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Analysis of formaldehyde transport from porous solid-sorbent media to hydroponic growth media

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Outline

- Background:
  - Research
  - Materials
- Research Objective & Questions
- Experiments
  - Materials
  - Conditions
  - Set-Up
  - Problems
- Lab Experience

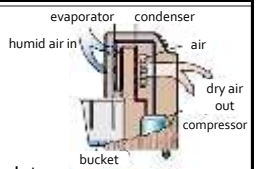
Background: Indoor Air Quality (IAQ)

- Sick Building Syndrome
  - occupants experience acute health and comfort effects that appear to be linked to time spent in a building
- Building Related Illness
  - symptoms of diagnosable illness are identified and can be attributed directly to airborne building contaminants
- Contributing factors:
  - Inadequate ventilation, contamination from indoor, outdoor, and biological sources. (copy machines, motor vehicle exhausts, bacteria and viruses).

(EPA, 2010)

Background: Approaches to IAQ

- Dehumidifiers
  - Prevention
- Ventilation
  - Prevention
- Air Filters
  - remove: sub-micron particulates
    - dust mites, dust, pollens, mold spores, pet dander, and other allergens
  - Need to be replaced
- Media (activated carbon)
  - Removal?



Background: Formaldehyde (HCHO)

- Adverse health effects vary at levels > 0.1ppm:
  - watery eyes, burning sensations in the eyes and throat, nausea, difficulty breathing, coughing, fatigue, skin rash, severe allergic reactions, cancer, death.
- Formaldehyde is one of the most well known volatile organic compounds and is readily identified, measured, and removed. *(EPA, 2010)*

Background: HCHO & IAQ

- Katrina and Rita aftermath:
  - 519 random sample travel trailers
  - 0.003-0.59 ppm (avg. 0.077ppm)
  - 0.01-0.02 ppm (Normal indoor levels) *(FEMA, 2009)*
- Known human carcinogen *(National Toxicology Program, 2011)*
- Regulations:
- < 2 ppm as a 15-minute short term exposure limit
- < 0.75 ppm as an 8-hour time weighted avg *(OSHA)*

Background: Engineered solution?

Active Phytoremediation Wall System (APWS)

- Replicable ceramic pods
- Watering system
- HVAC system
- Media
- Plant

(Skidmore, Owings & Merrill)

Background: APWS research

Table 1:
HCHO % reduction by epipremnum aureum (arial parts, rhizoshpere region, entire plant).

Table 2:
HCHO % reduction by media under various conditions (alone, dry in a pot, wet in a pot).

(Aydogan, 2011)

Table 1

Golden Pothos	% Reduction
Arial	95 ±1
Rhizoshpere	93 ±1
Plant	94 ±2

Table 2

Media	% Reduction
AC	97.6 ±3
AC/Dry/Pot	94.1 ±2
AC/Wet/Pot	88.9 ±1
EC	26.4 ±5
EC/Dry/Pot	47.5 ±4
EC/Wet/Pot	62.6 ±6
GS	17.4 ±1
GS/Dry/Pot	39.3 ±3
GS/Wet/Pot	62.3 ±11

Background: Why Transportation?

- Transportation of contaminants (such as HCHO) is important for phytoremediation.
  - ***Bioremediation***—Processes that use living organisms such as plants, bacteria, yeast, and fungi to break down hazardous substances into less toxic or nontoxic substances.
  - ***Phytoremediation***—bioremediation process; uses various types of plants to remove, transfer and destroy contaminants in the media.
  - ***Rhizosphere biodegradation***—In this process, the plant releases natural substances through its roots, supplying nutrients to microorganisms in the soil. The microorganisms enhance biological degradation.

Research: Objective & Questions

- Objective:
  - Evaluate the transportation rate of HCHO through the media
- Questions:
  - Does moisture in media affect VOC transportation?
  - Does the quantity of media affect transportation?
  - Activated carbon: minimum for max efficiency?
  - Are the media quantities proportional?

Experiments: Materials

Activated Carbon | Growstones | Expanded Clay

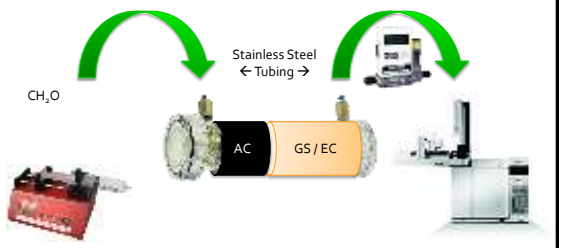
water & air treatment | hydroponic growth | hydroponic growth

	AC	GS	EC
Bulk Density (g/cm³)	0.46	0.40	0.18
Air Porosity (%)	37	70	79
Water Holding Capacity (%)	29	7	17

Experiments: Conditions

Experiment Set-Up		Condition	
		Dry	*Wet*
Media	*AC*	AC/Dry	AC/Wet
	GS	GS/Dry	GS/Wet
	EC	EC/Dry	EC/Wet
	AC/GS	AC/GS/Dry	AC/GS/Wet
	AC/EC	AC/EC/Dry	AC/EC/Wet
	AC/GS&EC	AC/GS&EC/Dry	AC/GS&EC/Wet

Experiments: Set-up



Experiments: Problems

- Experience
  - Communication & training
  - Learning equipment (syringe pump, mass flow controller, etc.)
- Materials
  - Identifying & ordering
    - Stainless steel tubing & fittings
    - GC equipment
      - Gas tanks
      - Column
      - Vials

In the lab: working with Sydney

- Autoclave
- Spiral Plater
- TOC Analysis
- Plate Counting
- Plate preparing (agar)
- Microwave Sterilization

Questions?