Calibrating J Sensors

Background:

This protocol is for calibrating the CH_4 sensor on the J sensors. This procedure will need to be repeated if we change either the CH_4 sensor or the humidity sensor on the J sensor. This calibration procedure needs to be carried out for each sensor. Multiple sensors can be calibrated at once, but *each* sensor needs its own calibration coefficients (they are not the same across sensors). Note that the CO_2 sensor arrives calibrated from the manufacturer. The CO_2 sensor's output is already in CO_2 ppm and does not need to be calibrated in our lab.

The CH_4 sensors on the J Sensors work by measuring the resistance in a special anode. The resistance in the anode changes based on the concentration of CH_4 present and the concentration of H_2O present (humidity). The sensor reads and outputs those changes in resistance as readings in millivolts (mV), meaning that when we offload the sensor the numbers we get for CH_4 are a bunch of millivolt readings. In order for that information to be useful to us, we need a way to "convert" those millivolt readings to ppm of CH_4. This procedure is how we gather the data to create the *conversion coefficients* we can then use to convert from millivolts to ppm of CH_4.

The resistance of the anode responds to changes in two things: 1) CH_4 and 2) humidity. As a result, in order to get our calibration coefficients we need to have a range of CH_4 concentrations (2 ppm to 115 ppm) at multiple humidity levels (High >= 20,000 ppm H2O; medium ~15,000 ppm H2O; and low <= 10,000 ppm H2O)

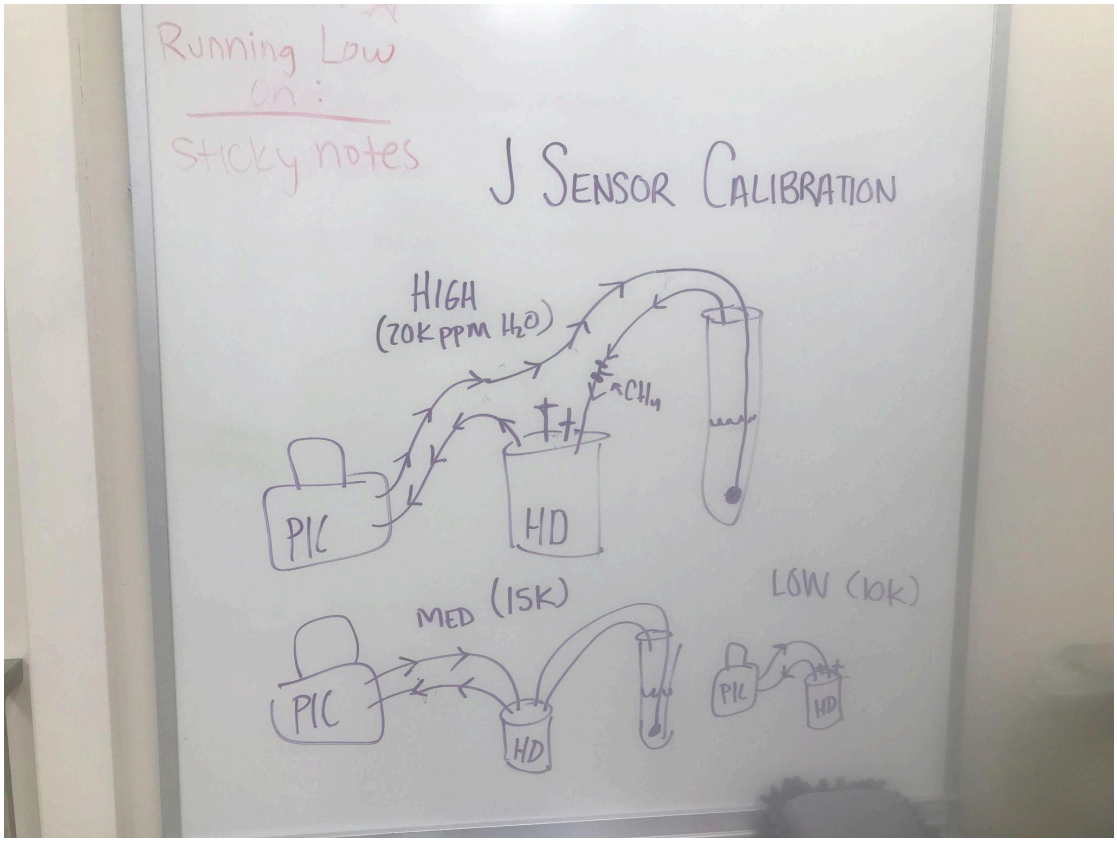
Protocol:

1. Power on J sensor(s) to be calibrated and LGR/Picarro to warm up.
2. Inside the calibration chamber (home depot bucket with lid) set up:
    a. Sensor(s) to be calibrated
    b. Battery connected to sensors (make sure to cover the battery with a towel or something to separate it from the sensors and prevent a short in the circuit)
    c. Large computer fan connected to the battery
    d. I also taped a p-cup to the side of the bucket and put the end of the tube coming from the humidity chamber in the p-cup to catch any excess water coming in

3. Set up tubing based on diagrams for high humidity.
    a. Outflow from Picarro or LGR is connected via 3 way stop cock to the tubing of the aerator.
    b. The Aerator is submerged in the humidity tube.
    c. Humidity tube is ¾ full of hot water.
    d. Tubing leaving the humidity tube goes directly into the calibration chamber (Home Depot Bucket).
    e. Tube leaving the calibration chamber goes into the inflow of the LGR
        i. Note: Use the shortest/least amount of tubing possible so that the LGR is reading the concentrations in the bucket (that the J sensors are reading) rather than in the tubing. Using shorter tubing also helps you change the humidity in the chamber and helps control leaks.
    f. The other two ports in the calibration chamber have short sections of tubing sticking out that are attached to closed luer locks.
4. Close the system with the hot water in the humidity tube and the aerator running with the outflow air from the LGR.
5. Using the LGR interface, monitor the humidity levels in the calibration chamber and wait until the humidity reaches above 20k ppm of H2O. (this can take a little bit, you might have to leave it for 20 minutes to a half hour).
6. Once the humidity levels are high enough, inject methane through one of the short tubes with a leur lock. Inject enough methane to get to above 100 ppm (This usually takes about 300 mL if you are using the 1% methane that we use for standard curves on the GC).
7. Because the system is not perfectly sealed, the methane will slowly diffuse out of the calibration chamber over time allowing us to get measurements continuously from 100

ppm down to 2. Leave the calibration system alone and check on it periodically (every 45 minutes or so). You should see the methane concentration gradually decreasing over time.
    a. Alternatively, you can add methane to increase the concentration in the calibration chamber in steps to monitor and make sure you cover each gradation equally. I have been increasing my 20 ppm every 20 minutes and letting the concentration decrease
8. Once the concentration of methane gets down to about 2 ppm (this can take a couple of hours) change the tubing configuration to that for medium humidity. Try to do this quickly to allow minimal escape of humidity.
    a. Outflow tube from the LGR connects to one of the inflow ports in the calibration chamber with the leur lock
    b. Tube going into the humidity chamber (through the aerator) connects directly into the other inflow port in the calibration chamber with the leur lock.
    c. Tube out of humidity chamber does not change (still goes directly into the calibration chamber) and tube out of calibration chamber into LGR does not change.
9. Note: The humidity levels also should have slowly decreased and should be around 15,000. Allowing the system to still be connected to the humidity chamber but not actively pumping air through the water should allow the system to stay at medium humidity.
10. Again, inject enough methane to get to above 100 ppm.
11. Leave the calibration system alone and check on it periodically as the methane concentration gradually decreases over time.
12. Just as before, once the concentration of methane gets down to about 2 ppm (this can take a couple of hours) change the tubing configuration. This time you are going to set it for low humidity by disconnecting the calibration chamber from the humidity tube completely. Humidity should decrease to about 10,000 ppm
13. Again, inject enough methane to get to above 100 ppm. Leave the calibration system alone and check on it periodically as the methane concentration gradually decreases over time.
14. Once concentrations get down to approximately 2 ppm, open the system and offload the J sensor SD card.
15. Use that data to run the J sensor calibration code: (01_J_Sensor_Calibration.R) https://github.com/meredithholgerson/JSensorCalibration (this is a private repository so you will need to ask MH for access)

Figures:


Running Low on:
sticky notes
J SENSOR CALIBRATION
HIGH (20K PPM H_2O)
CH_4
PIC
HD
MED (15K)
PIC
HD
LOW (10K)
PIC
HD


THE HOME DEPOT


ETHAN


CLEAN ACID WASHED