

Indian Science Technology and Engineering facilities Map

(I-STEM)

Application for Partial financial support for using R&D facilities in other institutions through the I-STEM web portal to Users from Academic Institutions

(Format-1)

Format for requesting support for accessing and using facilities through the I-STEM web portal.

(i) Details of the Personal Information

- a. Name of the Researcher/Faculty Member - Sam Daniel Silas
- b. Name of the Institution/Start-up – Karunya Institute of Technology and Sciences
- c. Name of the Department – Water Institute
- d. Degree registered for/Product being developed (for start-up) - Ph.D Water
- e. Mob. No. 8197460732
- f. Email ID: silas.sam10@gmail.com

(ii) Project/Research topic Details:

- a. Project Title/Research Title:
Performance Evaluation of Electro biochemical Reactor for Concurrent Treatment of Electroplating and Textile Dye Effluent.
- b. Sub area: Water and Energy Recovery: Remediation of Textile dye and electroplating effluent using Electro Biochemical Reactor
- c. Area Description:
- d. Aims & Objective (in Bullets):

Objectives:

Main Objective: To evaluate the improved performance of Electro-Biochemical Reactor in power output, desalination, COD and Chromium reduction by using raw and pre-treated textile dyeing wastewater and electroplating effluent concurrently.

Sub Objectives:

- To prepare novel carbon nanocomposite anode and cathode electrodes with high surface area
- To conduct characterisation studies by analytical techniques (SEM, EDX, XRD, UV, FTIR, XPS) and determine the water quality parameters

- e. Duration (MM/YYYY): 09/2022 – 03/2023
- f. Project Summary:

Performance Evaluation of Electrobiochemical Reactor for Concurrent Treatment of Electroplating and Textile Dye Effluent

Introduction:

Due to urbanisation and industrial development, the pollutant load entering the surface and subsurface water resources is increasing, which demand the efficient and effective treatment at the point of generation. Urban industrial aerosols that enter the water body through rain, animal solid waste, mining activities, electro plating industries, and agricultural activities are the main causes of heavy metal ions contamination. In India, there are more than 3,00,000 small scale electroplating units spread throughout the country. Only 30 to 40% of the used metals get plated, while the remaining metals are discharged in the forms of ions leading to great environmental concern, both on land and water. On the other hand, Energy crisis has been one of the major concerns in the current world scenario. Fossil fuels that are currently used for energy generation are highly exhaustible. In the context of Sustainable Development Goals, both water and energy resources are to be managed effective by conservation and the treatment or remedial measures. The current study helps to throw light on a sustainable solution that targets both the existing needs of energy and environmental protection.

Motivation for the Proposed Project:

There are around 400 metal-based industries (electroplating, foundry, and metal casting industries) located in Coimbatore, which is the second largest industrial hub and also known as Manchester of South. The heavy metals from these industries are toxic, bio-accumulative and have the neurological impact. So, it is necessary to treat the effluent and recover the water before it is being discharged on to the land and water.

Numerous physical, chemical and biological methods have been developed and are used for the treatment of heavy metals in surface or subsurface environments. The various physico chemical methods include processes such as Oxidation, Ion exchange, Adsorption, Coagulation, Photochemical treatments and biological treatments. Even though these treatments are effective in treating the contaminated surface, the requirement of high energy input, regenerative capacity of adsorbents and formation of by-products/sludge limit their feasibility and operation in several industrial environments. These methods have a draw back when it comes to the disposal as it is highly tedious and complicated to dispose the sludge because of the formation of hydroxides.

To overcome the limiting factors of both energy consumption and waste treatment, EBC method can be applied in which the organic contaminants in the wastewater which act as an electron donor and are removed through microbial degradation in the anode and Chromium which is a heavy metal from electroplating effluent get reduced by acting as an electron acceptor in the cathode chamber.

Existing Major Challenges in EBC Rector System:

Low power generation during scaling up: The power generation is low and the scaling up needs improvement in the reactor design and

- development cost effective and efficient electrode material (anode and cathode)

- nature and characteristics of microorganism / substrate used and
- selection and preparation of AEM and CEM.

To address the above challenges, it is proposed to evaluate the improved performance of Electro-Biochemical Reactor in power output, desalination, COD and Chromium reduction by using textile dyeing wastewater and electroplating effluent concurrently.

In this project, the performance of the EBC in treating the textile dyeing effluent having 1200 mg/L of COD in the anode chamber and electroplating effluent in the cathode chamber where Cr (VI) is reduced to Cr (III). Graphite and activated carbon cloth electrodes are used in the anode and cathode respectively for the transfer of electrons from anode to cathode. The middle chamber which separates other two chambers by Anion and Cation Exchange Membrane is filled with pre-treated textile dyeing effluent having salt content in the range of 2000 – 3000 ppm. The isolated microbes from the textile dyeing effluent and the soil are inoculated in the anode chamber. The electrons which are produced during microbial degradation process in the anode chamber are transferred to the cathode chamber through electrical circuit. The saline water gets treated in the middle chamber through the movement of cations to the CEM and anions to AEM. The efficiency of the process is evaluated through parameters like power generation, COD removal, salinity removal and water quality parameters.

(iii) Technical Details

- a. TRL - 3
- b. Methodology

The Bio Electro Chemical Cell contains three separate chambers distinguished from the middle chamber on either side by the Anion and Cation exchange membranes. The volume of the chambers is designed up to 3000 ml capacity. The graphite electrode coated with carbon nanofibers and activated carbon cloth are used as anode and cathode (electrodes). The electrodes are looped in a closed circuit with the help of an electric wire and multi meter. The anode chamber and the cathode chamber are separated from the middle chamber by an Anion exchange membrane and Cation exchange membrane respectively. The Anode chamber is enriched with a mixture of minerals Vitamins and glucose to facilitate the microbial growth. Phosphate Buffered Solution (PBS) is added to maintain pH of the aqueous mixture. The textile dyeing effluent with COD in the range of 1200 mg/L was used as substrate in anode chamber where pH is maintained in the range of 7-8. This pre-treated textile dyewater is filled in the middle chamber for desalination to occur through AEM and CEM placed on either side of the middle chamber. The cathode chamber is filled with chromate enriched electroplating effluent where the toxic Cr (VI) is reduced to Cr (III) by the electrons receives by the cathode.

c. Design & development

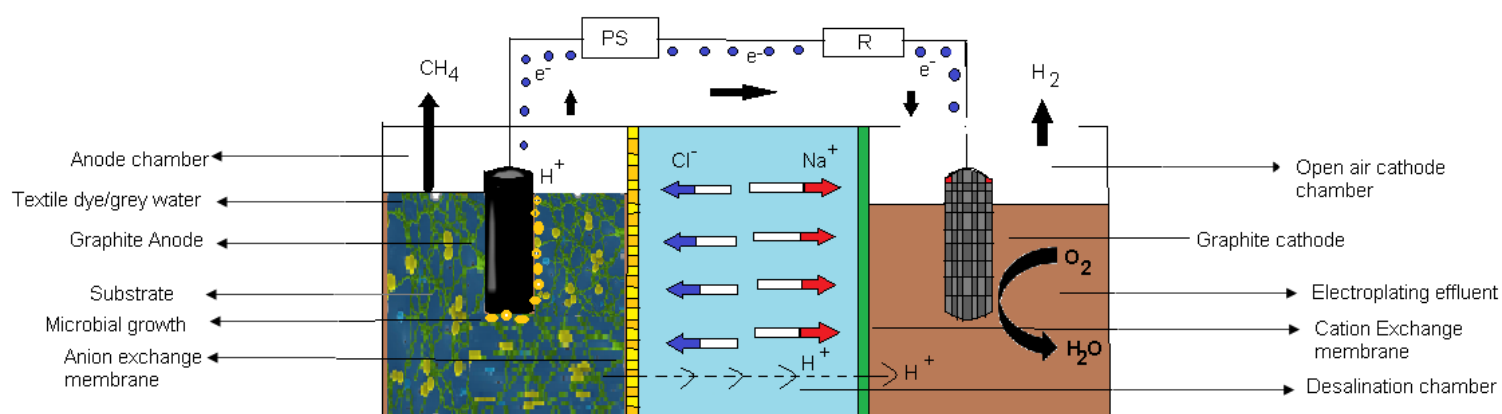


Figure 1: Schematic Diagram of Electro-Biochemical Reactor

d. Facilities and Instrumentation required and available

1. Atomic Absorption Spectrophotometer
2. UV Spectrophotometer
3. Photo Colorimeter
4. COD analyser
5. Water Quality Sensors
6. Membrane and Electrode Preparation Facility

e. Consumables (Scientific materials)

1. Polymers (Polysulphone, PVA, Polystyrene, Ammonium salt)
2. Graphite electrodes, activated carbon cloth, MCNT, Carbon nanofibre
3. Potassium dichromate, Ferrous ammonium sulphate

(iv) Expected output and outcome

- High performance EBC Reactor to treat simultaneously the textile dye effluents from a textile plant, grey water influent-treated effluents from textile industries and Cr contaminated electroplating. This technology is expected to provide four different sustainable benefits namely
 - The treatment of textile dye and grey water effluent to remove hazardous chemicals and compounds
 - Power generation by the promotion of microbial culture growth in the anode chamber
 - The removal of salts from the pre-treated effluent water in the middle chamber and
 - The reduction of Chromium (VI) carcinogenic form in electroplating effluent to Chromium (III) non-toxic form into the cathode chamber for safe disposal.
- Efficient electrodes and AEM and CEM
- Report and IPR (if any)

As a significant outcome, there will be a tradeoff between power generation, removal of heavy metals, COD and TDS and capital and operational cost.

v. Industry/Institute Collaboration**If, yes**

- a) Name of the Collaborating Industry:
- Devi Thread Pvt Ltd, Coimbatore – Small scale textile dyeing industry
 - ArulDas Electroplating Industry, Coimbatore - Small scale electroplating industry
- b) Collaboration Details: For field experimentation

(v) Funding required from I-STEM (with justification:**Details of Requirements & Mode of the Engagement: (Attach the quotation for the consumables)****(i) Short term Engagement:****a. Usage of testing/characterization facilities across the country (Characterization Mode)****i. Testing Charges**

Testing cost					
SEM/EDX	15 samples	Karunya Institute of Technology and Sciences	885	Rs/sample	Rs.13,275
FTIR	15 samples	NIT Calicut	300	Rs/sample	Rs.4,500
XRD	15 samples	NIT Calicut	400	Rs/sample	Rs.6,000
Xray Photo electron spectroscopy	4 hours	IISc Bangalore	2380	Rs/hour	Rs.9520
				Total	Rs.33,295

ii. Consumable charges - NIL**iii. Travel Cost (Boarding and Lodging, if any) – Rs.20,000****b. Usage of fabrication and testing facilities across the country (Fabrication Mode)****i. Fabrication and testing Charges**

Materials	Quantity	Unit cost	Final cost
Perspex glass	2.5m x 2.5 m	2900 Rs/m ²	Rs.6000
Ni/Cr wires	5 m	200 Rs/m	Rs.1000
Carbon cloth with Pt electrode	2 pieces	5500 Rs/piece	Rs.12,000
Binding agent (Poly Vinyl Alcohol)	500g	700 Rs/500g	Rs.4400
Carbon fibre	2.5m x 2.5 m	2500 Rs/m ²	Rs.6250
Graphite anode	2 pieces	1000 Rs/piece	Rs.2000
Mesh	1m	640 Rs/m	Rs.640
Sterilization filter	1	1200 Rs/unit	Rs.1200
Stainless steel	10 cm x 10 cm	4800 Rs/m ²	Rs. 4800
		Total	Rs.38,300

b.**i. Consumable charges (if any) - NIL****ii. Travel Cost (Boarding and Lodging, if any) - NIL****(ii) Medium term Engagement:****a. Execution of project in any one of the Host Institution (Project Mode)****a.Fabrication and or testing Charges****b.Consumable charges (if any)**

- c.Travel Cost (Boarding and Lodging, if any)
- b. Execution of project in Multi Host Institutions (Project Mode)
 - a.Fabrication and or testing Charges
 - b.Consumable charges (if any)
 - c.Travel Cost (Boarding and Lodging, if any)

(Round-trip to the Host Institution by 2nd class (non-AC) railway via the nearest route)

Details of User's Bank Account: SAM D SILAS

(Please send a copy of the cancelled cheque/copy of the passbook carrying all the information needed)

Beneficiary Name (User's name) SAM D SILAS PAN: GUXPS2751H

Bank Account No.10073395034 Name of the Branch: BKC-
NAMAN CHAMBERS BRANCH

IFSC Code: IDFB0040101

Note: Proposed proposal must be executed within stipulated duration (max. 6 month) to avoid fund availability issues. Travel form will be provided by the I-STEM office. The users will submit the technical report, original invoice (duly signed by the Head of the Institution) raised by the Host Institution through I-STEM portal only along with a copy of the travel forms and original tickets through post to the Nodal Officer, I-STEM, Indian Institute of Science, Bangalore. A scan copy of all the documents may be sent in advance.