

# Sensing Nitrate via Voltage between Combinations of Electrode Pairs



## Background:

- Nitrate is a concern:
- Nitrate → Eutrophication → Biodiversity Loss
- Measures to combat this issue exist: buffer systems, bioreactors, treatment plants, etc
- In order to maximize their effectiveness, they must be located near the highest concentrations of nitrate. This is the issue at hand.
- Current systems to detect nitrate are either expensive, inaccurate, time consuming, or a blend of all three. This project aims to eliminate all three detriments.

Purpose: Create a nitrate sensing system that is inexpensive, accurate, and efficient

Inexpensive	Accurate	Efficient
Use cheap materials to cut costs, namely the electrode pairs	Sensor should consistently yield accurate readings	Data can be collected in real time without manual extraction

## How it works:

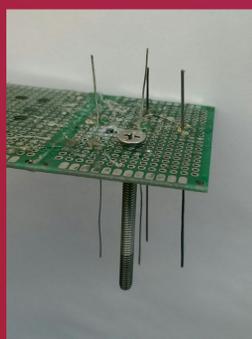
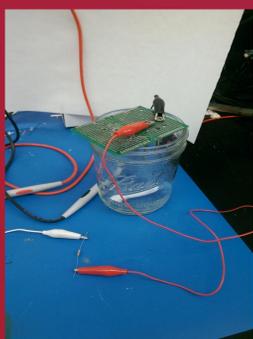
- Create database of voltage readings using common materials
- Develop series of electrode pairs with distinct voltage readings to accurately sense nitrate

## Once completed:

- Sensing probe linked to a control box
- Probe's signals encoded in the control box and these data is sent off to the cloud

## Methods:

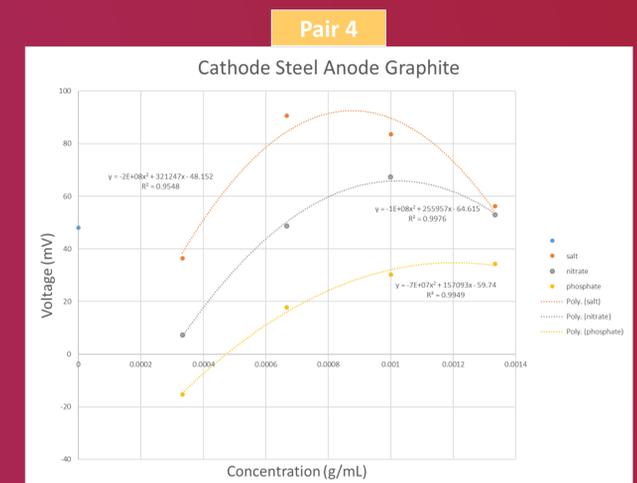
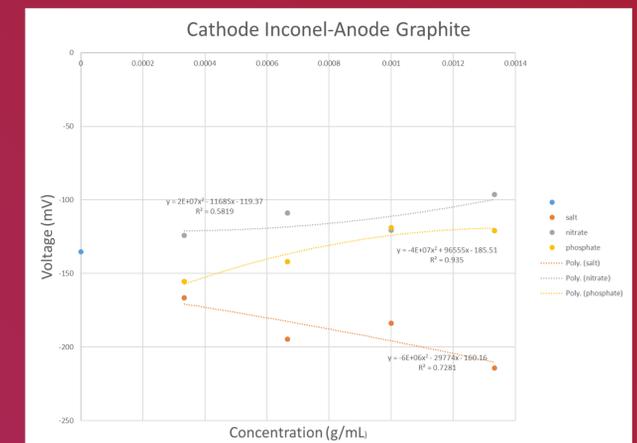
- The electrodes (stainless steel, inconel, graphite, and silver) were glued into a protoboard.
- Length the electrodes were submerged into the sample were identical.
- 16 combinations of electrode pairs
- 12 concentration of chloride, nitrate, phosphate with control of water
- 4 distances electrode pairs were apart, later averaged together



## Results:

- With distinctive readings, a mixed sample of multiple salts could theoretically be analyzed and the quantity of nitrate could be determined.
- The first three pairs of the series, were used to determine whether the sample was high in nitrate relative to the other salts.
- The quantity of nitrate could be found using the final electrode pair which yielded a distinctive parabolic pattern for nitrate.

	Chloride (mV)	Nitrate (mV)	Phosphate (mV)
Pair 1	295	255	245
Pair 2	-16	-17	18
Pair 3	-320	-280	-190



## Conclusion:

- Testing the quantities of nitrate in a known mixed sample did not prove to match the predicted values and were inconclusive, the distinctions are still present.
- Currently unable to identify quantitatively the amount of nitrate in a sample.
- Definitive patterns for some electrode pairs do exist.
- With the proper technique, the quantity of nitrate or any other chemical compound can be measured using voltage.

## Future steps:

- More precise instrumentation
- Test AC voltage
- Develop empirical equation

## Collaborators:

Luke LaMoore  
Undergraduate student in the Department of Bioproducts and Biosystems Engineering

Peter Marchetto

Associate Professor in the Department of Bioproducts and Biosystems Engineering