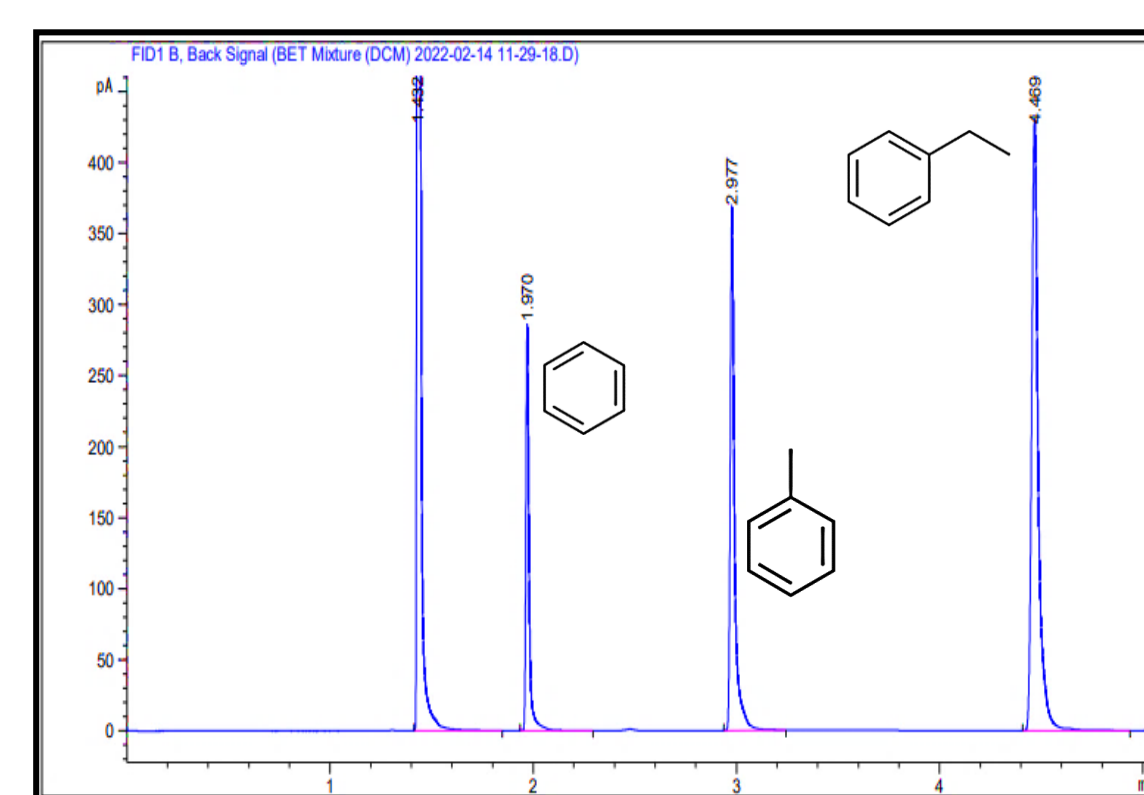


Fig 5.1.2: Typical B.T.E mixture in DCM calibration standard solution chromatogram, elution order: DCM, B, T and E in <5 min

5.2 EO Process, Removal efficiencies of B.T.E, COD & TOC measurements

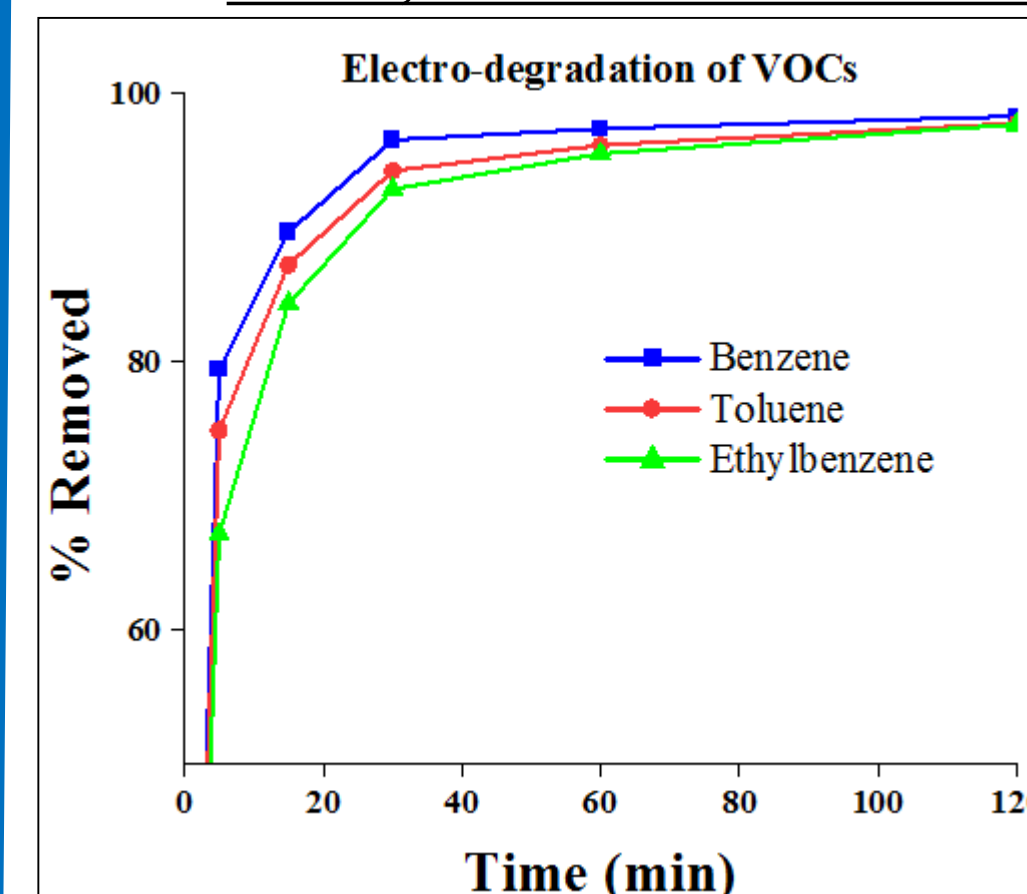


Fig 5.2.1: VOCs removal efficiency variation with time at 2.3 mA/cm², 2500 mg/L Cl, pH 5.5 and 300µM of [VOCs]

Table 5.2.1:
COD & TOC measurements

COD (mg/L)	TOC (mg/L)
74.07 (i)	119.13 (i)
34.73 (f)	41.21 (f)

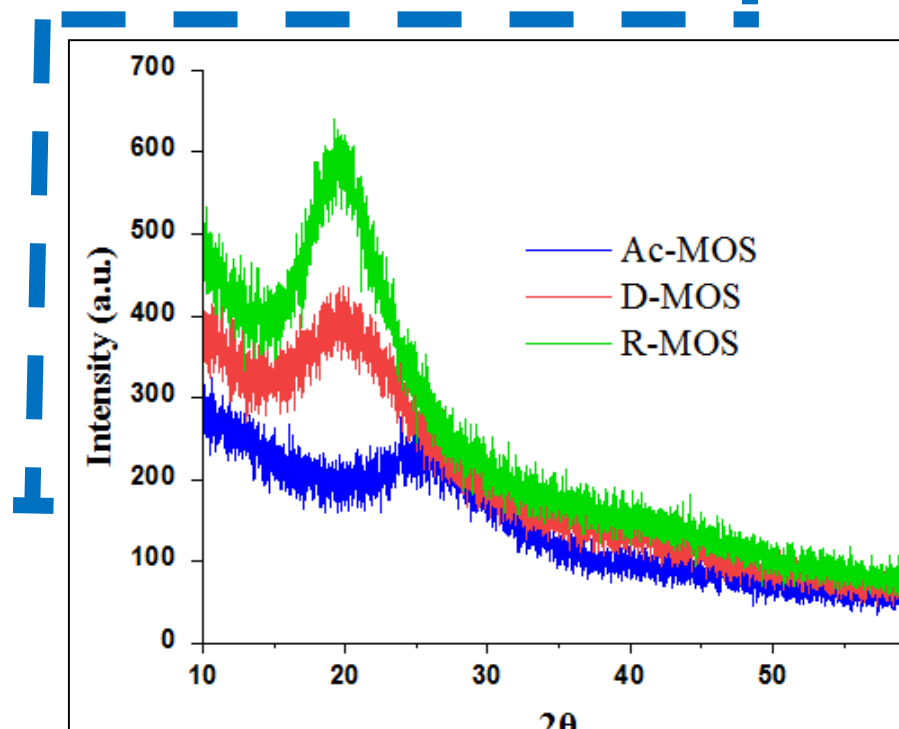


Fig 5.3.2 X-ray diffractogram of MOS adsorbents

5.4. Batch adsorption studies for AOX removals

Table 5.4.1: COD & TOC measurements

COD (mg/L)	TOC (mg/L)
11.43 (Ac-MOS)	19.8 (Ac-MOS)
14.08 (D-MOS)	21.87 (D-MOS)
17.12 (R-MOS)	22.08 (R-MOS)

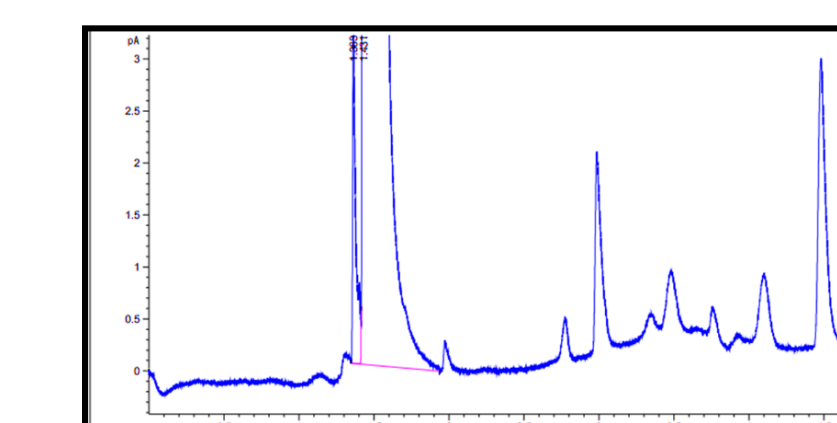


Fig 5.4.2:GC-FID chromatogram showing possible AOX compounds after bio-sorption

5.3 Characterization of MOS bio-sorbents

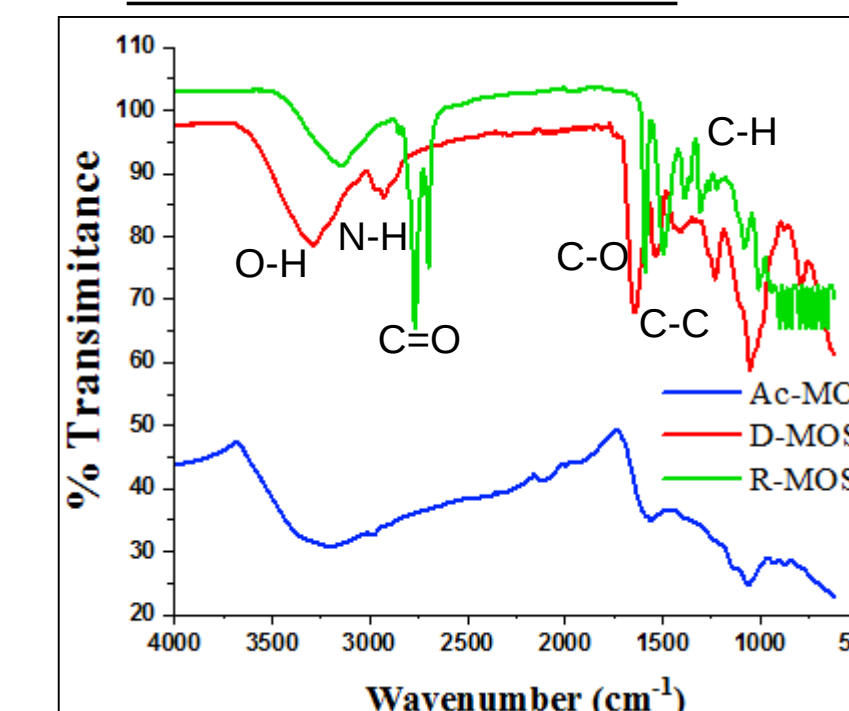


Fig 5.3.1: FT-IR spectra of MOS adsorbents

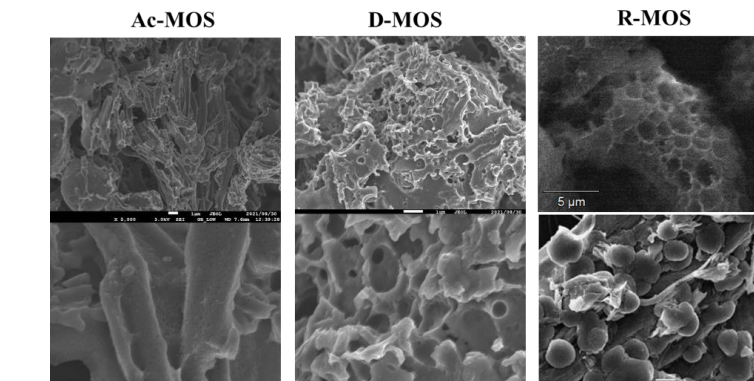


Fig 5.3.3: SEM imaging of MOS bio-sorbents

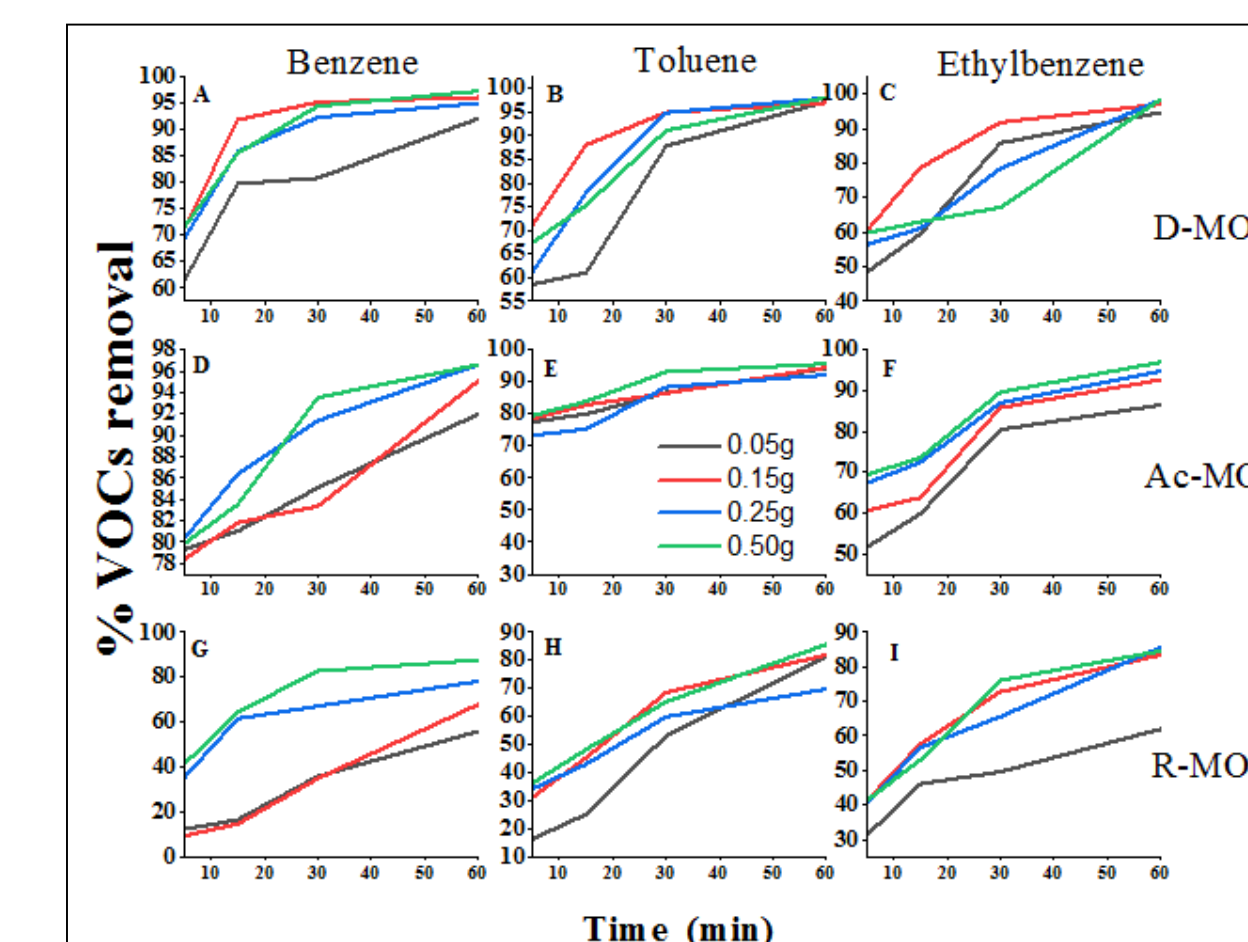


Fig 5.4.1: VOCs bio-sorption at pH 5.5 and 300 µM [VOCs] using MOS sorbents

Table 5.4.2: Comparison of determined pollutant concentration to WHO drinking guidelines

Pollutant	WHO guidelines (mg/L)	This study (mg/L)
Benzene	0.01	BD
Chloride	200-300	2486.31 (syn) 78.56 (EDP) 25.71 (B-Ac) 34.03 (B-D) 38.11 (B-R)
Chlorine	5.0	N/T
DCM	0.02	N/T
Ethylbenzene	0.3	BD
Nickel	0.07	52.46 (EDP) 0.64 (B-Ac) 4.27 (B-D) 6.09 (B-R)
Toluene	0.7	BD

NB: BD= beyond detection limit, syn= synthetic sample, EDP= electro-degradation process, N/T= not tested, B-Ac/B-D/BR= batch adsorption studies using activated, defatted and raw MOS biosorbents

6 CONCLUSION

- A suitable GC-FID method was developed & validated for quantification of VOCs
- The Ni@MMOxNWs anode achieved good removal performance of > 95% for all investigated VOCs.
- Up to 98 % removals of the chloride ion content after bio-sorption analysis.
- More than 75% COD and plus 80% TOC removals after complete treatment
- More than 80% removals in Ni species

7 FUTUREWORK

- Characterization of synthesized Ni@MMOxNWs to improve its stability
- Further investigation of the technology for scale-up and piloting applications in module systems in the pharmaceutical industries in the country.

8 ACKNOWLEDGEMENT

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9 REFERENCES

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