MANIPAL UNIVERSITY
JAIPUR

Manipal University Jaipur Lead in Water Conservation Off Campus

Manipal University Jaipur empowers local communities to become more resilient in the face of water-related challenges, such as droughts or flooding. Prepared communities are better equipped to adapt and manage such situations effectively. The impact of university-led off-campus water conservation extends well into the future. The knowledge and practices instilled in local communities lead to immediate water savings and foster a culture of sustainability. As these practices become ingrained in daily life, communities are better equipped to adapt to changing environmental conditions and advocate for responsible water management.

Manipal University Jaipur engages with neighboring communities to raise awareness about water conservation. Manipal University Jaipur organizes workshops, seminars, and educational initiatives to inform residents about the importance of efficient water usage and conservation practices. Manipal University Jaipur collaborates with local water authorities and environmental organizations to develop comprehensive water conservation strategies. These partnerships leverage the expertise of academic researchers to address specific community needs. Manipal University Jaipur conducts research to assess local water resources and the impact of various activities on water availability. This research informs local policies and management practices for sustainable water use. Manipal University Jaipur implements practical water-saving measures off campus, such as rainwater harvesting systems, community gardens with efficient irrigation techniques, and educational programs that promote water-wise landscaping. Off-campus water conservation initiatives provide valuable learning opportunities for students who can engage in hands-on research and community projects, gaining practical experience in sustainability efforts.

By reducing water waste and promoting sustainable practices, universities contribute to the preservation of local ecosystems, especially in regions facing water stress and drought. Water conservation practices can lead to cost savings for both the university and the surrounding community. Lower water bills and reduced infrastructure maintenance expenses are among the direct economic benefits

SCHOOL OF WATER AND WASTE

AAETI

ANIL AGARWAL ENVIRONMENT TRAINING INSTITUTE
(A UNIT OF CENTRE FOR SCIENCE AND ENVIRONMENT)

CERTIFICATE OF COMPLETION

Online Training on
Water Audit: A Tool for Water Conservation in Industries

This is to certify that Mr. / Ms. **Meena Kumari Sharma** has successfully completed the online training on **"Water Audit: A Tool for Water Conservation in Industries"** organised by the Centre for Science and Environment, New Delhi from **June 14** to **June 27, 2022.**

With best wishes,

Sunita Narain
Director General

Centre for Science and Environment — Online Course

Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi-110 062 INDIA

MANIPAL UNIVERSITY JAIPUR

Manipal University Jaipur

VPO - Dehmi Kalan, Near GVK Toll Plaza Jaipur-Ajmer Expressway Jaipur

Bank Payment Voucher

Voucher No. : **BP/22-23/000004502** Date: 13-09-22

Particulars	GL Code	Sub Code			Debit Amount	Credit Amount
	301240	*BANK/00012*	**Travel Academic** DEPARTMENT-CIVIL ENGINEERING EMPLOYEE-MEENA KUMARI SHARMA FACULTY-FACULTY OF ENGINEERING SCHOOL-SCHOOL OF CIVIL & CHEMICAL ENGINEERING	*Dr*	3,500.00	
To	*220120*	*BANK/00012*	**STATE BANK OF INDIA (OD A/c) - 40601753170** DEPARTMENT-CIVIL ENGINEERING EMPLOYEE-MEENA KUMARI SHARMA FACULTY-FACULTY OF ENGINEERING SCHOOL-SCHOOL OF CIVIL & CHEMICAL ENGINEERING Cheque No: NEFT Dated: 13-09-22			3,500.00
					3,500.00	**3,500.00**

Remarks : Dr. Meena Kumari/MUJ0446/CONFERNCE ATTENTED WORKSHOP WATER AUDIT-2022

Amount (in words):

Rs. THREE THOUSAND FIVE HUNDRED RUPEES AND ZERO PAISA ONLY

UTR No. -

Prepared by:

MUJ\DEEPAKB

Approved by:

MANIPAL UNIVERSITY JAIPUR

ID: 00001133 Entry type: Others

S.No.	Application for support to attend Conference / Workshop / FDP/ Short term course	
1	Name of the faculty with Employee code	Dr Meena Kumari MUJ0446
2	Designation: School: Department: Date of joining: Contact number (Ext. & Cell) and Email-id:	Professor School of Civil and Chemical Engineering Civil Engineering 03/01/2015 8003988532 meena.kumari@jaipur.manipal.edu
3	Name of the event & its website address (if any)	ONLINE TRAINING ON WATER AUDIT: A TOOL FOR WATER CONSERVATION IN INDUSTRIES (https://www.cseindia.org/water-audit-a-tool-for-water-conservation-in-industries-11231)
4	Place and date of the event	India 14/06/2022 - 27/06/2022
5	Venue of the event	Online
6	Whether organized @ MUJ	No
7	Organizers of the event: Nature of the event:	Centre for Science & Environment National
8	Financial liability of MUJ, if any (provide the details)	Yes 3500.0000
9	Nature of Participation	Attendee
10	Event Necessity	Research area
11	Have you published paper through conference with indexing?	No
12	No. of SPCL required to attend this event: No. of SPCL availed so far:	9 1
13	Indexing of the conference (Scopus/ UGC / any other) (attach the proof)	Other
14	Advance Sanctioned Amount : Utilized Amount : Sanctioned Amount:	 3500.0000 3500.0000
15	Title of the presented paper	Online Training on Water Audit: A Tool for Water Conservation in Industries
16	Highlights of the event	KEY LEARNINGS FROM THE PROGRAMME: Water audit – Introduction, Scope and Methodology Preparing industry specific water audit questionnaire Water audit instrumentation, metering and accounting Pre
17	What are the outcomes?	Understanding the relevance of the efficient wastewater treatment technologies, recycling and reuse practices which can bring down consumption and effluent generation. Further, substantial costs which

18	Whether your research work is recommended for publication	No

Process History

ID	Entry Type	Statusname	Updated by	Updated date	Remarks	Event Type
00001133	Others	New	Dr Meena Kumari	14/06/2022		Pre Event Request
00001133	Others	Submitted	Dr Meena Kumari	14/06/2022		Pre Event Request
00001133	Others	Recommended by HOD	Dr Meena Kumari	14/06/2022	Recommended	Pre Event Request
00001133	Others	Recommended by DDR	Dr Vivek Kumar Verma	15/06/2022	Recommended a per MUJ Policy (Kindly apply for pre-event well before the event)	Pre Event Request
00001133	Others	Recommended by DOR	Dr Roheet Bhatnagar	15/06/2022	Recommended	Pre Event Request
00001133	Others	Recommended by DOS	Dr Bhavna Tripathi	21/06/2022	Recommended	Pre Event Request
00001133	Others	Recommended by DOF	Dr Arun Shanbhag	01/07/2022	Recommended as per MUJ Policy	Pre Event Request
00001133	Others	Pre-Event Approved	Dr Nitu Bhatnagar	06/07/2022	Approved	Pre Event Request
00001133	Others	New	Dr Meena Kumari	18/07/2022		Post Event Update
00001133	Others	New	Dr Meena Kumari	19/07/2022		Post Event Update
00001133	Others	New	Dr Meena Kumari	19/07/2022		Post Event Update
00001133	Others	New	Dr Meena Kumari	19/07/2022		Post Event Update
00001133	Others	New	Dr Meena Kumari	19/07/2022		Post Event Update
00001133	Others	Post Event Submitted	Dr Meena Kumari	19/07/2022		Post Event Update
00001133	Others	Recommended by HOD	Dr Meena Kumari	19/07/2022	Recommended	Post Event Update
00001133	Others	Post Event Rework	Dr Vivek Kumar Verma	28/07/2022	Kindly attach supporting documents with the Expense report	Post Event Update

00001133	Others	Post Event Submitted	Dr Meena Kumari	28/07/2022		Post Event Update
00001133	Others	Recommended by HOD	Dr Meena Kumari	28/07/2022	Recommended	Post Event Update
00001133	Others	Post Event Rework	Dr Vivek Kumar Verma	29/07/2022	Kindly attach supporting documents with the Expense report	Post Event Update
00001133	Others	Post Event Submitted	Dr Meena Kumari	29/07/2022		Post Event Update
00001133	Others	Recommended by HOD	Dr Meena Kumari	29/07/2022	Recommended	Post Event Update
00001133	Others	Recommended by DDR	Dr Vivek Kumar Verma	06/08/2022	Recommended	Post Event Update
00001133	Others	Recommended by DOR	Dr Roheet Bhatnagar	07/08/2022	Recommended	Post Event Update
00001133	Others	Recommended by HR	Mr Kamlesh Kumar Bagda	20/08/2022	Recommended	Post Event Update
00001133	Others	Recommended by CF&AO	Dr Pradeep Chaturvedi	26/08/2022	approved	Post Event Update
00001133	Others	Post-Event Approved	Dr Rajendra Kumawat	13/12/2022	approved	Post Event Update

i.To be submitted to finance department with hard copies of all original receipts/uploaded documents.

Signature of faculty (with date).

"Autogenerated from Research Data Management System (RMS), Manipal University Jaipur on 20-04-2023"

SCHOOL OF WATER AND WASTE
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ANIL AGARWAL ENVIRONMENT TRAINING INSTITUTE
(A UNIT OF CENTRE FOR SCIENCE AND ENVIRONMENT)

CERTIFICATE OF COMPLETION

Online Training on
Water Audit: A Tool for Water Conservation in Industries

This is to certify that Mr. / Ms. **Sagar Gupta** has successfully completed the online training on **"Water Audit: A Tool for Water Conservation in Industries"** organised by the Centre for Science and Environment, New Delhi from **June 14** to **June 27, 2022.**

With best wishes,

Centre for Science and Environment Online Course

Sunita Narain
Director General

Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi-110 062 INDIA

MANIPAL UNIVERSITY JAIPUR

ID: 00001167 Entry type: Workshop

S.No.	Application for support to attend Conference / Workshop / FDP/ Short term course	
1	Name of the faculty with Employee code	Mr Sagar Gupta MUJ0495
2	Designation: School: Department: Date of joining: Contact number (Ext. & Cell) and Email-id:	Associate Professor(senior scale) School of Civil and Chemical Engineering Civil Engineering 25/06/2015 +91783788898 sagar.gupta@jaipur.manipal.edu
3	Name of the event & its website address (if any)	Sagar Gupta (https://www.cseindia.org/basic-laboratory-training-in-faecal-sludge-management-11299)
4	Place and date of the event	India 26/07/2022 - 30/07/2022
5	Venue of the event	Anil Agarwal Environment Training Institute (AAETI), Nimli, Rajasthan
6	Whether organized @ MUJ	No
7	Organizers of the event: Nature of the event:	centre for science & environmental National
8	Financial liability of MUJ, if any (provide the details)	Yes 3500.0000
9	Nature of Participation	Attendee
10	Event Necessity	OTHERS
11	Have you published paper through conference with indexing?	No
12	No. of SPCL required to attend this event: No. of SPCL availed so far:	05 07
13	Indexing of the conference (Scopus/ UGC / any other) (attach the proof)	Other
14	Advance Sanctioned Amount : Utilized Amount : Sanctioned Amount:	 3500.0000 3500.0000
15	Title of the presented paper	Online course on water audit
16	Highlights of the event	1. toolkits for water audits. 2. scooping projects for water audits and several niche parameter for measuring of water flow and pumping.3. requirement and areas in which water audits need to applied.
17	What are the outcomes?	1. certification for water audit projects. 2. able to develop tailored solution for water auditing.
18	Whether your research work is recommended for publication	No

Process History

ID	Entry Type	Statusname	Updated by	Updated date	Remarks	Event Type
00001167	Workshop	New	Mr Sagar Gupta	18/07/2022		Pre Event Request
00001167	Workshop	Submitted	Mr Sagar Gupta	18/07/2022		Pre Event Request
00001167	Workshop	Recommended by HOD	Dr Meena Kumari	18/07/2022	Recommended	Pre Event Request
00001167	Workshop	Recommended by DDR	Dr Vivek Kumar Verma	25/07/2022	Recommended	Pre Event Request
00001167	Workshop	Recommended by DOR	Dr Roheet Bhatnagar	25/07/2022	Recommended	Pre Event Request
00001167	Workshop	Recommended by DOS	Dr Bhavna Tripathi	25/07/2022	Recommended	Pre Event Request
00001167	Workshop	Recommended by DOF	Dr Arun Shanbhag	28/07/2022	Approved	Pre Event Request
00001167	Workshop	Pre-Event Approved	Dr Nitu Bhatnagar	03/08/2022	Approved	Pre Event Request
00001167	Workshop	New	Mr Sagar Gupta	18/08/2022		Post Event Update
00001167	Workshop	Post Event Submitted	Mr Sagar Gupta	18/08/2022		Post Event Update
00001167	Workshop	Recommended by HOD	Dr Meena Kumari	18/08/2022	Recommended	Post Event Update
00001167	Workshop	Recommended by DDR	Dr Vivek Kumar Verma	24/08/2022	Recommended	Post Event Update
00001167	Workshop	Recommended by DOR	Dr Roheet Bhatnagar	27/08/2022	Recommended	Post Event Update
00001167	Workshop	Recommended by HR	Mr Kamlesh Kumar Bagda	05/09/2022	Recommended	Post Event Update
00001167	Workshop	Recommended by CF&AO	Dr Pradeep Chaturvedi	24/09/2022	approved	Post Event Update

i.To be submitted to finance department with hard copies of all original receipts/uploaded documents.

Signature of faculty (with date).

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ORIGINAL ARTICLE

Effective salt removal from domestic reverse osmosis reject water in a microbial desalination cell

Aman Dongre[1] · Nitesh Kumar Poddar[1] · Rakesh Kumar Sharma[1] · Monika Sogani[1]

Received: 25 March 2022 / Accepted: 23 June 2022

Abstract

Microbial desalination cells (MDC) are evaluated as an environmentally friendly approach for purifying saline water by using power generated by the decomposition of organic materials in the wastewater. The present study is to evaluate the ferrocyanide-redox and biocathode approach in treating simulated saline water and subsequently recovering bio-electricity using actual domestic reverse osmosis reject water. For the desalination of simulated saline water and domestic reverse osmosis reject water, a three-chamber microbial desalination cell with graphite electrodes and anion and cation exchange membranes was constructed. When treating simulated saline water, the biocathode technique achieved a 5% improvement in salt removal and a 4.9% increase in current and power density when compared to the ferrocyanide-redox approach. When biocathode MDC was used to treat domestic reverse osmosis reject water, a maximum current and power density of 3.81 μA/cm^2 and 0.337 μW/cm^2, respectively, were recorded, as well as COD removal of 83.9% at the desalination chamber and ions reduction for Na, K, and Ca of up to 79%, 76.5%, and 72%, respectively, in a batch operation for 31 days with a stable pH (≈ 7). Thus, the study revealed a microbial desalination cell capable of recovering bioenergy and reducing salt from domestic reverse osmosis reject water with a consistent pH range.

Keywords Microbial desalination cells · Biocathode · RO reject water

Introduction

Currently, around 690 million people in the world have no access to potable water and the situation is predicted to worsen exponentially to 2 billion individuals in the near future (Talbot 2015). Water resources are showing scarcity due to the increased demand for potable water in domestic as well as industrial areas in almost all the continents of the world, resulting in the modern age's water shortage issues (Water Scarcity 2019; Baggio et al. 2021).

As a result of ever-increasing worldwide demand for potable water, innovative desalination techniques have a significant impact across the world (Badiuzzaman et al. 2017; Chowdhury et al. 2018; Tzanakakis et al. 2020). Hefty energy expenses, on the other hand, remain a big worry as energy accounts for about 74% of desalination expenditure for the whole treatment process (Elmekawy et al. 2014; Ding et al. 2021). This increases the cost of water desalination by roughly tenfold when compared with natural water treatment and supply, resulting in high prices for potable water. Reverse osmosis or R.O. with corresponding the usage of energy of 3.2 kWh/m^3 with a 50% recovery rate is the most advanced desalination treatment method in this sense (Ramírez-Moreno et al. 2019). The technologies aimed at temperature control, like multi-step flash and multi-effect distillation, use about 5.5–40 kWh/m^3 of energy, which is even greater (Sharon and Reddy 2015; Hemmat Esfe et al. 2021). Currently, reverse osmosis rejects water and residential sewage water are the most common wastewaters that are released into water bodies without being treated (Reddy et al. 2018). RO reject is a mixture of pre-treatment chemicals and concentrated feed water that eventually becomes a significant component of domestic wastewater (Panagopoulos and Haralambous 2020; Vigneswaran et al. 2021). Approximately, 79% of the water designated for houses for domestic consumption is returned as sewage water (Reddy et al. 2018). For disposing of RO reject, methods like as

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deep well injection and discharge onto surface waters are frequently used, although these approaches have caused serious environmental risks (Reddy et al. 2018). Wastewater reclamation and reuse are the sole options for finishing the water cycle, minimizing water crises, and mitigating severe environmental consequences (Vergine et al. 2017), however, most of these systems are unable to withstand the high salinity and heavy metal concentrations of RO reject (Giwa et al. 2017). Vigneswaran et al. 2021 conducted a study that the negative effects of untreated reject water from RO plants dumped into the soil system. The findings clearly demonstrated the decline of soil and ground water quality over time owing to ion build-up in the environment. Using RO concentrate for irrigation or direct discharge into the soil, on the other hand, may increase soil salinity and alkalinity. As a result, untreated direct discharge of RO concentrate into the soil may have a deleterious influence on soil quality and health (Panagopoulos and Haralambous 2020; Vigneswaran et al. 2021). Microbial fuel cell-based desalination is fundamentally appropriate for saline water treatment as electricity expenses are according to the salinity variations of the water input (Dwivedi et al. 2022). Other modernized membrane technologies like capacitive deionization, forward osmosis, and membrane distillation are used to treat the type of water on the basis pollutants (Yuan et al. 2012; Shaffer et al. 2015; Wang and Chung 2015; Pawlak-Kruczek et al. 2020).

A new way forward for potable water generation is the microbial desalination cell (MDC), utilizing the energy supply from electroactive microbial metabolism digesting organic matter with simultaneous desalination of water and providing power output as well. MDC consists of a three-compartment electrochemical unit (Liang et al. 2009; Yahiaoui et al. 2021). MDC contains a biofilm-based electrode that oxidizes the organic substance in anolyte and catholyte, which is necessary to transport electrons from organic compounds to the electrolyte interface. The electrons enter the cathodic chamber via an external circuit, where the reduction occurs, and ion movement is driven by the electrical potential. Desalination of the wastewater occurs when cations ions travel from the desalination compartment to the cathode via the cation exchange membrane and anions ions pass from the desalination compartment to the anodic compartment via the anion exchange membrane. Liang et al. primarily introduced the definition of MDC in a 9 cm^2 cell, with a saline volume of 11 mL at an initial salt concentration in a range of 5–35 g/L of NaCl with batch reactions reporting about 90% of the salt elimination (Liang et al. 2009).

Several modifications for MDC have been discussed previously, like tubular or cubic reactors (Mehanna et al. 2010a; Jacobson et al. 2011a, b; Ping et al. 2013; Gujjala et al. 2022), multiple stacked cells (Chen et al. 2011; Kim and Logan 2011; Tawalbeh et al. 2020), batch recirculation cycles in cells (Morel et al. 2012; Qu et al. 2012; Tawalbeh et al. 2020) using microbes in cathode chamber as well, termed as biocathodes (Chen et al. 2012; Gujjala et al. 2022), or integrating prototype membranes (Zhang and He 2012, 2013; Sevda et al. 2015; Gujjala et al. 2022) and ion exchange resins in the sections (Zhang and He 2012; Gujjala et al. 2022). Till date, fractional desalination of sea water was achieved with a nominal rate of 0.077 Lm^2/h and is considered to be the largest microbial desalination cell operated with a reaction volume of 100 L (Zhang and He 2015; Salehmin et al. 2021). Many studies have shown that organic matter in wastewater can be used to generate electricity and that the test saline sample is desalinated individually in the MDC. It has not yet been reported in the literature that changes in COD, pH, electrical conductivity, or other parameters in the MDC, especially focused on the electrolyte or test water sample in the desalination chamber. This is because microbial growth would not be possible to grow in the Domestic R.O. Reject Water with low organic content and high COD levels. The major impediment in electrochemical microbial technologies is the cathodic reaction (Lee et al. 2021). Much of the microbial desalination cell studies were done using the information gathered by microbial fuel cell systems that use oxygen as a dominant electron acceptor in the cathodic chamber. The improvement of air cathodes possessing high oxygen reduction reactions, high stability, and low prices are a few challenges that require addressing (Lu and Li 2012; Nie et al. 2021). Zhao et al. Identified three prime factors that influence the efficacy of air cathodes namely pH, the concentration of catholyte, and catalysts if used (Zhao et al. 2006). Despite the widespread use of oxygen as a terminal electron acceptor in electrochemical microbial cells, a ferricyanide catholyte was used to establish the proof of the MDC principle with about 94% salt removal up to 94%, and 2 W/m^2 of energy produced. Thus, naturally improving the system's performance when compared to using oxygen reduction reactions at the cathode. Nevertheless, due to the high price, the use of ferricyanide catholyte can only be feasible if the redox mediator is economic or an inexpensive method is developed to be used upon depletion (Zahid et al. 2022). Compared to abiotic cathode MDCs, biocathode MDCs have higher promise in wastewater treatment since organic matter may be reduced further by biofilm on the working electrode. Biocathode MDCs are also more durable and have lower operating costs (Zhou et al. 2016; Yang et al. 2017).

There has been few research focusing on the makeup of microbial communities and the detection of functional microorganisms in MDC. Harshita et al. (2019) employed constructed MFCs in the anode chamber to generate voltage using various bio-wastes such as cow manure and sludge. Using about 1% cow dung slurry, voltage output of around 229 mV was achieved suggesting the use of cow dung for wastewater treatment (Harshitha et al. 2019;

Naik and Jujjavarappu 2020). It has been found that MDCs with pure microbial cultures have lower power generating capacity than those with mixed microbial cultures (Guang et al. 2020a). Pure cultures, on the other hand, are extremely valuable for elucidating the electron transfer process at the microbiological and molecular levels, as well as reducing the complexity that comes with mixed cultures (Guang et al. 2020a). For example *Shewanella* spp. employ a variety of ways to transport electrons outside the cell, including direct electron transfer through contact, the utilization of cytochromes, and the use of conductive nanowires in cytochromes (Guang et al. 2020a). Because these pure cultures use one or two-electron transfer pathways, these processes are easily identified, and future research may focus on optimizing them for similar goals. A pure culture of *Bacillus velenzeus* strain AD1-ELB, as previously identified, is also utilized in this study (Guang et al. 2020b; Dongre et al. 2022). When MDC is used for real-world R.O. reject water treatment, the microbial population may be more diversified (Siddiqui et al. 2021). As a result, an in-depth study of functional microorganisms is required to comprehend the salt removal mechanism, electricity production, and desalination performance in the anode, cathode, and desalination chambers which are currently lacking in this study. To broaden the practical application of MDC, it is worthwhile to investigate their performance in domestic R.O. Reject water treatment, particularly ion migration, which can have negative effects on the water in the surrounding environment if disposed of directly and continuously for an extended period of time. In this study, MDC was constructed and used to desalinate firstly simulated saline water and then domestic R.O. reject water in microbial desalination cell setup with graphite electrode assembly. Finally, salt removal, changes in COD and conductivity of the desalination chamber, as well as MDC stability and characterization in terms of current and power density were demonstrated along with the advantages and disadvantages of the fabricated MDC methods.

Materials and methods

Microbial desalination cell (MDC) construction

The proposed MDC consisted of three polypropylene tubular compartments (diameter 6 inches) stacked sequentially in a horizontal arrangement having a total volume of 100 ml each (Fig. 1). Graphite sheet (4 × 3 × 0.5 cm) grade FC-GR347B was used as electrodes in both anode and cathode chambers. The separators for the three chambers were anion and cation exchange membranes, namely Fumasep FAS PET 75 for separating the anode chamber from the desalination chamber and Fumasep FKB PK 130 for separating the desalination chamber from the cathode chamber. Both the graphite sheet and ion exchange membranes were ordered from Fuel Cell Store (Texas, USA).

Experimental setup

Two types of MDC setups were examined to treat standardized simulated saline water sample, with the best performing one being used to treat domestic R.O. reject water. MDC setup1 consisted of *Bacillus velenzeus* strain AD1-ELB, cultured as anolyte in the anode chamber and 100 mL of $K_3Fe(CN)_6$ solution of 100 mM concentration as catholyte in the cathode chamber making it a Ferrocyanide-redox MDC. The *Bacillus velenzeus* strain AD1-ELB was identified as an electrogenic bacteria and isolated from cow dung in a recent study (Dongre et al. 2022) and used in the MDC setups. The MDC setup 2 included *Bacillus velenzeus* strain AD1-ELB in anolyte, while catholyte consisted of 5% (w/v) cow dung slurry in single strength nutrient broth, thus making it Biocathode MDC. Fresh cow dung weighing approximately

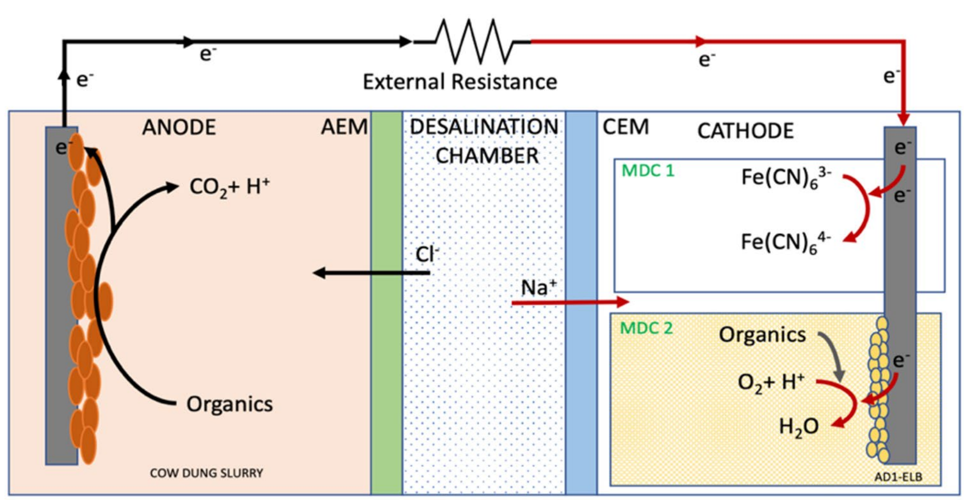

Fig. 1 Diagram of microbial desalination cell unit. *AEM* anion exchange membrane, *CEM* cation exchange membrane

700 g was gathered straight from a local dairy farm and left to dry for 3 days at room temperature in an open container. The top stiff layer of cow manure was removed after 3 days. A 5% (w/v) cow dung slurry was prepared using autoclaved distilled water (Yogamoorthi et al. 2018).

Setups 1 and 2 were utilized to treat simulated saline water generated with 5 g/L NaCl first, and the best of the two MDCs in terms of desalination was then used to treat domestic R.O. reject water, which was MDC setup 2 in this study. All MDCs were operated in batch mode for 31 days at 30 °C with the same external load range (820 kΩ to 100 Ω) and matching electrode surface area of 31cm^2 and 28.27 cm^2 ion exchange membrane cross section. Prior to inoculation, the cell was sterilized by autoclaving (15psi, 121 °C for 20 min) in a sealed box and then dipping each component for 10 min in a sterile 90% w/w ethanol/water solution in a laminar air flow cabinet with UV light on, followed by drying on components in the same laminar air flow cabinet with UV light on for another 20 min to ensure ethanol evaporation and a sterile surface environment inside the device upon assembly as somewhat similar to a previously described start-up approach, as employed by Borjas et al. 2017, was followed for all MDC configurations under examination (Borjas et al. 2017). The nutrient broth simulated saline water and RO Reject water solutions used in the MDCs were firstly sterilized using an autoclave at 15psi, 121 °C for 20 min. The cation and anion exchange membranes were washed in sterile 0.5 M NaCl solution and stored in autoclaved distilled water for 24 h at 25 °C to remove any surface additives and then placed with the stabilizing spacers between the respective chambers and then the MDC was sealed in laminar air flow cabinet. The anolyte, a pure culture of *Bacillus velenzeus* (strain AD1-ELB) (2 ml of exponential-phase culture with OD 600 nm = 1), was inoculated into the anode compartment for MDC setups 1 and 2. In MDC setup 1, 100 mL of $K_3Fe(CN)_6$ sterile solution of 100 mM concentration was utilized as catholyte, and in MDC setup 2, a solution of 5% (w/v) cow dung slurry in single strength nutritional broth was used as catholyte. After assembling the electrodes in both anode and cathode chambers and their respective solutions, the MDC with a vacant middle desalination chamber was kept in a BOD incubator for 3 days at 30 °C enabling microorganisms to grow on the electrode surface (graphite sheet). After incubation, the water samples were introduced into the middle desalination chamber. Once the bioanode and biocathode became stable showing the least variation in current output, the desalination cycle was initiated by replacing the sample in the middle desalination cell with fresh solutions. The desalination cycles were concluded when the conductivity of the saline reservoir was less than 1000 µS/cm, since this value was regarded to be the optimal value for water quality (Council Directive 75/440/EEC 2019; Li et al. 2019).

Electrochemical calculations

The open circuit voltage was recorded by a hand-held digital multi-meter (Haoyue DT830, India) at the regular time interval of every 24 h for a duration of 31 days.

Current (*I*) was calculated using ohm's law as a ratio of cell voltage (*V*) to resistance (*R*) across the different resistors in the 820 kΩ to 100 Ω range:

$$I = V/R.$$

Power (*P*) was calculated as the product of cell voltage and current:

$$P = V \times I.$$

Further, current (*j*) and power (*p*) density were calculated by dividing with the surface area of the electrode (A_{es}) (Sonu et al. 2020).

$$j = \frac{\mathrm{I}}{\mathrm{A_{es}}}$$

$$p = \frac{\mathrm{P}}{\mathrm{A_{es}}}.$$

Salt removal percent, *SR%*, refers to the percentage of NaCl depleted for each desalination cycle, expressed as follows:

$$\mathrm{SR\%} = \frac{c_i - c_f}{c_i}$$

where c_i and c_f indicate the salt's initial and final molar concentrations in the desalination chamber (mol/m^3), respectively (Ramírez-Moreno et al. 2019).

Change in COD for electrolyte in desalination chamber (COD%) is expressed as follows:

$$\mathrm{COD\%} = \frac{\mathrm{COD}f - \mathrm{COD}i}{\mathrm{COD}i}$$

where COD_f is the final COD value and COD_i is the initial COD value.

Analytical methods

Electric conductivity and pH measurements were carried out using an HQ11D conductivity meter (HACH) with microprobes for pH and conductivity measurements (Ibrahim et al. 2019). Both measurements were recorded at 25 °C. For total COD determination, 5 mL of sample were collected and kept at 4 °C until the COD was determined using the dichromate reflux technique, which involved adding a specified amount of oxidant to the sample and afterward boiling the mixture for 20 min till the sample was digested. The oxidant oxidizes the COD of the sample in this stage. The initial concentration of organic species may be estimated after a particular duration of oxidation by calculating the quantity of the remaining oxidizing agent. The sample was then refluxed for 2 h in a strong acid solution containing a known quantity of potassium dichromate ($K_2Cr_2O_7$) in the presence of an Ag_2SO_4/$HgSO_4$ combination, which converted chromium (VI) to chromium (III) during oxidation. The quantities of oxidant were calculated using an ultraviolet/visible spectrophotometer at 670 nm (Zendehdel et al. 2022). Chemical characterization of domestic R.O. rejects water was done at Jagdamba Laboratories, Bagru, Jaipur, for parameters like concentration of calcium, magnesium, chloride, sulfate, sodium, potassium, and phosphate using titration methods as standardized in IS 10500:2012 and IS:3025 for drinking water provided by government of India. The flame photometric analysis and inductively coupled plasma mass spectrometry (ICP-MS) analysis were done by sending samples to CEG test house, Malviya Nagar, Jaipur.

Field emission scanning electron microscopy imaging (FESEM)

FESEM imaging was performed to determine the surface morphology of the graphite electrode (Anode). About 1cm^2 size sections of the graphite anode were cut before and after 31 days of MDC operation. Only the section after 31 days of MDC operation was rinsed twice with 0.01 mol L^{-1} PBS buffer (pH 7.4). The sections were then dehydrated in a graded series of ethanol 50% and 100% for 20 min before being dried overnight in a desiccator and the electrode section before MDC initiation was used directly. The sections were coated with gold before imaging on a JEOL JSM-6480LV Scanning Electron Microscope (acceleration voltage 6 kV, HV-mode, SEI detector) (Mansoorian et al. 2020).

Results and discussion

Both MDC setups 1 and 2 (i.e., Ferricyanide redox and Biocathode with simulated saline water) were compared at laboratory scale. Experiments were carried out using simulated saline water (NaCl 5 g/L) with an initial electric conductivity of 9010 μS/cm (Fig. 4a). Furthermore, the MDC setup 2 was more efficient in salt removal, which was used to treat domestic R.O. reject water with an initial electric conductivity of 6390 μS/cm (Fig. 6a).

Simulated saline water desalination

Maximum power density of 0.212 and 0.221 μW / cm^2 and, the maximum current density of 3.117 and 3.291 μA / cm^2 were recorded in MDC setups 1 and 2, respectively (Fig. 2a, b). This was recorded after operating the MDC for 31 days. The MDC setup 2 (biocathode) showed an increase of 5.6% and 4.2% in current and power density, respectively, when compared with MDC setup 1 (ferricyanide redox) and this is because of the lack of oxygen (batch reactor MDC), molecules like nitrates, manganese, carbon dioxide, and others operate as electron acceptors. With the exception of their role as electron mediators in anaerobic environments, they have similar, if not superior, metabolic activity to that of oxygen (He and Angenent 2006). Moreover, cow dung is rich in nitrogen and manganese-based compounds, as well as various organic matter (Randhawa and Kullar 2011), thus providing alternatives for terminal electron acceptors other than oxygen at the cathode. Therefore, anaerobic biocathode inhibits the back-diffusion of oxygen through the selective ion exchange membrane, preventing electron loss (He and

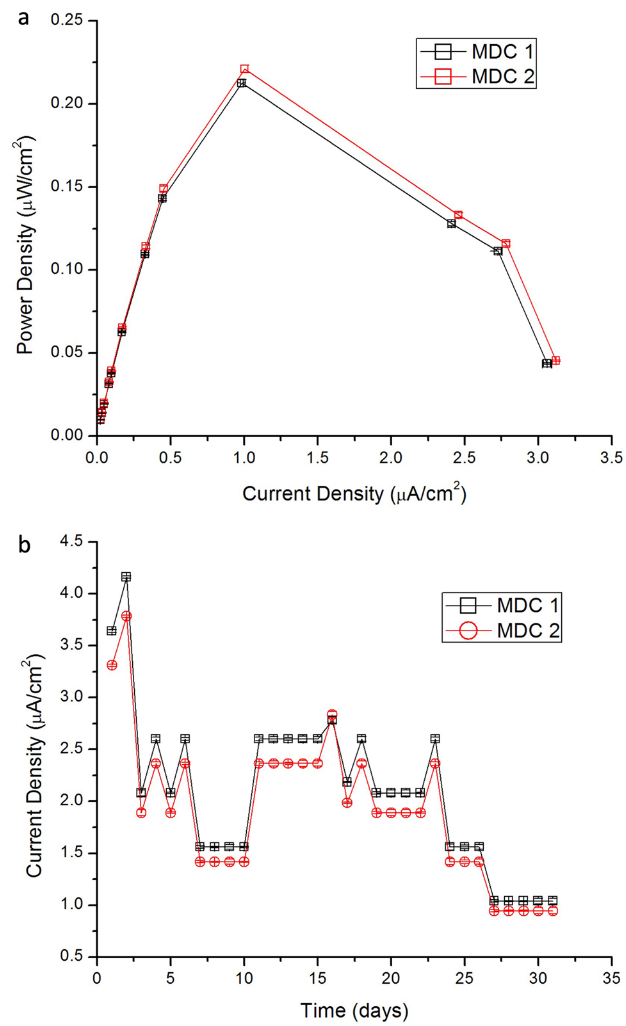

Fig. 2 **a** Power density (μW/cm^2) vs current density (μA/cm^2) and **b** current density (μA/cm^2) vs time (days) observed in MDC setups 1 and 2

Angenent 2006), and thus improve the performance of the microbial desalination cell when compared to the ferrocyanide-redox approach. All of this has a direct relationship with the mixed culture of microorganisms in the cow dung slurry, which aids in the cathode reactions providing greater ability to run the desalination process (Jatoi et al. 2022).

However, the range of current densities observed during desalination in MDC systems using the ferricyanide reduction reaction demonstrated less potential than expected, owing to the reaction's slow kinetics, which is common in microbial fuel cell-based desalination systems at neutral pH and increases methane generation while slowing electron release, reducing MFCs overall power density range. With a higher pH of 8.0 and above, the efficiency of methanogenic microbes is reduced, and electrons are released to aid in the oxidation of the substrate (Singh et al. 2019). Despite the reduced thermodynamic potential in the cathode compartment when biocathode reduction is utilized, the increase in MDC kinetics gives greater accessible potential in MDC systems due to the presence of mixed culture and alternative electron acceptors other than oxygen in the cathode chamber (He and Angenent 2006; Randhawa and Kullar 2011). In retrospect, compared to the ferricyanide reduction approach, the mixed culture of microorganisms in the cow dung slurry or Biocathode can provide rapid MDC kinetics with help of a biofilm formation on the graphite electrode. The build-up of sodium ions on the graphite electrodes in a dynamically adsorbed initial layer produces an effective positive surface charge density, which is charge-balanced by the accumulation of chloride ions on the other electrode after passing through the selectively permeable membranes, respectively (Finney et al. 2021). The concentration of ions falls exponentially at the lowest overall electrolyte concentrations, with the layer thickness diminishing with increasing concentration (Finney et al. 2021). As the NaCl concentrations increase, overlapping layers of cations and anions start developing before the net surface charge is neutralized on the electrode, resulting in the stable biofilm formation and rise in MDC kinetics for biocathode assembly (Finney et al. 2021).

The AD1-ELB bacterial strain was strongly adhered to the surface of the electrode after 31 days of MDC inoculation, as observed by FESEM imaging (Fig. 3a, b). Bacteria adhering to the anode have a uniform, consistent morphology. The bacteria's biofilm formation over the 31-day trial period may serve as biocatalysts in electron transfer to the anode. In a recent study (Dongre et al. 2022), three-minute exposure of low-frequency ultrasonic treatment to AD1-ELB strain resulted in a maximum power density of 4.33 μW/cm^2 and a current density of 51.78 μA/cm^2 in the MFC, which declined after four or five minutes of exposure. It further demonstrated stabilization of OCV after the sixteenth day of inoculation. This is because the microbial cell adherence to a stable electrode surface is improved by biofilm formation. Under these circumstances, the carbon in the graphite support becomes positively charged, promoting the strong attachment of negatively charged bacteria. According to the literature, whenever the biofilm is developed using applied potential, the MFC start-up time is reduced when compared to the identical MFC where the biofilm was generated without polarization (Marcílio et al. 2021).

The electric conductivity for simulated saline water desalination under the mentioned experimental conditions is depicted in Fig. 4a (setups 1 and 2). Since electric current is also linked to ion species movement, the Salt Removal rate (i.e., percentage of NaCl removed from the desalination chamber for each desalination cycle) for the Biocathode MDC was 83% and for ferrocyanide-redox, MDC was 78% making Biocathode MDC more effective desalination assembly (Table 1).

The current density in MDC setup 1 decreased from 4.16 μA/cm^2 (on day 2) to 1.03 μA/cm^2 in 31 days (Fig. 2b). This reduction might be due to a fall in the conductivity of the desalination compartment from 9010 to 1000 μS/cm (Fig. 4a). In the case of the MDC setup 2 (biocathode), the current density dropped from 3.78 to 0.94 μA/cm^2 in 31 days

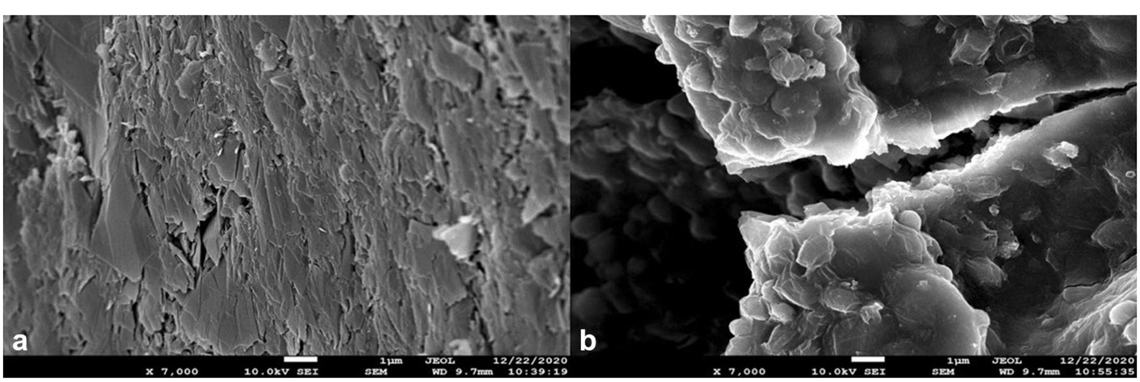

Fig. 3 FESEM image of graphite anode of MDC setup 2 **a** before inoculation and **b** after 30 days of inoculation

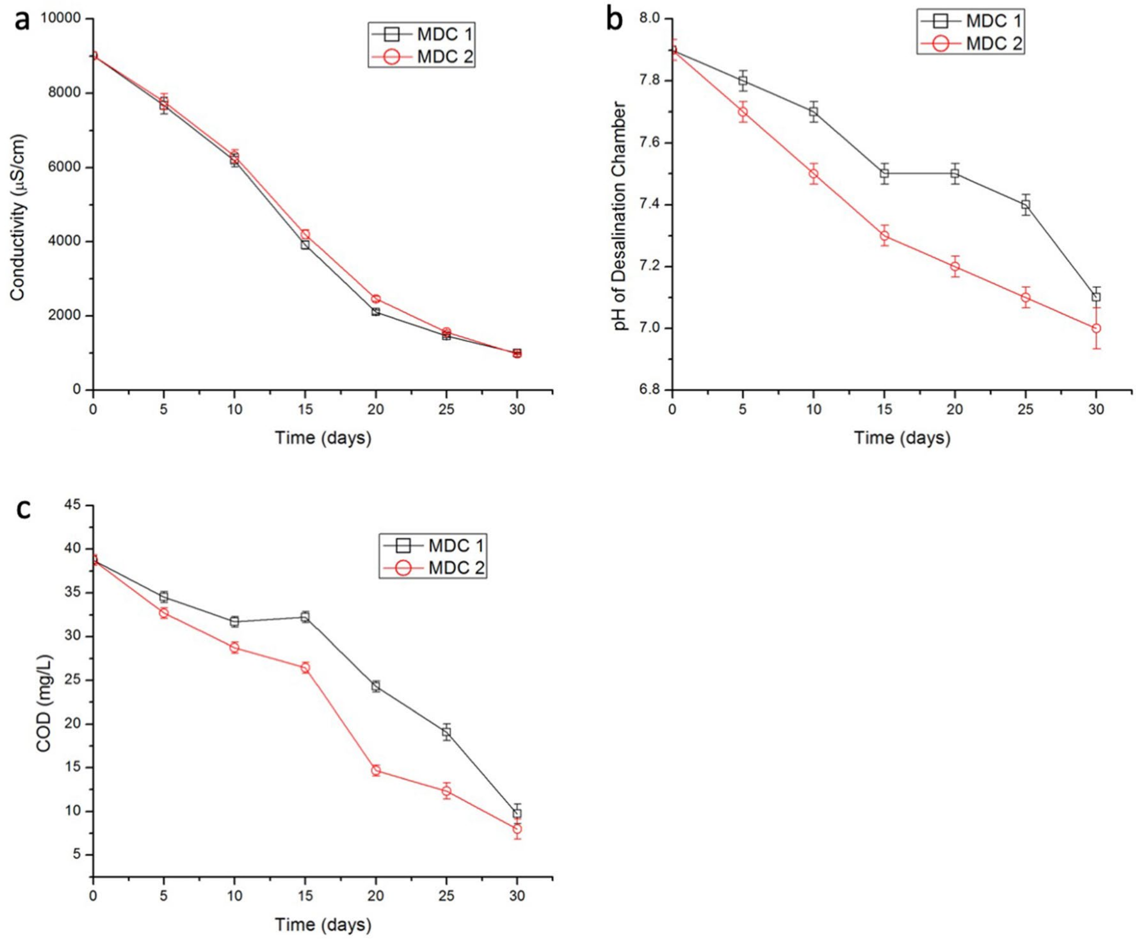

Fig. 4 Change in conductivity (**a**), pH (**b**), and COD (**c**) of electrolyte in desalination chamber of MDC setups 1 and 2 during 30 days of incubation

Table 1 Salt removal percent for MDC setups 1 and 2

Setup	Concentration of NaCl (initial) g/mL	Concentration of NaCl (final) g/mL	Salt removal %
MDC 1	5	1.1 ± 0.1	78 ± 2
MDC 2	5	0.85 ± 0.01	83.1 ± 0.1

(Fig. 2b), as a drop in the conductivity in the desalination compartment from 9010 to 967 μS/cm was also recorded (Fig. 4a). But since electric conductivity decreased during the trials, the drop in current density in both MDCs could be attributed to an increase in the MDC's internal resistance and substrate consumption in the electrode chambers, as well as a decrease in ion concentration in the desalination chamber acting as a salt bridge. These findings are consistent with earlier MDC behavior while operating in batch mode (Borjas et al. 2017). The salt removal rate for all desalination cycles surpassed 70%, showing that both MDCs function well as desalination devices. The pH value of the electrolyte in the desalination chamber for setups 1 and 2 remained between pH 7.9–7.1, respectively, and never fall in an acidic range (Fig. 4b).

In terms of wastewater treatment, MDC setups 1 and 2 treated simulated saline water removed 74.9% and 79.5% of COD of the electrolyte in the desalination chamber, respectively (Fig. 4c). This COD reduction in the desalination chamber provides the ions that generate electric current and drives the desalination process (Koomson et al. 2021). This observation indicates that it is possible to generate electricity while desalinating water and treating wastewater (Carmalin Sophia et al. 2016; Sevda and Abu-Reesh 2018). These results also suggest that desalination was largely due to electricity production by microbes also with the possibility of dilution resulting from water osmosis from the less concentrated anode and cathode chambers into the desalination chamber. A similar observation of the dilution effect due to the concentration gradient was reported by Mehanna et al. (2010a, b) (Mehanna et al. 2010b). Also, the large inter-membrane distance of 3.5 cm of the MDC in this study, possibly contributed to the dilution effect observed (Abubakari et al. 2019). Earlier research by Ping and He (2013) indicated that longer inter-membrane distances promoted water osmosis into desalination chambers (Ping and He 2013; Ping et al. 2013).

Domestic RO reject water desalination

It was evident from the chemical characterization of domestic R.O. reject water contained a variety of ions and salts (Table 2). This domestic R.O. rejects water was treated in MDC setup 2 and demonstrated higher salt removal when compared with simulated saline water treatment (MDC setups 1 and 2) containing only NaCl salt**.** In MDC setup 2 treating domestic R.O. reject water, it achieved a maximum power density of 0.337 μW/cm^2 (Fig. 5a) and the current density decreased from 4.63 μA/cm^2 (at day 2) to 1.15 μA/cm^2 in 31 days (Fig. 5b). This was in accordance with a 78.3% drop in conductivity in the desalination chamber of MDC setup 2 treating domestic RO reject water (Fig. 6a). This is because different direct or mediated electron transfer mechanisms may occur at the biocathode surface at the same time, based on bacterial membrane proteins and cytochrome molecules with lower redox potential, as well as some metabolic end products that can be oxidized at the electrode surface, acting as mediators for electron transfer (Ebrahimi et al. 2018). All of this is possible in the biocathode because it contains a community of mixed bacteria metabolizing various organic substrates (cow dung slurry) that operate together as one (Randhawa and Kullar 2011).

It is important to note that for MDC setups 1 and 2, the salt removal was around 75%, indicating promising directives when compared to the partial desalination as previously reported with respect to the cathode reaction of about 50% salt removal (Zhang and He 2015; Moruno et al. 2018).

Table 2 Chemical characteristics of domestic RO reject water used in desalination chamber of setup 2

S no.	Properties	Range
1	Turbidity	Nil
2	pH	8.23
3	Total dissolved solids (mg/L)	12,660
4	Electrical conductivity (μS/cm)	6390
5	Calcium (mg/L)	824.18
6	Magnesium (mg/L)	214.70
7	Chloride (mg/L)	2824.65
8	Sulfate (mg/L)	1130.80
9	Sodium (mg/L)	1890.40
10	Potassium (mg/L)	850.70
11	Phosphate (mg/L)	4.66
12	Chemical oxygen demand (COD)	43.82

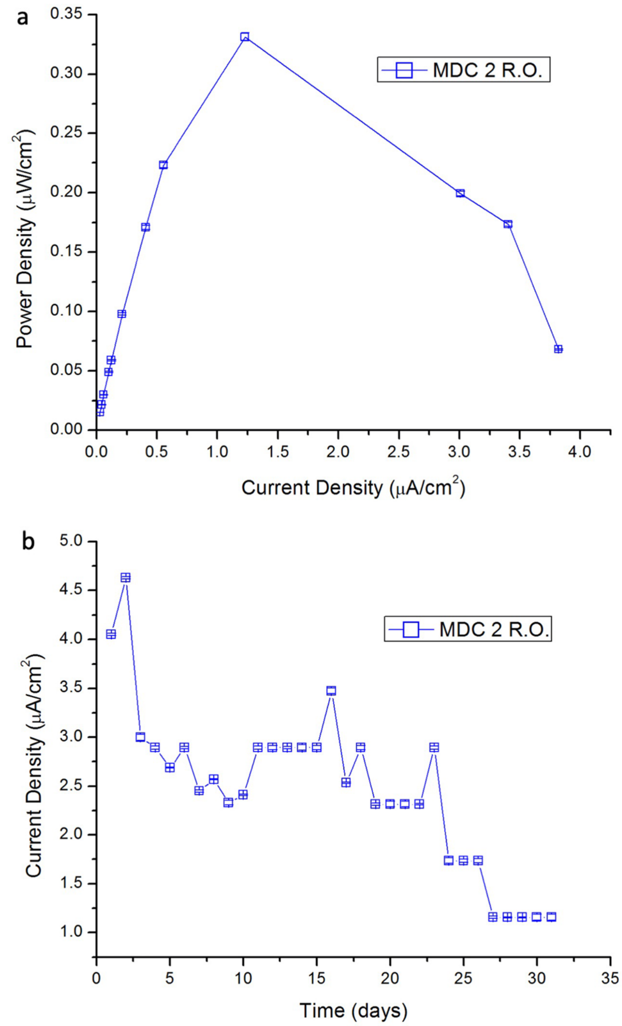

Fig. 5 **a** Power density (μW/cm^2) vs current density (μA/cm^2) and **b** current density (μA/cm^2) vs time (days) observed in MDC setup 2 using domestic RO reject water

This result might be linked to the high available potential for driving ion migration, which is aided by the selective ion exchange membranes utilized in both MDC setups, which assist in successful ion transfer. Ion back-diffusion transit became a significant constraint, which was mitigated by the buffering capability of domestic R.O. reject water (Ebrahimi et al. 2018). As a result, the desalination chamber showed a zero net salinity balance (Ping et al. 2016; Xie et al. 2021; Yang et al. 2021). The presence of the desalination chamber between the anode and cathode chambers, as well as the buffering capability of the Domestic R.O., reject water due to the diversity of ions and salts already present in it, reducing the inhibitory impact of oxygen diffusion in the anode chamber (Ebrahimi et al. 2018). This impact is seen in Figs. 6a and 4a as an asymptotic trend of conductivity with pH between 8 and 7 for all MDC configurations (Figs. 6b and 4b). The COD reduction percentage increases

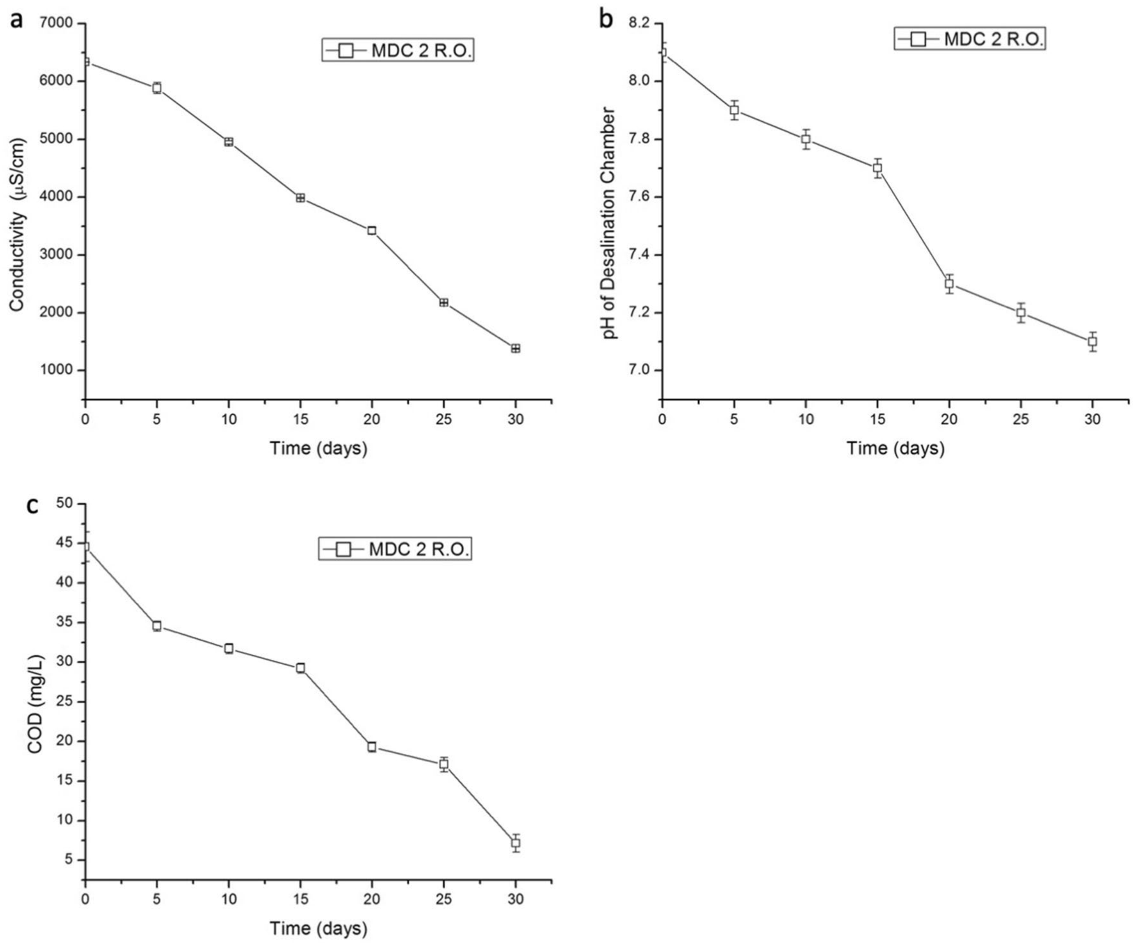

Fig. 6 Change in conductivity (**a**), pH (**b**), and COD (**c**) of electrolyte in desalination chamber of MDC setup 2 using domestic RO reject water during 30 days of incubation

in proportion with the sodium chloride content (Mohamed et al. 2016), and is related to the fact that the higher the chloride ion concentration, the greater the capacity of chloride ions to eliminate any passive oxidizing components that tend to collect on or around the anode, limiting anode dissolving and increasing desalination of the microbial desalination cell (Mohamed et al. 2016).

In the case of domestic RO reject water treatment, the concentration of sodium ions reduced from 1760 to 352 mg/L, potassium ions reduced from 825 to 187 mg/L, and calcium ions reduced from 817 to 220 mg/L resulting in a percent reduction of 79, 77, and 73%, respectively, during 31 days. Flame photometry (Fig. 7a) and ICP-MS (Fig. 7b) analysis revealed nearly identical ion concentrations. COD removal (84%) (Fig. 6c) and average desalination percentage of Na, K, and Ca ions (76%) for domestic RO reject water treatment yields a favorable outcome due to the provision of a buffering zone (desalination chamber) in the midst of both electrode chambers, as well as the buffering capability of the domestic RO reject water (Mohamed et al. 2016; Ebrahimi et al. 2018). This will improve the overall performance of the microbial desalination cell including the assistance of a consortium of microorganisms with several electron transfer mechanisms operating at the same time (Ebrahimi et al. 2018).

Simulated saline water desalination is simple in terms of real-world application as it only contains sodium and chlorine ions. In the case of domestic R.O. reject water desalination, MDC setup 2 (biocathode approach) may accomplish optimum desalination, since the reject water may include a wide range of ions and the mixed culture of cow dung slurry can subsequently use it. In a similar study, Yogamoorthi et al. (2018), discusses the prospect of sustainable generation of electricity, which could be attributed to two factors: first, the quality of cow dung used as a substrate; and second, the concentration of potassium permanganate solution (2%) used as catholyte in their study (Yogamoorthi et al. 2018). Regarding the quality of the cow dung utilized in the present study, fresh cow dung was pre-processed before being placed in the MFC with a cow dung slurry at 5% (w/v) with water.

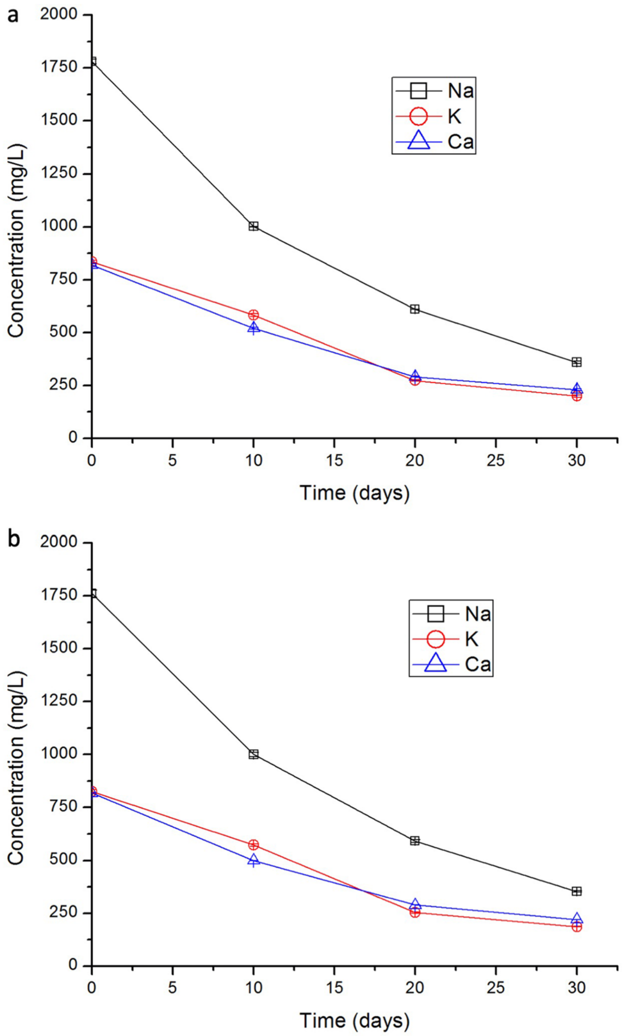

Fig. 7 Change in the concentrations of Na, K, and Ca in desalination chamber of setup 2 with domestic RO reject water during 30 days of incubation as analyzed by **a** flame photometry and **b** ICP-MS

The cow dung once collected from the site was left at room temperature in an open container for 3 days for hardening the surface layer, which aided in the formation of an anaerobic environment underneath the top layer. The pre-processing of fresh cow dung stimulated the development of the microbial population in the cow dung (Yogamoorthi et al. 2018). Because it was a microclimate in an acidic medium, it could only sustain a certain type of microorganism, and those bacteria would live and thrive to consume the organics in the cow dung.

According to Abubakari et al. (2019), their MDC obtained a maximum COD reduction of 49%, perhaps owing to fermentation and methanogenesis. Furthermore, other electron acceptors like nitrates and oxygen have contributed to the poorly observed Coulombic efficiency. In a typical batch cycle of their study, the MDC removed 1.07% of the nitrate. The elimination of nitrate was attributed to heterotrophic denitrifying bacteria. Phosphorus removal of 9.97%, on the other hand was observed, which was connected with the activities of polyphosphate accumulating bacteria (Abubakari et al. 2019). As a result, phosphorus reduction may have happened early in the experiment before anaerobic conditions were established in their setup. When they purged analytes with nitrogen gas prior to experimental commencement, the formation of anaerobic conditions was delayed. Thus, cow dung base microbes are able to utilize a variety of ions when used in MDC setup.

Furthermore, because cow dung slurry is inexpensive, if Biocathode MDC shows an increased rate of salt removal and energy production in the MDC device, it can be inexpensively replenished when exhausted. As discussed earlier, most MDCs have significant reagent and material costs. Thus, low-cost and effective techniques for regeneration of the redox mediator catholyte, such as exploiting novel sources of electrogenic microorganisms, must be investigated in future studies (Liang et al. 2009).

Conclusion

Microbial desalination cell combines microbial fuel cells with electrodialysis in a singular design to create freshwater at a minimal energy expenditure and furthermore, MDC provides current and power density with the use of treated wastewater. We were able to evaluate the desalination performance of both systems and identify the significant technological restrictions while treating simulated saline water and domestic R.O. reject water using two identical MDC experimental setups with different cathode approaches (ferricyanide redox and biocathode). Even though the salt removal rate and COD reduction rate increased by 5.0% and 4.6%, respectively, which is one order of magnitude higher than those produced using a ferricyanide redox method, the biocathode approach outperforms ferricyanide redox in simulated saline water, increasing the desalination rate from 78 to 83% and the COD reduction rate from 74.9 to 79.5%, respectively, with an average 5% increase in current and power density. When setup 2 (biocathode) was used for domestic RO reject water, maximum current and power density of 3.81 μA/cm^2 and 0.337 μW/cm^2 were recorded, with a desalination and COD reduction of 76% and 83.9%, respectively. The study establishes the practicality of MDC technology, as well as its limitations, benefits, and downsides when applied in a real-world setting. Catholyte regeneration methods are being investigated further in order to reduce costs and allow low-cost and successful desalination utilizing cow dung slurry. A trade-off between MDC performance and costs may be addressed for future upscaling and application in actual circumstances. As a result, the findings of this study will help to enhance MDC technology and scale it up for usage in real-world circumstances, with a focus on novel sources of electrogenic bacteria.

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Author contributions AD wrote and interpreted the data of the manuscript; MS contributed in the conception of the work; RS and NKP edited the final version of the manuscript. All the author(s) read and approved the final manuscript.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human or animal subjects performed by any of the authors. Therefore, it is not applicable here.

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on

Sustainable Development Techniques of Water and Environment (SDTWE-2022)

Organized by

Kautilya Institute of Technology & Engineering

Certificate of Appreciation

Ref. No.: KITE/2021-22

This is to certify that Prof. (Dr.) Meena Kumari Sharma, Professor & HOD, Manipal University, Jaipur has delivered a keynote speech on the title of "Sustainable Techniques for Wastewater Management in Non Sewered Areas" in the Faculty Development Programme on "Sustainable Development Techniques of Water and Environment" (SDTWE-2022) organized by Kautilya Institute of Technology & Engineering, Jaipur during March 21st to 25th, 2022.

Principal
KITE, Jaipur

Convener
SDTWE-2022

Department of Water Supply, Sanitation and Environmental Engineering

Prof. D. Brdjanovic, Ph.D
T +31 15 215 17 76
E d.brdjanovic@un-ihe.org

Dr. Anil Dutt Vyas,
Manipal University Jaipur,
India.

From:
Prof. D. Brdjanovic, PhD

Subject: Invitation to GSGS Summit in Ahmedabad, India.

Date:
August 22, 2022.

Dear Dr. Anil Dutt Vyas,

It is my pleasure to invite you to the Asian Global Sanitation Graduate School (GSGS) Summit that will take place in Ahmedabad, India, from 1-3 November, 2022.

The Summit will focus on the present and the future of the GSGS in Asia with particular focus on sustainability of the GSGS program at your university, update of the program, and communication, co-operation and networking. A detailed program will be shared with you soon.

Another objective of the Summit is to generate interest and commitment of other academic institutions across Asia and to make plans for the future of GSGS in this continent.

You are expected to arrive in Ahmedabad on Monday, October 31, 2022, and to depart on Friday, November 4, 2022. IHE Delft administration will arrange and pay an air ticket for you. What you need to do is to, as soon as possible, confirm the flight itinerary suggested on the GSGS Telegram Channel or propose your desired schedule for your flight from your home base to Ahmedabad and back. We shall also need a copy of your valid passport featuring your photo and personal details in order to purchase your economy class ticket. Your passport data will be used only for the purchase of tickets through our network of travel agencies. The ticket will be sent to you by our travel officer via email. The travel arrangements from your home to the airport and back is your responsibility, but the costs will be reimbursed to you based on the proof of purchase of transportation. Please note that we shall prepare a declaration form for the reimbursement that you will need to send to us after your return home, signed and with your bank account details. Upon your return home, please send a single PDF file with the signed declaration form and all the proofs of the costs incurred, to Ms. Nnamaka Ojogbo (n.ojogbo@un-ihe.org), the GSGS admin assistant. We shall make a reimbursement to you soon after we receive your proofs via bank transfer.

You are responsible for checking and, if required, obtaining the visa to enter Ahmedabad in time. The costs for your visa will be reimbursed by IHE Delft based on the proof of purchase. You may wish to use this letter to obtain the visa, if needed.

Please, observe the entry regulations concerning the COVID check requirements. Also, the costs for your COVID test will be reimbursed by IHE Delft based on the proof of purchase, if needed. Do not underestimate the time that it may take to obtain all the necessary entry requirements, so please plan ahead of time and prepare accordingly.

You may also be required to do a COVID check on departure. We shall investigate if we can organise this for you sometime on Thursday, November 3, 2022, and if possible, in the hotel where you stay. The Summit will also take place in the same hotel (except for the opening ceremony which will take place at CEPT University). At the moment we are identifying the appropriate hotel for our stay and the event.

It is very likely that we shall arrange pick-up services for you from the airport to the hotel and back. If not, you need to take care of that by yourself and we shall reimburse you for the incurred transportation costs based on the proof of purchase.

Breakfasts and lunches will be arranged for you in the hotel, where we will secure a room for you for four nights, Monday night till Thursday night, with departure on Friday. IHE Delft will cover the costs of hotel, breakfasts and lunches in the hotel. For dinners (at location of your choice) we shall make an allowance according to IHE Delft regulations for Ahmedabad. Dinners will be reimbursed individually via the expense claim form mentioned earlier, based on the proofs and within the allowance which will be communicated to you in time. So, you will need to pay for your dinner yourself and we shall reimburse you later for it.

In case you wish to arrive earlier (before Monday, October 31) and/or depart later (after Friday, November 4), please inform us about that. However, the hotel and other staying costs for these extra days must be covered by you. In case there are no available flights for you to arrive in Ahmedabad on Monday, October 31, and you need to arrive a day earlier, we shall cover the additional hotel overnight stay. The same is also applicable in a case where there are no flights to return to your home on Friday, November 4, and so you need to depart a day later. Seeing that we have a limited budget for this Summit, we hope that you will be able to find a flight that will bring you to Ahmedabad and back home at our preferred schedule.

The person to send your preferred travel schedule and copy of the passport is Ms. Nnamaka Ojogbo (n.ojogbo@un-ihe.org), the GSGS admin assistant.

In terms of preparation, we shall inform you timely about the Summit agenda and what we expect from you before, during and after the Summit.

Our partner, CEPT University, has formed a great support team and will be assisting us in the organization and implementation of this Summit.

So, for the time being, that is all from us. Looking forward to seeing you in Ahmedabad soon.

Best regards,

Prof. Dr. Damir Brdjanovic
Professor of Sanitary Engineering
Director Global Sanitation Graduate School

To

Dr. A. D. Vyas

Deputy Director Students Welfare,

Manipal University Jaipur

Date: 14 March 2022

Subject: Invitation to deliver an offline expert session to the Environmental and Civil Engineering students and faculty members at Marwadi University, Rajkot, Gujarat

Respected Sir

Namaste!

This is to cordially invite you to deliver an expert session on *"Water & Sanitation, Faecal Sludge Management, Urban water conveyance planning, and management"* to the students of the environmental engineering and civil engineering programs. The session has been organized in two parts on 25 March and 26 March 2022 at the university campus to make it effective for the learners.

During your visit, we have planned to demonstrate a few best practices regarding the green campus initiatives and we are eager to receive your valuable inputs for the advancement and strengthening of the same.

It will be a privilege and pleasure to have you with us.

We are looking forward to your support and consent for the invitation.

We are sure that it will be a great learning and knowledge-sharing session for all the students and faculty members.

Thank you

Yours sincerely

Dr Ankur Bhogayata

Head of CED-FOE, Marwadi University ,
+919427431112

SCHOOL OF WATER AND WASTE

AANETI

ANIL AGARWAL ENVIRONMENT TRAINING INSTITUTE

(A Unit of Centre for Science and Environment)

CERTIFICATE OF PARTICIPATION

Advanced Training Programme on

Decentralised Wastewater Management and Local Reuse

This is to certify that SAGAR GUPTA has participated in the advanced residential training programme on **"Decentralised Wastewater Management and Local Reuse"** organised by the School of Water and Waste, Centre for Science and Environment (CSE), New Delhi from **May 10 - 13, 2022** at Anil Agarwal Environment Training Institute (AAETI), Nimli, Rajasthan.

With best wishes,

DS Kapur

Depinder Singh Kapur
Director – Water Programme
Centre for Science and Environment

A REPORT ON
INDUSTRY EXPERT SEMINAR
ON

WATER SECURITY AND SUSTAINABLE INFRASTRUCTURE

Even Organizer
Dr. Mohammad Parwez Akhtar, Associate Professor
Department of Civil Engineering
School of Civil & Chemical Engineering Manipal University

Department of Civil Engineering in collaboration with Directorate of E Cell organized an offline seminar under industry expert lecture series to foster the entrepreneurship mindset among civil engineering students of Manipal University Jaipur on 8th November 2022 at Room No. 307, AB1 Maipal University Jaipur, Jaipur (Raj.)

On 8th November 2022, (at Room No. 307 AB1, MUJ), the industry guest lecture was organized in physical mode by the Civil Engineering Department, Manipal University Jaipur. The esteemed Guest of the event was (Guest Speaker: Dr. Harinarain Tiwari, Managing Director, Floodkon Consultants LLP Noida India. The objective of the industry expert lecture was to acquaint the students about the importance of professional career building with adequate exposure on sustainable approach on water security and infrastructural development with specific focus on undermentioned thrust areas but not restricted to,

1. To learn the practical concepts, technicalities and to equip with the procedures for major engineering project

2. To provide a platform for students to discuss with industry expert for further career development.

3. To do formal MoU between Manipal University Jaipur and Floodkon LLP.

4. To create opportunities such as internships, minor and major projects, training and job placement, and research for students and faculties.

5. To build networking for counseling in future curriculum development.

More than 60 student/faculty members participants attended this physical event.

On this occasion, Prof. (Dr.) Bhawna Tripathi, Director SCCE and Dr. Meena Kumari Sharma, Head of the Department welcomed Dr. Harinarain Tiwari and encouraged attending students to ask their queries with the esteemed after his discussion. Dr. M. Parwez Akhtar formally introduced Dr. Harinarain Tiwari (Managing Director, Floodkon Consultants LLP Noida India) with brief discussion on Dr. Tiwari's credentials and achievement and experience. After his very fruitful speech and discussion with attendees, Dr. Tiwari expressed his gratitude for the august gathering.

HoD (Civil)

The vote of thanks was expressed by Dr. Meena Kumari Sharma. The entire event was smoothly conducted by a PhD Scholar. Ms. Shweta Kodihal.

Esteemed dignitaries and attending faculty members heaped praise for the successful organization of the event that would boost the morale of the participating students and shared the knowledge on the topic of “Water security and sustainable infrastructure”.

Images

Figure 1: Attendees in the seminar at Room No 307 AB1 during the lecture

Figure 2: Dr. Harinarayan Tiwari delivering his lecture

Figure 3: Dr. Harinarayan Tiwari interacting to Civil Engineering students

Figure 4: Attendees listening to Dr. Harinarayan Tiwari

Figure 5: Esteemed guest signing an MoU with MUJ jointly managed by E-Cell and Department of Civil Engineering

Figure 6: Visit of the esteemed guest the Registrar MUJ for MoU signing ceremony with MUJ jointly managed by E-Cell and Department of Civil Engineering

Circulation Email from MUJ Exchadmin to MUJ Faculty community for the event announcement

Invitation for Industry Expert Lecture_- Dr. Harinarayan Tiwari on 8th November 2022 from 12.15 PM to 2.00 PM

Exchadmin [MU - Jaipur] <exchadmin@jaipur.manipal.edu>
Mon 07-11-2022 14:13
To: MUJ Faculty <muj.faculty@jaipur.manipal.edu>

Dear All

Greetings!!!

The Department of Civil Engineering, Manipal University Jaipur cordially invite you to the **Industry Expert lecture**, on 8th November 2022. The Lecture will be delivered by **Dr. Harinarayan Tiwari, Managing Director, FLOODKON CONSULTANTS LLP, Delhi, India** on a very interesting topic with global significance on "Water Security and Sustainable Infrastructure".

Faculty members and students who all are interested in the domain of Water and sustainable Infrastructure, please join the lecture.

Time: 12:15 PM – 2:00 PM

Venue: 307, Academic Block 1

Regards,
Dr. Parwez Akhtar
Associate Professor (Civil Engineering)
Manipal University Jaipur
Contact: 8235630860

MANIPAL UNIVERSITY JAIPUR

FACULTY OF ARTS

SCHOOL OF HUMANITIES AND SOCIAL SCIENCES

DEPARTMENT OF ARTS

Societal Connect "Cleanliness Awareness Drive".

Date of Event : 28/09/2022

1. Introduction of the Event

Department of Arts School of humanities and social science in collaboration with DSW And NCC Air wing Cadets Manipal University Jaipur conducted a cleanliness awareness drive at MUJ Main gate to Gram Panchayat Dehmi Kalan on 28 September It was a physical activity involving the students or NCC Cadets.

2. Objective of the Event (bullet points or about 50 words)

- To spread awareness about cleanliness among villagers.
- To spread awareness about diseases related to a clean environment.
- To reach the shopkeepers and told them not to liter around shop

3. Beneficiaries of the Event

The event was conducted for Manipal university Jaipur students to be aware of social connect activity starting from the MUJ Main gate to Gram Panchayat Dehmi Kalan on 28 September It was a physical activity involving the Students of Department of Arts (SHSS) Manipal University Jaipur, and villagers of Dhemi kalan village

4. Brief Description of the event (about 200 words)

Department of Arts School of humanities and social science in collaboration with DSW And NCC Air wing Cadets Manipal University Jaipur conducted a cleanliness awareness drive at MUJ Main gate to Gram Panchayat Dehmi Kalan on 28 September 2022 It was a physical activity involving the students from Department of Arts (SHSS), NCC cadets, and some volunteers. Providing MUJ students exposure to the society around them through such societal connect activities. The event was inaugurated by Dr. Abhishek Shrivastava Deputy Director of DSW, Prof Richa Arora, Dr. Rina Poonia Deputy Director of Physical Education, and convenor of the event Mr. Mohit Sharma and Sanjeev Sharma NCC officer, Mr. Hemant Kumar NSS Program coordinator and Dr. Shyam Sundar Sharma were present.

5. Photographs

Faculty and students generating awareness about societal cleanliness

All faculty , students and GSWs together during the cleanliness drive

Organisers of the vent with director, SHSS

Students engaged in cleanliness awareness drive

6. **Brochure or creative of the event (insert in the document only)**

7. **Schedule of the event (insert in the report)**
   - Started at Manipal University main gate at 10:00 AM
   - 1st Stop Bus stop near water tank MUJ at 10:15
   - 2nd Stop Govt School Dehmi Kalan
   - Ends at Manipal University Main gate with refreshment distribution.

Attendance of the Event

S. no	Name of Institution	Place of Institution	Registration Number	Name of Attendee	Name of Dept
1	Manipal University Jaipur	Jaipur	221106005	ARJUN	Arts
2	Manipal University Jaipur	Jaipur	221106001	UTKARSH SINGH	Arts
3	Manipal University Jaipur	Jaipur	221106003	VAIBHAV VERMA	Arts
4	Manipal University Jaipur	Jaipur	221106004	HARSHIT GAUR	Arts

5	Manipal University Jaipur	Jaipur	221106006	HIMRATNA SINGH RANAWAT	Arts
6	Manipal University Jaipur	Jaipur	221106009	KARNI SINGH SHEKHAWAT	Arts
7	Manipal University Jaipur	Jaipur	201106001	ARYAN BHARGAVA	Arts
8	Manipal University Jaipur	Jaipur	201106011	HIMANSHU KUMAR	Arts
9	Manipal University Jaipur	Jaipur	201106013	PRASHANT KUMAR	Arts
10	Manipal University Jaipur	Jaipur	201106015	DIVYARAJ SINGH RATHORE	Arts
11	Manipal University Jaipur	Jaipur	201106016	DEVENDER	Arts
12	Manipal University Jaipur	Jaipur	201106002	ARYAN GANDHI	Arts
13	Manipal University Jaipur	Jaipur	211106004	LAVANYA RAJAWAT	Arts
14	Manipal University Jaipur	Jaipur	211106005	JAYANT BHATI	Arts
15	Manipal University Jaipur	Jaipur	211106006	ISHAAN YADAV	Arts
16	Manipal University Jaipur	Jaipur	211106007	ASHUTOSH GAUTAM	Arts
17	Manipal University Jaipur	Jaipur	211106015	RISHAB MODI	Arts
18	Manipal University Jaipur	Jaipur	209301181	Akshat Tyagi	B TECH IN COMPUTER SCIENCE & ENGINEERING (CSE)
19	Manipal University Jaipur	Jaipur	209301209	Manas Jha	B TECH IN COMPUTER SCIENCE & ENGINEERING (CSE)
20	Manipal University Jaipur	Jaipur	209205047	Vidhit Shetty	B TECH IN COMPUTER SCIENCE &

					ENGINEERING (CSE)
21	Manipal University Jaipur	Jaipur	209301363	Sarthak Srivastava	B TECH IN COMPUTER SCIENCE & ENGINEERING (CSE)
22	Manipal University Jaipur	Jaipur	209302258	Shreyansh Rai	B TECH IN COMPUTER SCIENCE & ENGINEERING (CSE)
23	Manipal University Jaipur	Jaipur	219311321	Vaibhav Yadav	B TECH IN COMPUTER AND COMMUNICATION ENGINEERING
24	Manipal University Jaipur	Jaipur	209302034	Shubhangam Kumar Mishra	B TECH IN INFORMATION TECHNOLOGY
25	Manipal University Jaipur	Jaipur	RJ/20/SWF/278459	CHETNA KESI	NCC
26	Manipal University Jaipur	Jaipur	RJ/20/SDF/278462	DEEPENDRA RATHORE	NCC
27	Manipal University Jaipur	Jaipur	RJ/20/SDF/278469	PRASHANT KUMAR	NCC
28	Manipal University Jaipur	Jaipur	RJ/21/SWF/2784..	AVANI AHLAWAT	NCC
29	Manipal University Jaipur	Jaipur	RJ/21/SWF/2784..	KHUSHI MORE	NCC
30	Manipal University Jaipur	Jaipur	RJ/21/SWF/2784..	LAVANYA RAJAWAT	NCC
31	Manipal University Jaipur	Jaipur	RJ/20/SWF/2784..	TANYA SINGH THAKUR	NCC
32	Manipal University Jaipur	Jaipur	RJ/21/SDF/2784..	NAJID KHAN	NCC
33	Manipal University Jaipur	Jaipur	RJ/21/SDF/2784..	ANIRUDH SINGH	NCC
34	Manipal University Jaipur	Jaipur	RJ/21/SDF/2784..	ROYAL RAJPUROHIT	NCC
35	Manipal University Jaipur	Jaipur	RJ/21/SDF/2784..	ARYAMAN RATHORE	NCC

36	Manipal University Jaipur	Jaipur	RJ/21/SDF/2784..	DIVYANG TIWARI	NCC
37	Manipal University Jaipur	Jaipur	RJ/21/SDF/2784..	ANKIT YADAV	NCC
38	Manipal University Jaipur	Jaipur	MUJ0492	Dr. Rina Poonia	Arts
39	Manipal University Jaipur	Jaipur	MUJ0619	Dr. Abhishek Shrivastav	Electronics and Communication Engineering
40	Manipal University Jaipur	Jaipur	MUJ0246	Mr.Hemant Kumar	Mechatronics Engineering
41	Manipal University Jaipur	Jaipur	MUJ0981	Mr. Sanjeev Sharma	Sports Officer
42	Manipal University Jaipur	Jaipur	MUJ1224	Mr. Mohit Sharma	Arts

8. Link of MUJ website stating the event is uploaded on website

https://jaipur.manipal.edu/muj/news-events/events-list/cleanliness-awareness-drive.html

Dr. Mani Sachdev
Head, Department of Arts
Manipal University Jaipur

Seal and Signature of HOD

MANIPAL UNIVERSITY JAIPUR

NAAC A+ GRADE WITH 3.28 SCORE

April 27, 2022
Wednesday
10:00 AM- 12:00 PM

Department of Economics

School of Humanities and Social Sciences

Manipal University Jaipur

Presents

The WORLD CAFE

UNDERSTANDING SDGs

MANIPAL UNIVERSITY JAIPUR

Manipal University Jaipur (MUJ) was launched in 2011 on an invitation from the Government of Rajasthan, as a self-financed State University. MUJ has redefined academic excellence in the region, with the Manipal way of learning; one that inspires students of all disciplines to learn and innovate through hands on practical experience.

A creative process for leading collaborative dialogue, sharing knowledge and creating possibilities for action in groups of all sizes.

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DEPARTMENT OF ECONOMICS

The Department of Economics at School of Humanities and Social Sciences is committed to provide students with elective mix of pure practical, analytical as well as theoretical knowledge in the areas of micro economics, macro economics, industrial and managerial economics, comparative economic policy issues, money and banking systems, international economics, quantitative analytical methods, understanding Indian and International economy and its system as well as the upcoming fields such as transport economics, environmental economics, energy economics, financial and Public economics, urban and regional economics etc. The Department offers Undergraduate, Postgraduate and PhD in Economics.

Dr. Monika Mathur
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The World café- Understanding SDGs

April 27, 2022

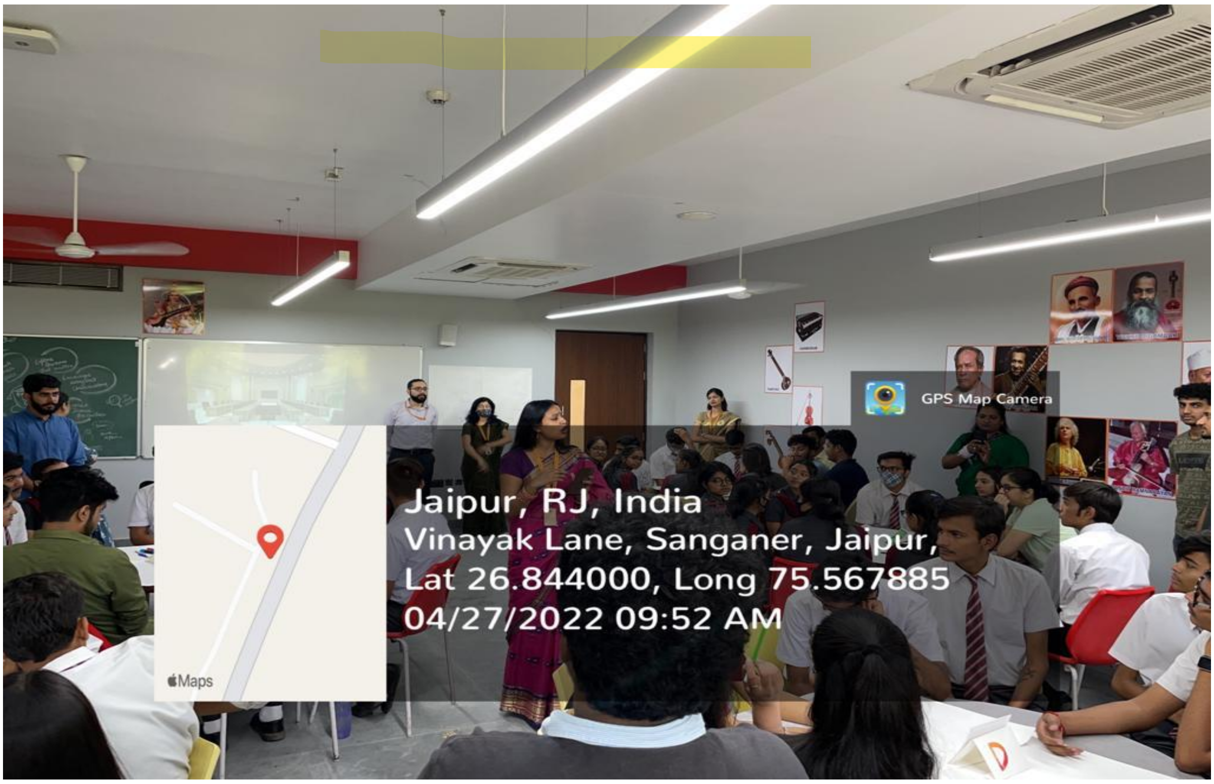
Introduction:

A school connect activity titled the World café was organised by the Department of Economics, School of Humanities and Social Sciences, Manipal University Jaipur on 'Sustainable Development Goals. Fifty-eight students of class XII from Spring field school, Mansarovar Jaipur, participated. The aim was to make students self-reflect and discuss some of the emerging global issues.

The three rounds of discussion took place on Poverty, Quality education, good health, climate action, responsible consumption, Economic growth, gender equality, and clean water. The students participated very enthusiastically. The discussion took place informally in a café setup. The students reflected on these issues by colouring their ideas into the chart papers.

The event winds up with some career counselling sessions.

Photographs:



Students participating in the activity

Dr. Monika Mathur
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Students participating in the activity

Collage of different student tables

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Link: https://jaipur.manipal.edu/content/dam/manipal/muj/foa/Document/event-economics/The%20World%20caf%C3%A9-%20Understanding%20SDGs.docx.

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