# Device for Evacuation of Gas Chromatography Vials

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## Introduction

Gas chromatography is commonly used when analyzing quantities of greenhouse gases at ambient concentrations. To ensure accurate measurements, we must use evacuated vials to obtain pure gas samples that are free of contamination. Pre-evacuated vials are available on the market but once the vacuum has been broken, the vials must be evacuated once again if they are to be reused. Thus, we sought to design a vial evacuation device that would allow us to reuse vials for ongoing gas analysis. This will allow for a more efficient use of lab resources while minimizing waste.

## Objectives

1) Design a device which evacuates vials to a vacuum quality comparable to that of pre-evacuated vials in a cost-effective manner

2) Establish a protocol for using the device by testing different durations of evacuation

*Figure 2: Qualitative estimation of contamination. On the left is a pre-evacuated vial, on the right is a 1-minute evacuation.*

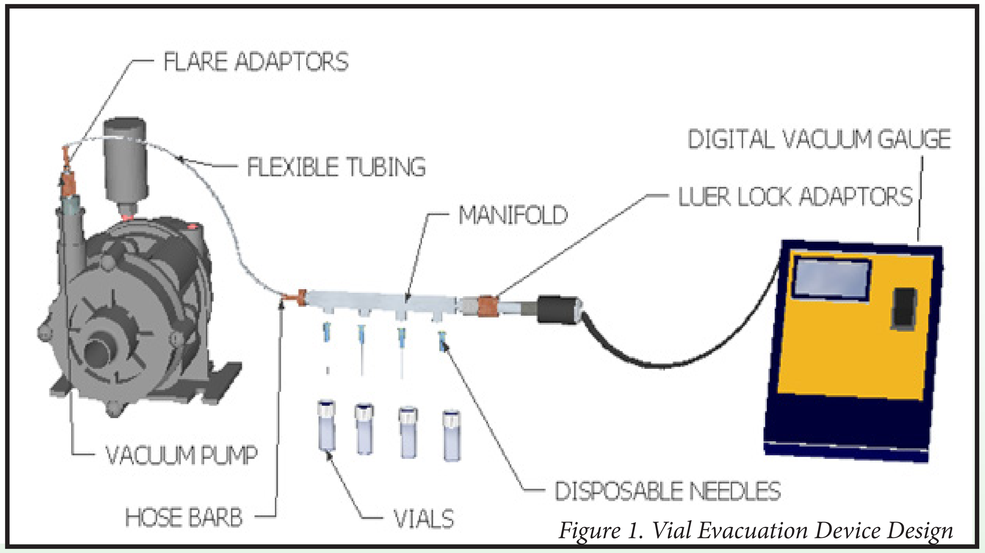


*Figure 1. Vial Evacuation Device Design*

## Methods

After construction of the device, we evaluated the quality of the vacuum created within the vials. This was done through a visual qualitative estimation as well as through a quantitative measurement of concentration using gas chromatography. Vials were evacuated for 1, 2, or 4 minutes, and were compared to pre-evacuated vials from the manufacturer.

Qualitative Estimation:
-Invert vial and submerge in water
-Pierce septum with disposabale needle
-Allow water to flow into vial until interior pressure equilibrates with ambient pressure
-Trapped air bubble represents volume of gases that remain in the vial after evacuation
(Rochette and Bertrand, 635)

Quantitative Measurement:
-Using a syringe, overpressurize evacuated vials with a calibration gas standard
(Carter and Gregorich 473-5)
-Gas standard contained 600ppm $CO_2$, 1ppm $N_2O$, and 5ppm $CH_4$
-4 replicates for each treatment level were analyzed using a gas chromatograph
-Concentrations and their variance are used to assess quality of vacuum

## Results

Qualitative Estimation:
-Size of contamination bubble did not differ between 1, 2, and 4 minute evacuations
-Pre-evacuated vials had a visibly larger contamination bubble than those evacuated by our device (see figure 2)

Quantitative measurement:
-No significant difference in concentrations between 1, 2, and 4 minute evacuations (see figure 3)
-Pre-evacuated vials were not significantly different for CH4, N2O
-CO2 readings were significantly larger in pre-evacuated vials
-All treatment levels were significantly different from the intended concentrations of the gas standard.

| | |
|---|---|
| Vial Evacuation Device | $1,279.10 |
| Case of Pre-Evacuated Vials (1000 units) | $394.69 |
| Evacuating 1000 vials (4.5hrs labour) | $56.31 |
| Savings per 1000 Units | $338.38 |
| **# of cases to break even** | **3.78** |

*Table 1: Cost Breakdown*

## Conclusions

-Costs of a vial evacuation device can be recouped over the course of a single study (Table 1)

-Quality of vacuum is comparable to that of pre-evacuated vials.

-One-minute evacuations are sufficient to clear contaminant gases to a reasonable level.

-Since contamination is a different factor for all evacuation types, it is important to use consistent methods among data points.

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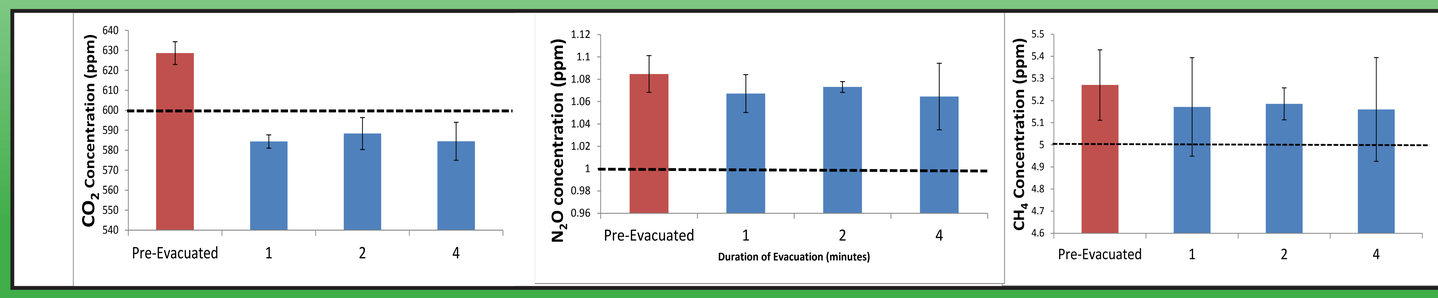


Figure 3: Results of quantitative comparison of evacuation methods (Pre-evacuated vs. 1, 2, 4 minute evacuations). Dotted line depicts concentration of calibration gas standard. Error bars show 95% confidence intervals, n=4 for all trials.

## Literature Cited

Carter, M.R., and E.G. Gregorich. Soil Sampling and Methods of Analysis. 2nd edn. Boca Raton: Canadian Society of Soil Science, 2008. 473-5. Print.

Rochette, P. and Bertrand, N. 2003. Soil air sample storage and handling using polypropylene syringes and glass vials. Can. J. Soil Sci. 83: 631–637