

Effect of temperature on the nitrate removal from the Waste Water Using the Microbial Fuel Cell (MFC)

K. Paulnath and C. Vipulanandan, Ph.D., P.E.

Texas Hurricane Center for Innovative Technology (THC-IT)

Department of Civil and Environmental Engineering

University of Houston, Houston, Texas 77204-4003

E-mail: pcrajana@uh.edu, cvipulanandan@uh.edu Phone: (713) 743-4278

Abstract: In this study, nitrate removal in a MFC cathode chamber with algae was investigated by varying the temperature. In this study, dual chamber MFC was used. In addition to that voltage, pH and resistivity changes in the cathode chamber were monitored. Concentration of nitrate reduced by 37.6% in 14 days. Maximum removal rate of nitrate was achieved when the temperature was in the range of 30⁰C-40⁰C.

1. Introduction

Nitrogenous compounds especially nitrate are found in various types of wastewaters namely, domestic and industrial wastewaters, chemical fertilizers and farmlands [1]. Discharging of such effluents directly to the natural water bodies cause serious environmental problems such as eutrophication and algae bloom in lakes and ponds ecosystem. High nitrate concentrations cause blue baby syndrome or methemoglobinemia, mainly in infants [2]. The maximum acceptable level of nitrate in drinking water by the World Health Organization (WHO) is set as 50 mg/L [3]. Hence, the removal of nitrate from wastewater is necessary before discharging to the clean natural water resources.

Microalgae are photosynthetic microorganisms that can grow rapidly and live in harsh conditions due to their unicellular or simple multicellular structure [4]. They provide a way for contaminants-removal (nitrogen, phosphorus and carbon) from wastewater while producing biomass that could find use for the production of high-value chemicals (algal metabolites) and/or biogas through anaerobic digestion [5]. Micro algal consortium is capable of removing nitrate from wastewater sludge [6].

Chlorella species had a high photosynthetic productivity over a broad temperature range 26–39 °C. *Chlorella* species R-06/2 grow at 44 °C to 51 °C temperature up to 4 h [7].

2. Objective

The main objective of the study was to investigate the effect of temperature on nitrate removal rate in the cathode chamber of MFC with algae.

3. Materials and Methods

A dual chamber microbial fuel cell was used in this study with one anode chamber and one cathode chamber. The anodic solution consisted of 300 mL of bacterial growth medium sparged with Nitrogen gas to establish O₂ reduced environment (anaerobic condition), 0.5 g/L of yeast extract, 20 mL/L of used vegetable oil, and 20 mL of bacterial inoculation. The used vegetable oil was the carbon source for bacterial metabolism. The cathode chamber consisted of 1158 ppm NaNO₃ and *chlorella vulgaris*. The anode and the cathode were separated by a commercial cation exchange membrane (CMI-7000). The anode and cathode electrodes were carbon fiber brush connected to a 1000 ohm external resistor. The working volume of each chamber was 500 mL. The closed circuit voltage (CCV) of the system was also constantly monitored. The nitrate content in the cathodic solution was measured with the help of nitrate ion selective electrode from Hanna Instruments. The setups are shown in Fig.1

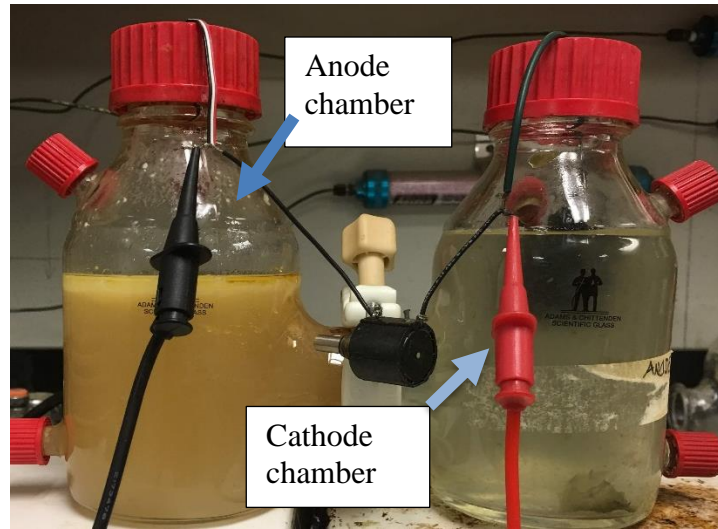


Figure 1.MFC set up

Temperature ranges 20⁰C-30⁰C, 30⁰C-40⁰C, 40⁰C-50⁰C and 50⁰C-60⁰C were selected for the study. Temperature was controlled by the magnetic stirrer which supplied the heat to the cathode chamber. Temperature was increased in two to three days interval.

4. Results and Discussion

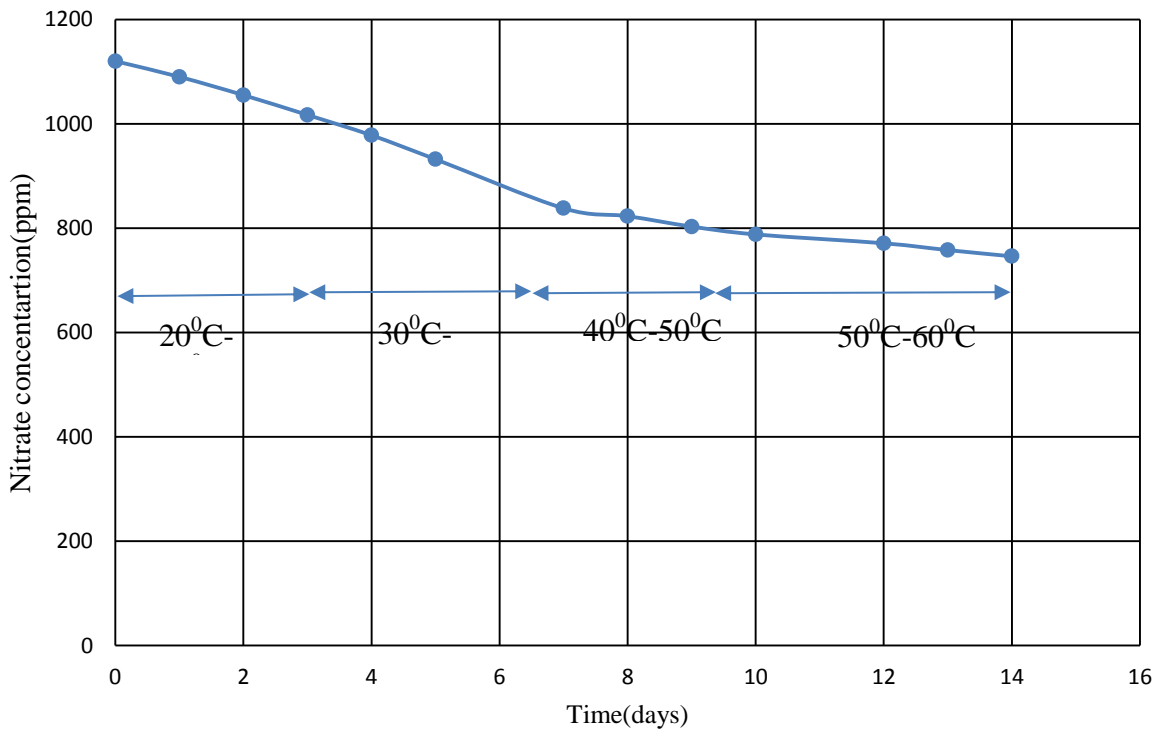


Figure 2.Nitrate Removal at Various Temperature Ranges

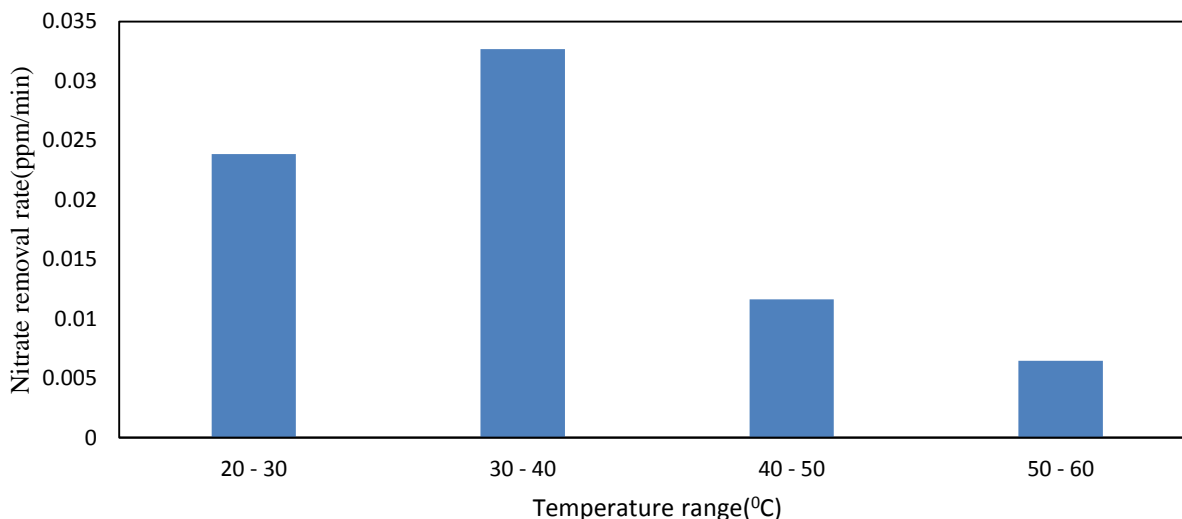


Figure 3. Nitrate Removal at Various Temperature Ranges

Nitrate concentration in the cathode decreased with the time. But the rate of removal of nitrate varied when the temperature was changed. Rate of removal reached its peak when temperature was 30°C-40°C. beyond that temperature, removal rate (Fig.2) started to decrease with increasing temperature (Fig.3)

4. Conclusions

From the results above, it is proved that nitrate removal using bio cathode MFC is possible. Nitrate removal rate is affected by the temperature of the cathode solution which in turn affects the growth of the algae. A nitrate removal rate of 0.033ppm/min was achieved when the temperature was 30°C-40°C.

5. Acknowledgement

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6. References

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