Warren J. Baker Endowment
for Excellence in Project-Based Learning
Robert D. Koob Endowment *for Student Success*

CAL POLY

Proposal Cover Page

Title of Project: Indoor air monitoring of select volatile organic compounds in wineries using active sampling and gas chromatography-mass spectrometry

Proposal Author: Andrew Kaneda **Cal Poly Email: akaneda@calpoly.edu**

Student ID: 008809381 **Dept.: Civil/Environmental Engineering**

Signature (Optional): _____

Signature provides permission to check financial aid eligibility.

Previous Baker/Koob Endowment funding? (circle one): Yes (No)

Is this request to support a Senior Project or thesis? (circle one): (Yes) No

Team Member(s)	Signature	Cal Poly Email	Department

Faculty Advisor: Tracy Thatcher **Department:** CE/ENVE

Faculty Advisor email: TThatche@Calpoly.edu **Telephone:** 756-6273

Anticipated Start Date: Fall 2017 **Anticipated End Date:** Fall 2018

Total Funds Requested ($): 2500

Signature of Faculty Advisor: _____ **Date:** 10/30/17

I. Abstract

Most wine-making processes occur indoors or inside enclosed areas, where the threat of accumulating volatile compounds can result in compromised human health and safety. Compounds such as benzene, toluene, ethylbenzene, xylene, styrene, and ethanol have concentration limits set by the Occupational Safety and Health Administration (OSHA). These volatile organic compounds (VOCs), as well as carbon dioxide, will be tested for during various stages of the wine-making process using EPA Method TO-17: a standardized method for determining VOCs in ambient air using active sampling onto sorbent tubes. VOCs that are collected on the sorbent tubes will be analyzed using thermal desorption gas chromatography-mass spectrometry to provide speciated VOC concentrations while avoiding the use of extra solvents during analysis. The goal of this thesis is to determine if there is any point during the wine-making process where workers are exposed to possibly hazardous levels of VOCs or CO_2, as well as evaluate current strategies utilized to control exposure levels.

II. Introduction

The average person will spend up to 90% of their day in closed sites (such as homes, schools, and workplaces), making it crucial for human health to understand and control indoor air quality [1] [3]. Volatile organic compounds (VOC) concentrations are an important parameter to monitor as many products and materials can emit VOCs, including paints and building materials [4]. Wine aroma, mainly comprised of VOCs, is a critical component of wine that can affect the overall quality of the product [9]. Concern for these VOCs possibly contributing to the creation of smog through photochemical reactive hydrocarbons has resulted in regulation of winery emissions through the California Air Resources Board [11]. However, little research has been done regarding the nature of the indoor air of wineries. This thesis looks to quantify concentrations for 6 VOC compounds (benzene, toluene, ethylbenzene, xylene, styrene, and ethanol), as well as CO_2, in indoor winery air during various stages of wine-making. This interdisciplinary project applies the principles of environmental engineering to the field of enology, utilizing the expertise of individuals in both disciplines. The collaboration will be cross-college, involving members of the College of Engineering as well as the College of Agriculture.

III. Objective(s)

The objectives for this thesis are as follows:

1. Analyze the collected air for select VOCs using gas chromatography-mass spectrometry, following EPA Method TO-17 sampling and analysis methodology [2].
2. Determine whether the concentrations of the select VOCs are of concern for indoor air quality, compared to OSHA standards.

IV. Methodology

1. Initiate contact with wineries for sampling in Fall Quarter 2017
    a. In this phase, wineries will be contacted for the opportunity to sample facility air. Winery identity would be kept anonymous in the report.
2. Sample facility air in Winter/Spring/Summer 2018
    a. Sampling and analysis methods will follow EPA Method TO-17 methodology. Sampling is to take place at four different stages of the wine-making process: bulk storage, grape crush, fermentation, and aging/storage.
    b. Will also sample for CO_2 if time permits.
3. Analyze samples and compare to allowable levels mandated by OSHA
    a. Utilizing university resources, thermal desorption gas chromatography-mass spectrometry will be used to analyze the samples collected at the wine facilities. Testing will follow EPA Method TO-17 methodology.
    b. CO_2 levels will be monitored using a CO_2 gas analyzer instrument, currently owned by the Civil/Environmental Engineering Department.

V. Timeline

By end of Fall 2017:

- Establish relationship with two or three wineries as sampling locations
- Procure supplies needed for sampling (e.g. sorbent tubes, calibration gas, carrier gas)

By end of Winter/Spring 2018:

- Run workshop open to students to learn how to conduct GC-MS analysis, including creating calibration curves for gases.
- Sample air from wineries at locations to be determined onsite.
- Run GC-MS analysis on collected samples from wineries.

By end of Summer/Fall 2018:

- Conduct further sampling and analysis for wine crush and grape harvesting period during summer/early fall.
- Complete writing thesis report and defend.

VI. Final Products and Dissemination

As this is a thesis-based project, the final product will be a thesis and thesis defense. One peer-reviewed journal article is expected to result from this project. Plans are being made to run a workshop for students to learn how to calibrate and use a gas chromatography-mass spectrometry machine. Future presentations or talks are not planned, but may arise during the project.

VII. Budget Justification

A total breakdown of the materials requested include:

- $1400 for sampling tubes. 20 Sorbent Tubes (Stainless Steel Thermal Desorption Tubes, Anasorb GCB1/Carbosieve S-III, Unpurged) will be purchased for air sampling. EPA Method TO-17 requires the usage of field and method blanks ensure proper QAQC measures are taken. 2 method blanks, 2 trip blanks, 2 field blanks, and 14 samples tubes for the field and spares in case of breakage or contamination.
- $200 50 ft. ¼" ID tygon tubing for sampling
- $700 for calibration gas procurement.
- $200 for journal publication

20 Sorbent Tubes (Stainless Steel Thermal Desorption Tubes, Anasorb GCB1/Carbosieve S-III, Unpurged) will be used for the following purposes: 2 method blanks, 2 trip blanks, 2 field blanks, and 14 samples tubes for the field and spares. Each tube will be bought online from SKC Inc. at a price of $62 per stainless steel tube. Tubes will be bought unpurged, as they are reusable and will need to be re-purged after each use.

50 ft. Tygon ¼" inner diameter tubing will be purchased for sorbent tube connections to the sampling pump.

Calibration gas standards must be used for gas-chromatography-mass spectrometer calibration to ensure that accurate readings are being made by the equipment for each sampling group. Custom or group sets of pre-determined canisters are available, based on the manufacturer. Calibration gas make up will include benzene, toluene, ethylbenzene, xylene, styrene, and ethanol.

As stated in Part VII, a peer-reviewed journal article is expected to be published at the conclusion of this project.

The budget items proposed directly support the "Learn-by-Doing" emphasis of this project by supplying the required sampling supplies. This project is not financially supported by any other grant or funding source.

Appendix A: Proposal Budget

Student Applicant(s): Andrew Kaneda	
Faculty Advisor: Tracy Thatcher	
Project Title: Indoor air monitoring of select volatile organic compounds in wineries using active sampling and gas chromatography-mass spectrometry	**Requested Endowment Funding**
Travel *subtotal*	**$0**
Travel: In-state	**$0**
Travel: Out-of-state	**$0**
Travel: International	**$0**
Operating Expenses *subtotal*	**$2500**
Non-computer Supplies & Materials	**$2300**
Computer Supplies & Materials	**$0**
Software/Software Licenses	**$0**
Printing/Duplication	**$0**
Postage/Shipping	**$0**
Registration	**$0**
Membership Dues & Subscriptions	**$0**
Multimedia Services	**$0**
Advertising	**$0**
Journal Publication Costs	**$200**
Contractual Services *subtotal*	**$0**
Contracted Services	**$0**
Equipment Rental/Lease Agreements	**$0**
Service/Maintenance Agreements	**$0**
TOTAL	**$2500**

Appendix B: References

[1] R. Boulton, "A self-sustainable winery, an advanced passive building and remote monitoring of environments in wineries," (in English), Journal of Agricultural Engineering, Article vol. 48, pp. 53-58, 2017.

[2] C. f. E. R. Information and O. o. R. a. Development, "Determination of Volatile Organic Compounds in Ambient Air Using ActiveSampling Onto Sorbent Tubes," ed. Cincinnati, OH 45268: U.S. Environmental Protection Agency, 1999.

[3] N. B. Goodman, A. Steinemann, A. J. Wheeler, P. J. Paevere, M. Cheng, and S. K. Brown, "Volatile organic compounds within indoor environments in Australia," (in English), Building and Environment, Article vol. 122, pp. 116-125, Sep 2017.

[4] H. L. Huang et al., "Efficient degradation of gaseous benzene by VUV photolysis combined with ozone-assisted catalytic oxidation: Performance and mechanism," (in English), Applied Catalysis B-Environmental, Article vol. 186, pp. 62-68, Jun 2016.

[5] N. Madrid, R. Boulton, and A. Knoesen, "Remote monitoring of winery and creamery environments with a wireless sensor system," (in English), Building and Environment, Article vol. 119, pp. 128-139, Jul 2017.

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[9] D. Sanjuan-Herraez, S. de la Osa, A. Pastor, and M. de la Guardia, "Air monitoring of selected volatile organic compounds in wineries using passive sampling and headspace-gas chromatography-mass spectrometry," (in English), Microchemical Journal, Article vol. 114, pp. 42-47, May 2014.

[10] C. Schueuermann, B. Khakimov, S. B. Engelsen, P. Bremer, and P. Silcock, "GC-MS Metabolite Profiling of Extreme Southern Pinot noir Wines: Effects of Vintage, Barrel Maturation, and Fermentation Dominate over Vineyard Site and Clone Selection," (in English), Journal of Agricultural and Food Chemistry, Article vol. 64, no. 11, pp. 2342-2351, Mar 2016.

[11] D. R. Storm, Winery Utilities: Planning, Design, and Operation. 115 Fifth Avenue New York, NY 10003: The Chapman & Hall Enology Library, 1997.

[12] C. J. Weschler, "Chemical reactions among indoor pollutants: what we've learned in the new millennium." (in English), Indoor Air, Article vol. 14, pp. 184-194, Aug 2004.

CALPOLY

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November 6, 2017

This letter is being written to support the grant proposal from Andrew Kaneda to the Warren J. Baker Endowment for Excellence in Project-Based Learning and the Robert D. Koob Endowment for Student Success. I believe that the research being proposed addresses a potentially important problem in Environmental Engineering, is strongly interdisciplinary in nature (combining disciplines from two separate colleges: Environmental Engineering and Enology), and epitomizes the Learn by Doing philosophy supported by these grants.

The proposed project is a graduate thesis looking at emissions of volatile organic carbon compounds (VOCs) from wine making processes. The nature and concentrations of these compounds have not been well studied and have the potential to impact the health of workers. The project hypothesis was developed by the graduate student, who has identified gaps in the current research regarding the role VOC emissions play in air quality during wine processing. The project is currently unfunded, so conducting the hands-on sampling required will require additional resources for materials and supplies. The attached proposal lists these supplies and the rationale for each request. The student will have access to considerable support/facilities through the department. There is space to conduct set-up and analysis, as well as pumps, balances, repair equipment, and flow calibration devices that can be used. In addition, the student will have access to a Gas Chromatograph/Mass Spectrometer for the analysis (a very expensive analytical device). As advisor for the project, I will work closely with the student to provide technical advice, administrative support, and assure that the project goes smoothly.

The proposer, Andrew Kaneda, is an excellent student who has the intelligence, background, work ethic, and creativity to assure that this project is successful: both in terms of academic learning and by adding to the research community's understanding of this important issue. This grant support would provide the funding that is essential for the successful completion of this thesis project.

Sincerely,

Tracy L. Thatcher, PE, PhD
Professor, Civil and Environmental Engineering
California Polytechnic State University
San Luis Obispo, CA