

Methane Assessment in the Four Corners Region

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Q1: Research Question/Engineering Goal

Problem
To identify sources of methane on the Navajo Nation, and to document the intensity of the atmospheric methane in PPM (parts per million).

Hypothesis
There are sources of global warming methane in the Four Corners region of the Navajo Nation. It is being emitted in portions of the Navajo Nation through one or more of the following: cattle feedlots, garbage dumps, methane gas plants, and methane production wells.

- Variables**
- Methane measured in parts per million
 - Location of Measurement
 - Wind Speed and Direction at the time of the Measurement

- Materials**
- Arduino UNO microcomputer
 - Arduino UNO protective clear plastic case
 - MQ-4 methane sensor [ref.2]
 - Red (positive), Black (negative, ground), and Yellow (signal) jumper wires
 - Red Light Emitting Diode (LED)
 - 330 ohm protection resistor for the LED
 - USB cable
 - Laptop
 - Arduino IDE version 1.8.16 [ref.3]
 - Soldering iron and solder
 - Insulating electrical tape

Background Research
Methane is a powerful greenhouse gas with a 100-year global warming potential 28-34 times that of CO₂. Measured over a 20-year period, that ratio grows to 84-86 times. About 60% of global methane emissions are due to human activities. The main sources of anthropogenic (people created) methane emissions are the oil and gas industries, agriculture (including fermentation, manure management, and rice cultivation), landfills, wastewater treatment, and emissions from coal mines. Fossil fuel production, distribution and use are estimated to emit 110 million tons of methane annually. [ref.1].

It is my goal to identify and document any high sources of methane on the Navajo Nation, in the Four Corners Region of the USA.

Q3: Data Analysis & Results

Data Analysis
For this experiment, I took data from 9 locations. To gather the data, I drove to the locations and used my laptop and Arduino UNO to measure the methane concentration in the air. Within the results of the data taken from this experiment, it shows that there are higher methane concentrations in the air near abandoned methane gas wells. There is also high methane concentrations near coal mines, such as in Black Mesa and Kayenta. It is also shown that coal mine areas, have higher methane concentrations in the air than oil drilling areas do. It is also shown in the results that there are high methane levels near gas stations, such as Handy Mart, Cortez, which is predictable considering that vehicles release methane into the air regularly.

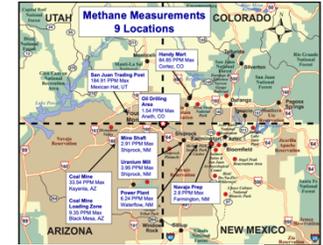
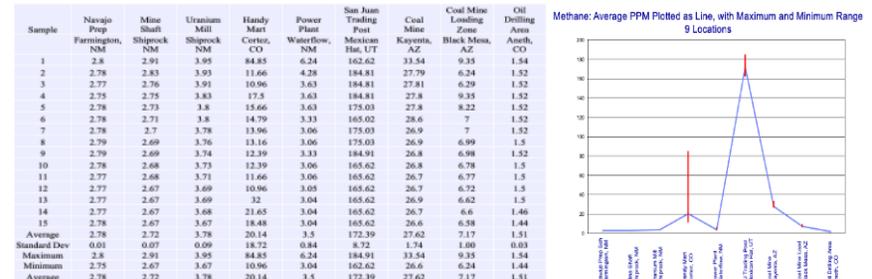


Table of Methane Measurements in PPM: 9 Locations



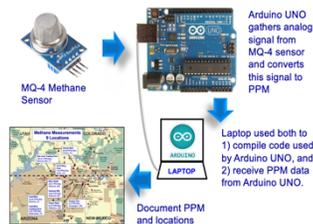
Q2: Methodology/Project Design

A. Download the Arduino IDE (Integrated Development Environment) [ref.3]. This is available for Windows, Mac OS X, and Linux operating systems. The environment is written in java and includes other open source software.

B. Connect the Arduino UNO to the MQ-4 methane sensor, alarm LED, and laptop as shown in Figure 1, below. The MQ4 methane sensor shown in Figure 2 has a single power supply wire (red) and a single ground wire (black), and the output signal is via a yellow wire. The alarm LED uses a 330 ohm protection resistor to limit the electrical current through the delicate light emitting diode.

C. Bring up the Arduino IDE by clicking on the Arduino icon (green circle with an infinity sign, with + and - symbols). Bring up "tools" from the toolbar to interface the laptop and the Arduino UNO. As shown in Table 1, pick a board (Arduino UNO) and a port (assuming you have an Apple iMAC). Also, pick the Serial Monitor for display of the measured methane values.

TOOLS	SETTING	COMMENTS
Auto Format		
Archive Sketch		
Fix Encoding & Reload		
Serial Monitor		Select for Display of Methane PPM
Board	> <input checked="" type="checkbox"/> Arduino UNO	
Serial Port	> <input checked="" type="checkbox"/> /dev/cu.usbmodemFD121	USB communication between iMAC and Arduino UNO



Q4: Interpretation & Conclusions

Conclusions

Methane is in the Earth's atmosphere. Methane had its highest concentrations in PPM near methane gas wells in Mexican Hat, Utah and Cortez, Colorado. If we are going to survive as species, we need to cap abandoned methane gas wells, which currently belch methane into our atmosphere, unabated. This includes sealing (such as with "soil cement") the ground outside of the pipe, which could allow methane gas to leak from underground even if the well is capped.

Future Directions

In the future, I plan to expand my data taking to all four seasons which include summer, fall, winter, and spring. With more data I could determine if there is a certain time that methane is released. I could also determine what time of the year has the highest methane concentrations.