ENVH 555

Industrial Hygiene Methods: Laboratory

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Instructor:
Edmund Seto
Office: F226C
Phone: 206 543-1475
Email: eseto@uw.edu

Teaching assistant:
Grace Liao
Office Hours: by arrangement
Email: gracel4@u.washington.edu

Schedule
Course hours are on Tuesday and Thursday, 1:30 - 5:20. The attached schedule of the experiments gives more information about the types of sampling and analysis that will be covered in each experiment.

References

The course text for ENVH 555 is the Lab Manual, which consists of 8 individual sections, one for each of the eight experiments you'll complete during the course. Each experiment is listed as a "module" on the canvas website for the class, and the lab guide and other associated specific readings for each experiment are hot-linked to the modules on the website. Any students who have not taken or are currently taking either ENV H 553 or ENV H 453 should ask about additional reference material. Suggested references are:

Ramachandran, G., Occupational Exposure Assessment for Air contaminants, CRC Press, Boca Raton FL

McDermott, H.J., Air monitoring for toxic exposures, 2nd Ed. John Wiley and sons, Hoboken, NJ

Cohen, BS and McCammon, CS Jr., eds. Air Sampling Instruments, 9th edition. Cincinnati: ACGIH, 2001. (Reserve Copy in the Department Library)

Methods of Air Sampling and Analysis, APHA ISC, Lodge, Third Ed., 1989.

NIOSH Manual of Analytical Methods (NMAM), Online at http://www.cdc.gov/niosh/nmam/
- 0500--Nuisance Dust
- 0600--Respirable Dust
- 7400--Sampling and Analysis of Fibers in air
- 3500--Formaldehyde
- 7082--Lead
- 7030--Zinc
- 1500—Hydrocarbons
- 9002--Bulk Asbestos Method

Perkins, J. Modern Industrial Hygiene, Van Nostrand Reinhold, NY(1997).

OSHA Analytical Methods Manual, Pt 1. Organic substances, Vol. 1-4 (1990-93); Pt. 2, Inorganic substances, Vol. 1 & 2 ('91)

The Occupational Environment: Its Evaluation and Control, Edited by S.R. DiNardi, AIHA Press, 1998.

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Copies of important readings from the references will be on available in Room F226, HSB, or will be made available electronically.

Course Description:

This course and the companion lecture course ENV H 553 cover the detection, sampling and analysis techniques for Industrial Hygiene assessment and monitoring. The laboratory experiments are intended to simulate typical industrial hygiene measurement situations and to provide a basis for the selection of sampling and analytical techniques and for the critical evaluation of the laboratory results.

The course emphasizes industrial hygiene sampling and measurement techniques primarily for airborne exposures to chemical agents. Students are introduced to the most common types of field measurements, sampling methods and laboratory analyses, which are used in evaluating occupational health hazards. A familiarization with the instrumentation and techniques is obtained through application in a laboratory-based scenario. The direct measurement techniques are compared to each other and to laboratory based methods. Methods of generating test atmospheres are used to provide concentrations for field type sampling methods. Typical samples are collected for later laboratory analysis. The principles of sampling are emphasized and the laboratory results and environmental results are evaluated by use of quality control measures. The students will learn the format as well as the content of a number of the standard methods that are used. While the examples used in this class focus on workplace sampling and analysis, the techniques that you'll learn are also directly applicable for measuring personal exposures and contaminant concentrations in the ambient environment.

Content

- Calibration of airflow measuring devices
- Aerosol sampling using filter samplers, cyclones and cascade impactors. Aerosol analysis using gravimetric and real-time methods.
- Direct measurement techniques for gases and vapors: Detector tubes and direct reading instruments.
- Infra red spectroscopy: non-dispersive carbon dioxide monitor and the dispersive MIRAN instrument for the measurement of single compounds and the evaluation of mixtures in air.
- Adsorption sampling for organic gases using charcoal tube and badge samplers and analysis by gas chromatography.
- Asbestos is identified in bulk materials by polarized light microscopy and is analyzed in air samples by NIOSH Method 7400 using phase contrast microscopy. Introduction to automated image analysis.
- Atomic absorption and x-ray fluorescence spectroscopies for analysis of metals in airborne particles and surface samples.
- Computer spreadsheet technology will be applied to the processing of the data and for testing method reliability.

Course Learning objectives:

At the end of this course, students should be able to accomplish the following:

1. Identify literature sources of standard methods for measurement of occupational exposures to chemical contaminants

2. Identify the advantages and the limitations inherent in a variety of techniques and instruments used for industrial hygiene measurements, and what specific factors in the sampling situation might prevent accurate application of that approach.
3. Describe a framework for selection of appropriate methods for measurements of specific workplace contaminants.
4. Demonstrate knowledge of the operating principles of several kinds of contemporary field meters for chemical agents. Demonstrate proficiency in the use of these devices.
5. Demonstrate knowledge of the operating principles, advantages and limitations of several kinds of major laboratory instruments commonly used for chemical analysis, including: FTIR, UV/visible absorption spectrometers, gas chromatographs, atomic absorption spectrometers. Demonstrate proficiency in the operation of these devices.
6. Apply basic concepts in quality control and quality assurance for chemical measurement data.
7. Critically evaluate the reliability of chemical measurement data.
8. Express and interpret the chemical measurement results in terms that are applicable to occupational standards and situations.
9. Demonstrate competency in technical writing.
10. Demonstrate the ability to work effectively and co-operatively as part of a team.

Responsibilities

The student responsibilities for the course are the following:

1. Prepare in advance of each lab period. Read/understand each experiment and assigned readings before class. Complete all necessary calculations for adequate sampling times, for preparation of standard solutions, and for dilution schemes to provide appropriate concentrations.
2. Submit a lab report on each experiment. Reports will be due one week from the scheduled completion date for each experiment, unless otherwise announced.

The students will work in small groups for most of the experiments. However, each student is responsible for taking part in all phases of each experiment and for preparing and submitting a report of their lab results and findings.

Class organization:

Refer to the class schedule. The course consists of laboratory sessions every Tuesday and Thursday. Teams of 3-5 students will work co-operatively to undertake each experiment. Students will prepare individual reports describing their finding from each experiment. These reports are due one week after the completion of each laboratory experiment.

Grading
Each experimental report will be graded as described in the Reports Section. The questions at the end of the procedures will be given emphasis because of their importance. Penalties for late reports could affect the grades.

Students with Disabilities:
To request academic accommodations due to a disability, please contact Disabled Student Services, 448 Schmitz, 206-543-8924 (voice/TTY). If you have a letter from Disabled Student Services indicating that you have a disability that requires academic accommodations, please present the letter to me so we can discuss the accommodations you might need in this class

LABORATORY SAFETY

Fire and Emergency- Know the locations of the following:

Telephone (RED) in South Main Hall outside T-568.
Fire and Emergency: **9-911**
Hazardous Spill (large): **9-911**
Other important numbers**:** **See Red Wall Chart by Door Room T564**

6

Fire Extinguishers:

Type A - For wood, paper, etc.
Type B - Chemical
Type C - Electrical

Fire Alarm:

Located next to T-Wing main stairwell, 5th Floor Entrance.

Deluge and eyewash showers:

Showers: outside in South hall. Eyewash Nozzles at main lab sinks.

First Aid Kit

By South doors to each lab.

Injury, Illness, and Incident Reporting:

Within 24 hours of an incident, an SIAR (Supervisors Incident Accident Report must be filled out by the instructor).
If you report in to Hall Health or Hospital Emergency for treatment of a lab reported illness, they must fill out a form.
For info call campus Environmental Health and Safety, **543-7262**.

Personal Protection

Safety Glasses are provided and should be worn at all times in the lab.
Know about the chemicals used in lab.
Use common sense. Control your own exposures.
Lab coats and protective gloves are available and should be used when handling hazardous chemicals.
Ask any questions about Lab Safety before you act.
Bringing food and beverages into the laboratory, or consuming these items in the laboratory is illegal under state law. Use the shelving in the hallway outside the lab for storage of open food and beverage containers.
Wear appropriate footwear to protect feet from chemical spills and broken glass.

Chemical Hygiene Plan

The Chemical Hygiene Plan is available on the reference shelf of the Laboratory in Room T564. All Students should familiarize themselves with contents of the Plan, especially for the following topics:

Chemical Storage:

MSDS Library – know where it is, be familiar with what you use!
Label samples and standards for storage until the next period.
Storage in refrigeration; follow guidelines for combustibles.
Lab Techniques- prevent bulk sample and stock contamination.

Safety of Compressed Gasses

Tanks are to be secured by straps to walls and benches.
Tanks not in use will have their caps secured. Especially during transportation.
Each tank has a labeled regulator. Many regulator fittings are designed for specific gasses to prevent cross-mixing and other hazards.

To obtain a gas from a compressed gas tank.

1. Attach the proper regulator and tighten the nut.
2. Assure valve of regulator's second stage is closed (counter clockwise).
3. Be sure gas outlet valve (to the system) is closed.
4. Open the valve on the compressed gas tank. (usually in a counter-clockwise direction) and observe pressure on first stage of the regulator.
5. Open second stage regulator to desired pressure (turn clockwise).
6. Attach sample bag or sample line or container to outlet and open valve.

To shut off (Proper shut down) of the Compressed tanks

Shut off tank valve (Usually turn handle clockwise till tight.)
Observe pressure gauges drop to zero
Close second stage regulator valve and outlet valve.
After class experiments, help the instructor turn-off tanks, remove regulators, cap tanks and store regulators. Write the last primary tank pressure with the date on the tag.

Chemical Disposal

Follow approved procedures--ask instructors and/or see the Chemical Hygiene Plan
Do not dispose of chemicals down the drain or into the trashcans.
Dispose of organic solvents into the Organic Waste Bottle in the Hood.
Dispose of strong acids into the Acid Waste Bottle in the Hood.
Dispose of metals solutions into the Metal Waste Solutions bottle in the hood.
When in doubt ask an instructor how to dispose of your chemicals.

Standard Operating Procedures

See the appropriate procedures (SOPs) in the Chemical Hygiene Plan Notebook.

LABORATORY SCHEDULE

NO.	DAY/DATE	EXPERIMENT
1	**Tues 1/6**	Introduction & Orientation *Briefings:* *Course Overview* *Laboratory Safety* **I. PUMP OPERATION & AIR FLOW CALIBRATION**
2	**Thurs 1/8**	Pump operation and air flow calibration (cont.) *(Note: Semiahmoo Conference)*
3	**Tues 1/13**	**II. AIRBORNE PARTICLE CHARACTERIZATION** *Lecture:* *Particle Sampling* *Size Selective Sampling* *Direct Reading Instruments*
4	**Thurs 1/15**	Airborne Particle Characterization (cont.)
5	**Tues 1/20**	**III. DIRECT MEASUREMENT** *Lecture:* *Detector tubes* *Direct reading instruments*
6	**Thurs 1/22**	Direct measurement (cont.)
7	**Tues 1/27**	**IV. ASBESTOS DETERMINATION**
8	**Thurs 1/29**	Asbestos determination (cont.)
9	**Tues 2/3**	**V. AEROSOL ANALYSIS: Metals by AAS** *Calibration Regression Curves* *Atomic Absorption Spectrometry.* *Serial Dilution & Standard Additions* *Alternative methods for elemental analysis:* ICP/XRF
10	**Thurs 2/5**	Metal analysis (cont.)
11	**Tues 2/10**	**VI. ROOM VENTILATION RATE by IR** *Discussion*: FTIR and MIRAN, *Discussion: Infra Red*
12	**Thurs 2/12**	Gas Mixtures by IR
13	**Tues 2/17**	**VII. ADSORPTION SAMPLING Analyzed by GC** *Lecture: Gas Chromatography & adsorption sampling*
14	**Thurs 2/19**	GC ANALYSIS (cont'd.)
15	**Tues 2/24**	**VIII. SPECIAL FIELD PROJECT** *Students will develop and execute individual sampling & analysis projects in consultation with the instructor. These projects may be conducted outside of class time.* (Note: field project presentations will be on last day of class)
16	**Thurs 2/26**	
17	**Tues 3/3**	
18	**Thurs 3/5**	
19	**Tues 3/10**	
20	**Thurs 3/12**	

Guidelines for preparation of laboratory reports

All students will be required to submit an individual lab report for each lab. Students are encouraged to actively participate in all aspects of generating the data in the laboratory to better learn and understand all of the principles and procedures. This is essential in order to be able to independently carry out such surveys and make the required reports in the future. Data should be kept in bound laboratory notebooks to prevent loss or compromise.

In general, lab reports should follow this outline:

Experimental Objectives - In one paragraph, state the major aims of the lab.

Methods - List the citation for the methods and/or references used, serial numbers of the equipment utilized, and any procedural modifications. Do not re-write the manual. Also provide the calculations and the schemes for standards preparation and dilutions. Reviewers cannot help troubleshoot errors without verification of standards and any questionable data. **The Objectives and Methods sections typically should not exceed 1 page combined.**

Results - Provide all sample data, standards data, and regression data with appropriate curves. Show precision of replicates and coefficient of variation for the method. Also give worked examples of all your calculations, equations and formulas, especially when serial calculations are calculated by spreadsheet. Copies of computer printouts or integrator data plots, should be accompanied by a listing of the formulas, constants and factors.

Discussion - Compare your observed vs. expected results where appropriate. Include any information of variables, which might have spuriously affected your results. Speculate as to the reasons your results may differ from theoretical. Address recovery problems, analytical errors, and uncertainties.

Conclusions - The conclusion section of the reports should provide not only your evaluation of the method and the validity of your data, but should also address the relation of the measured levels of contaminants to those of standards such as TLVs or PELs. The optimum length of the Discussion and Conclusion Sections should be but is not limited to 1 page each. Provide summary tables of all major results.

Questions – Specific questions may be included in the lab guide. These questions can be answered at an appropriate place in the report or in a separate section at the end.

Grading: The reports will be graded on the accuracy and precision of the results, the application of the techniques, the validity of the conclusions, the investigation and explanations of errors. The reports do not have to be typed or word processed, but must be neat, legible and organized. Grades can be adversely affected by data that cannot be readily found and/or recognized because of poor organization of the report.

SUMMARY INDEX CHART AND REFERENCES: The following table outlines some of the common techniques of measurement, sample collection and analysis used in this lab, and by Industrial Hygienists in general. Direct measurements and sample collection often supplement each other to provide a complete evaluation of the exposures.

Exposure	Instrument/Sampler	Analytes	Analysis	Expt #.	References
Air Volume*	Pumps			I	SKC Manual, P 389-412
	Rotameters, DryCal Mass Flow Meter Bubble Meters		Calibration	I	NESS App A, pp 488-511. ASI 238-245, 149-175.
Aerosols & Particulates	Filters	Total Dust	Gravimetric Microscopic	II	NESS 93-104, ASI 281-290 NIOSH 7400, P 508-528
	Cyclones Impactors Impingers	Respirable dust Size selection		II	NESS 104-121, ASI 135-146 ASI 316-346, P 528-547
		Mineral Dusts: Asbestos, (Silica)	Microscope (XRD)	IV	P 380-385 NIOSH 7400, 9002
		Metals: Pb, Zn, Fe	AA, XRF, (ICP), (IC)	V	P 376-379
Gases	Meters	CO, CO_2	IR, Electrochemical	III	ASI 507-517
	Detector Tubes			III	NESS 512, ASI 458-470
	(Bubblers**)		Wet Chemical**	III	ASI 415-420, P 379-380
Vapors	Meters Detector Tubes	Solvents: TCE, toluene, xylene	OVA, TIP, IR	III	NESS 220-241 ASI 458-470
	Bags, CT, CB	Solvents	IR spectroscopy	VI	NESS 260-273, 513-518 P 379
	Adsorption tubes		Gas chromatography	VII	NIOSH 1500, P CH19, P370-374, ASI 415-457 NESS 51-68, 242-259

*Accurate measurement of the volume of air sampled requires calibrated flow measuring devices.
**Collection by bubblers and impingers with wet chemical and colorimetric analysis can be applied to numerous gas and vapor exposures.
Items in () are included for completeness but are not covered in the course.

References:
NESS-Air monitoring for toxic exposures, An integrated approach, Shirley A. Ness, VanNostrand Rheinhold, New York, 1991.
ASI—Air Sampling Instruments, ACGIH, 9th Ed., 2001. P – Perkins, Modern Industrial Hygiene, 1997
NIOSH NMAM--NIOSH Manual of Analytical Methods, Online at http://www.cdc.gov/niosh/nmam/nmammenu.html