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Using local Iraqi *Bacillus* isolate to reduce water salinity

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ABSTRACT
Microbial desalination cell (MDC) has been created for expelling water saltiness, power generation, and wastewater administration. The MDC comprised of three chambers (anode, center desalination, and cathode).Were tested ability of type locally isolated bacteria *Bacillus* spp.in produce electricity to water desalination. In recent study results showed that a remove where the salinity recorded 4000 ppm at room temperature at the voltages of 0.6 volts and less salinity at room temperature at 0.2 volts was 200 ppm. Recent results highlight the need to reduce time for reduce salinity decreased from 3500 ppm to 500 ppm the eleventh day at a voltage of 0.5 volts that depended on type of substrate.

Keywords: Microbial Desalination Cell, Bacillus, Salinity.

استخدام العزلة المحلية العراقية لل *Bacillus* لاختزال ملوحة الماء

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الخلاصة
تم إنشاء خلية التحلية الميكروبية لازالة ملوحة المياه وتوليد الطاقة وإدارة مياه الصرف الصحي. وتتألف هذه الخلية من ثلاثة غرف (الأنود ، مركز تحلية المياه ، والكاثود). تم اختبار قدرة نوع البكتيريا المعزولة محليًا.*Bacillus* spp في إنتاج الكهرباء لتحلية المياه. في هذه الدراسة أظهرت النتائج أن إزالة الملوحة حيث سجلت 4000 جزء في المليون في درجة حرارة الغرفة عند الفولتية 0.6 فولت وأقل ملوحة في درجة حرارة الغرفة عند 0.2 فولت كانت 200 جزء في المليون. تسلط النتائج الضوء الحاجة للتقليل الوقت لازالة الملوحة حيث انخفضت نسبة الملوحة من 3500 جزء في المليون إلى 500 جزء في المليون في اليوم الحادي عشر عند فرق الجهد 0.5 فولت والتي كانت تعتمد على نوع المغذيات.

Introduction

Desalination is a series of processes performed to remove all or part of excess salts and minerals from water. This term may be used to remove salts and dissolved minerals in water solution [1]. Microbial desalination cell (MDC) developed from the microbial fuel cell (MFC) and electricity had as of late gotten a critical thought for desalination and wastewater treatment as an ecologically inviting innovation Desalination is possible to be used in practical life such as agriculture, drinking, Electrical energy through biomass[2].A new concept of water desalination has recently the latter is based on the use of electrical energy generated by bacteria in organs called microbial cells for desalination using bacteria that have the potential to decompose organic matter and are being developed as use where it can be used in home sewage treatment By removing organic matter from water, while at the same time

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having the ability to produce electric power units that have the ability to desalinate water[3,4]Considering the world-wide water deficiency, and the reality of copious saline water, desalination of seawater or brackish water has been progressively considered as an alternative for water supply source [5]. The middle chamber contains salty water containing cations and anions such as Na^+ and Cl^-. Each ion is attracted to the same electrode after passing through the ion exchange membrane .Therefore the aim of this study to treatment of wastewater and produce desalination water at same time.

Materials and Methods

Microbial desalination cell consists of provides the following steps according to [6]: consist of Moderation desalination cell with anode cell and cathode cell, artificial wastewater with bacteria and Substrate (nutrients).

MDC Construction

The design of the MDC was based on a cubic-shaped MDC from polycarbonate. The MDC comprised of three chambers (anode, center desalination, and cathode), isolated utilizing AEM and CEM films, clamped alongside gaskets that give a water seal between the chambers (Figure-1). An AEM(DF120,Tianwei Film) was utilized to isolated the anode and center chambers, and a CEM (Ultrex CMI7000, Layers Universal) was utilized to isolated the center and cathode chambers. The cross area of the working zone of these two chambers was 9 cm^2. The interior volumes of the anode, center desalination, and cathode chamber were 27, 3, and 27 ml respectively. Outside electrical contact to the anodes was created by carbon graphite fiber brushes (5mmdiameter) into the felt. Prior to utilize, the carbon brash fibers were washed for 48 h in 1 M HCl and to remove any trace minerals. Titanium wire was utilized to associate to external circuit [7].

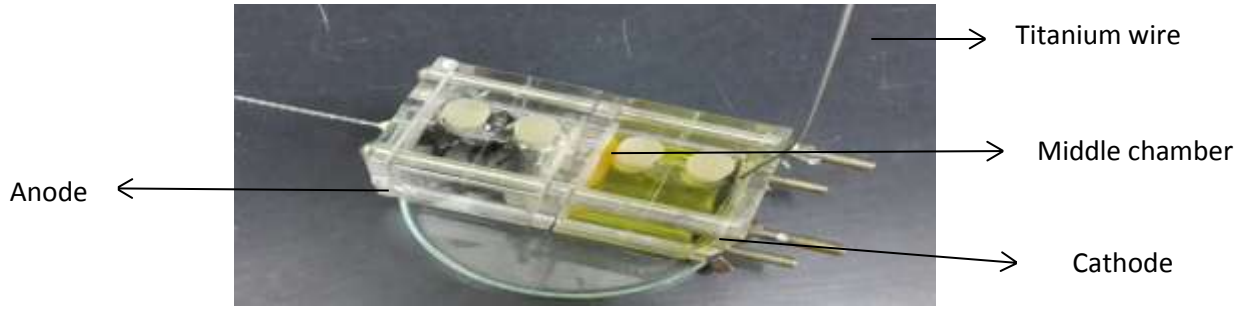

Figure 1-Show the Design of MDC Three-chamber MDC used for desalination.

Medium

The anode chamber of the MDC was fed a solution of sodium acetate (1.6 g/L) in a nutrient buffer solution containing (per liter in deionized water) 4.4g KH_2PO_4, 3.4g $K_2HPO_4 \cdot 3H_2O$, 1.5g NH_4Cl, 0.1g $MgCl_2 \cdot 6H_2O$, 0.1g $CaCl_2 \cdot 2H_2O$, 0.1g KCl and 10mLof trace mineral metals solution [1]. The cathode chamber of the MDC cell is fed with a solution containing (per liter in deionized water)16.5g $K_3Fe(CN)_6$,9.0g KH_2PO_4 ,8.0g $K_2HPO_4 \cdot 3H_2O$ [1].The middle chamber was filled with the water to be desalinated at NaCl concentrations 35g/L. These concentrations represent a reasonable range of salinities for brackish water and sea water [8] show Figure-2.

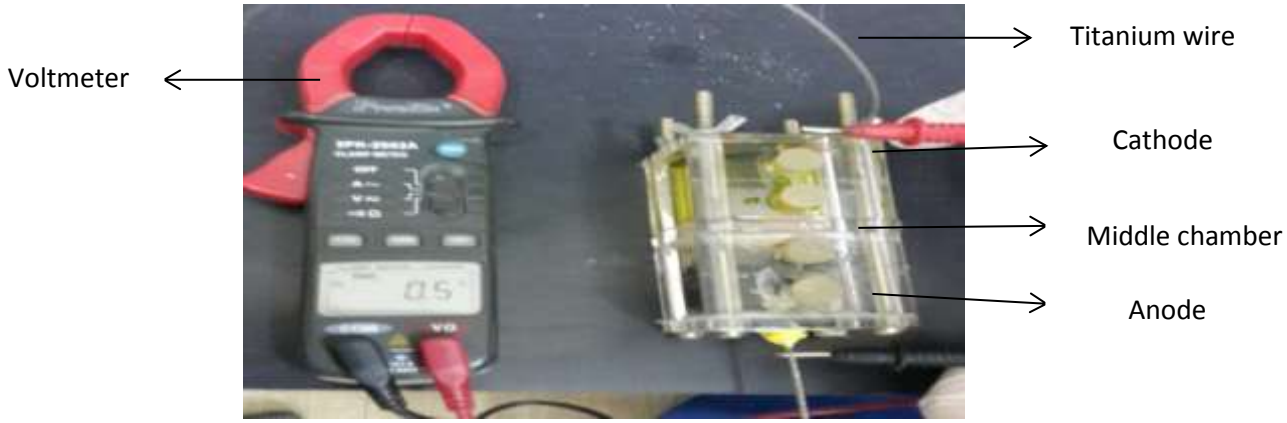

Figure 2-Shows voltmeter in the MDC for *Bacillus* spp. produce voltage to reduce salinity across circuit.

Isolation and characterization of *Bacillus* spp

Experiments were performed by using contaminate water with *Bacillus* spp (artificial wastewater). These bacteria isolated from soil contaminated with water generated. Identification was carried out by using a culture media isolate colonies from primary culture on non-selective agar (nutrient agar and MacConkey agar). On selective agar such as Polymixin egg yolk mannitol bromothymol blue agar (PEMBA) are identified by colonial appearance [9].Carried out Gram stain positive, rod-shaped, aerobic or facultative anaerobic and have a single endospore identification by malachite green staining [10].Also biochemical test as idol test negative, methyle red tes negativet, voges-proskaure test positive, citrate test positive (IMVIC), triple sugar iron (TSI) test negative for fermentation and sulfur reduction, catalase positive test , oxidase positive test ,urease test negative and motility positive for *Bacillus* spp. according to [11].

Method of measuring salinity ratio

Salinity meter model Ino lab manufactured WTW origin German was used to measure the salinity ratio by drawing water carefully to ensure that is not lost from middle cell where the salinity ratio were recorded and return after that to cell.

Result and Discussion

The results showed that the salinity ratio in Figures-(3, 4) show that the salinity of the water in the middle cell depends on the output of the electrical power, where the increase in the voltages increases the removal rate, where the salinity recorded 4000 ppm at room temperature at the voltages of 0.6 volts, Less salinity at room temperature at 0.2 volts was 200 ppm, indicating that salinity decreased with lower voltages, with pH values ranging from 6.8-5.7. This change was due to existing chemicals and their consumption [3]. Nowadays study suggest obtain *Bacillus* spp., produced maximum electricity of 0.366±0.4 V at 2h of incubation and low to 0.249±0.3 V at 5 h and remained stable till 12 h of incubation this result depended on growth curve type of substrate and pH[12]. While another researcher desalination reached 29% and 67% after 72 h and 42 day operation, respectively, using a 35 g.L-1 NaCl solution. The higher salt removal rate in the operated MDC is mainly attributed to the higher volt [13].This decline of volt can be interference to the consumption of nutrient by bacteria in the chamber as well [14]. For the same concentration of NaCl, to different study the control MDC cycle displayed a most extreme voltage of 0.226 V. but It was watched that desalination of lower salt concentrations 25 ppm displayed higher voltage than that of higher salt concentrations 35ppm. The reasons may be (i) lesser development of anode respiring bacteria; (ii) restraint in biofilm arrangement due to the higher chloride concentration; or (iii) decrease pH inside the anode biofilm [15].

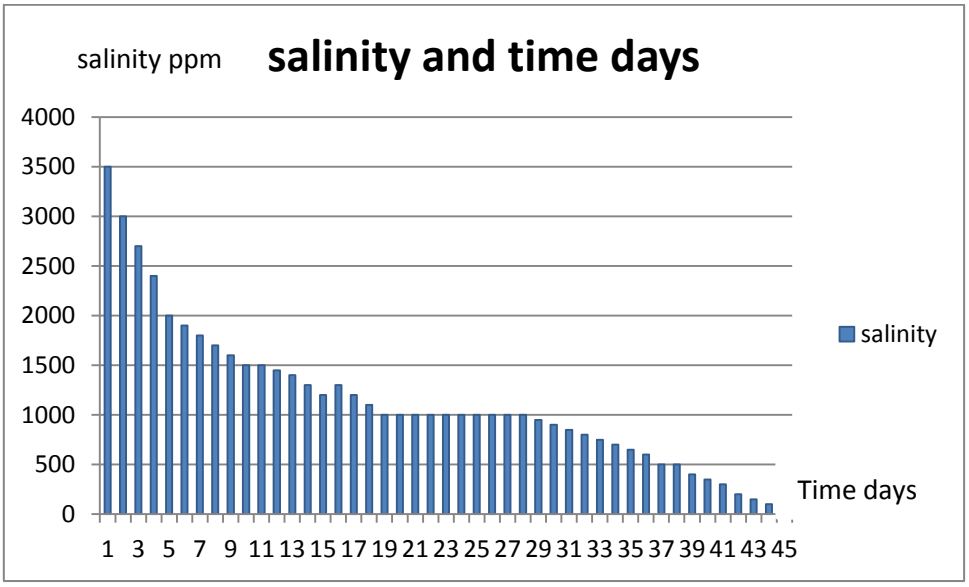

Figure 3-Shows lower salinity of *Bacillus* spp. In the MDC

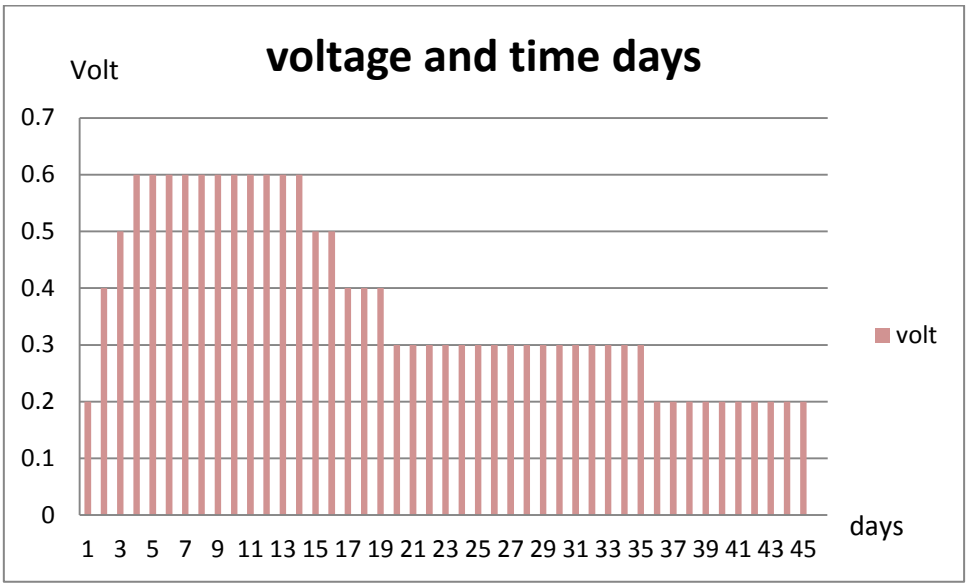

Figure 4-Shows produce voltage of *Bacillus* spp. In the MDC

Best result which recorded to reduce the time period of salinity reduction in the bacterial cell of *Bacillus* spp. Where the concentration of 35000 ppm at the first day at pH 6.8 and room temperature at the voltages of 0.3 volts where the salinity decreased to 500 ppm at the thirty-fifth day. To reduce this time period was added nutrients valine, Riboflavin, Glucose L where salinity decreased from 3500 ppm to 500 ppm The eleventh day at a voltage of 0.5 volts as shown in Figures-(5,6).

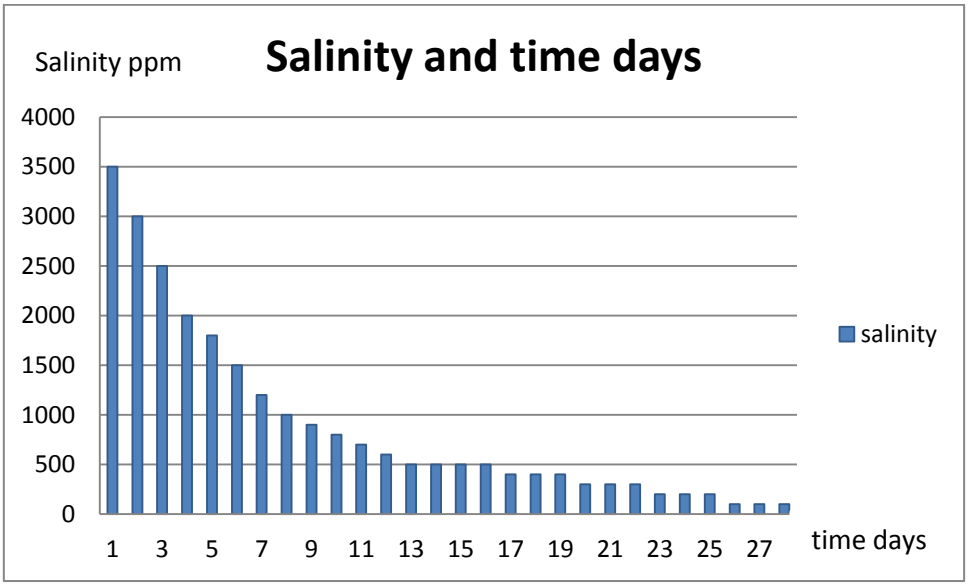

Figure 5-Shows the low salinity of *Bacillus* spp. In the MDC after add nutrient.

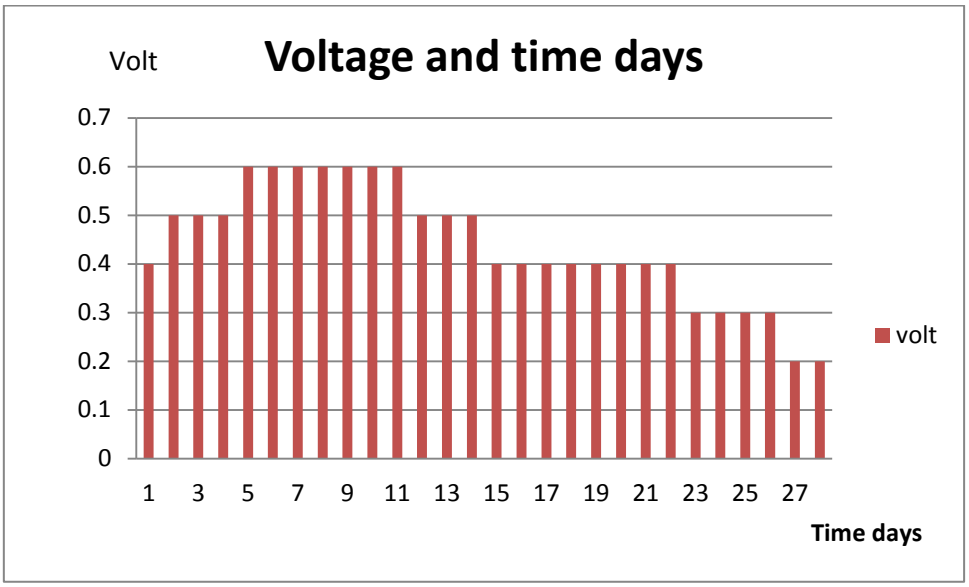

Figure 6-Shows produce voltage of *Bacillus* spp. In the MDC after add nutrient.

The reduction in the time period for the production of voltages and the removal of salinity can be attributed to *Bacillus spp*. In the MDC the ability of bacteria to consume nutrients and amino acids, which helped to reduce the time and produce voltage period this result compatible with [16]. Nowadays the study suggesting the type of nutrient and amine acid surface may bolster a stronger bacterial community and expanded electron exchange in the anodic chamber, through the arrangement of a biofilm may be lead to reduce time period [15].

Conclusion

From the over we conclude that depended on MDC design had financially impact and may be developed from small-scale this is often an environmentally-friendly process for the decontamination of water derived from industrial processes high ability of Bacillus sp. to produce voltages was able to remove salinity in microbial analysis cells and The use of other types of bacteria to determine their ability to produce electric voltages and compare them with the previously studied species.

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