Ozone Interaction with Building Insulation Materials

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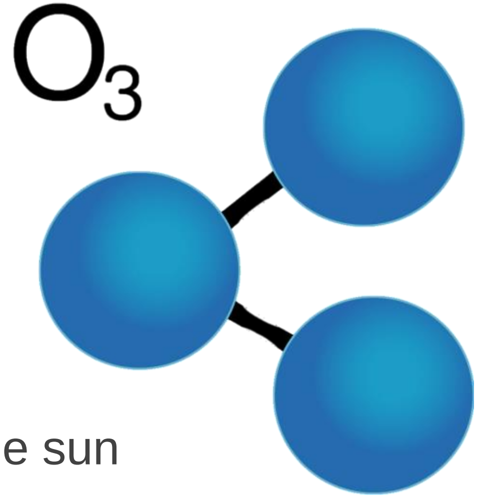
Overview

1. Background into Ozone and Indoor Air Quality
2. Deposition Velocity Methods, Results and Discussion
3. Emissions Methods, Results and Discussion
4. Future Work

Ozone

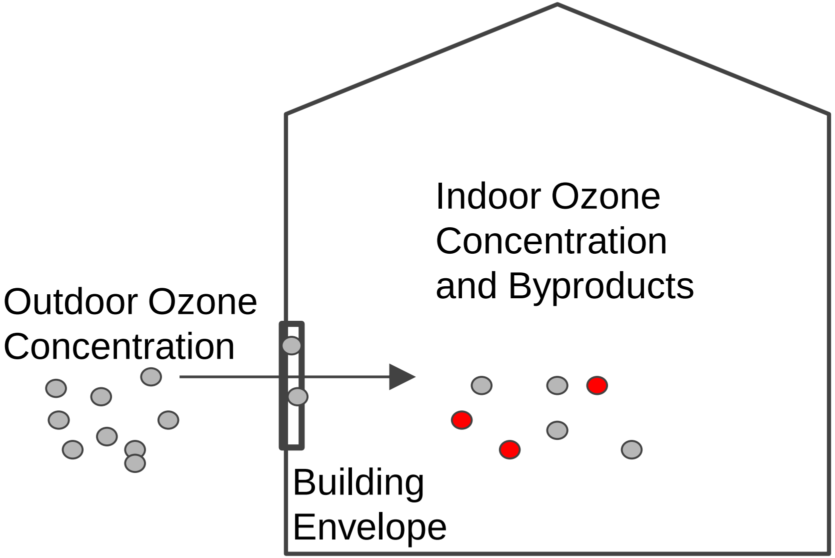


- Ozone is naturally occurring
- It is formed through readily reacting with UV light from the sun
- It is becoming more abundant in the troposphere due to pollutants
- Environmental Protection Agency (EPA) regulates levels to 70 ppb
- Ozone has been linked to cardiovascular effects, exacerbated asthma symptoms, and an increase in daily mortality.

http://userscontent2.emaze.com/images/6e2f8bd6-11fd-4192-9117-330150f98aed/4a08c5ac-4dc8-495e-b37f-f2de0ada112b.png

Ozone and Indoor Air Quality

- A study found that Americans spend 87% of their time indoors
- 25-60% of ozone exposure occurs indoors
- Deposition velocity: leads to a first order reaction constant
- Secondary and primary emissions of different building insulation materials
- Emissions fall into category of Volatile Organic Compounds (VOC)

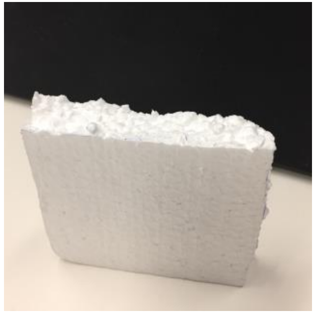
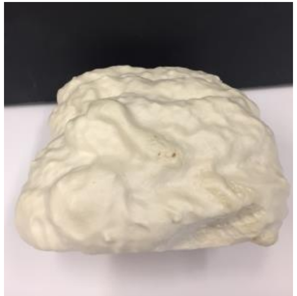
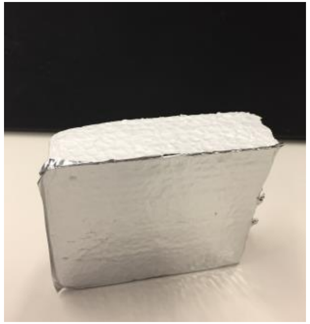
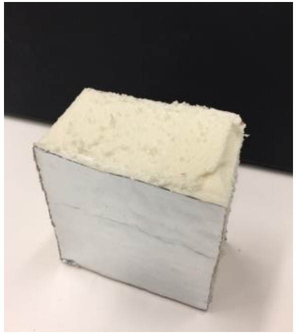


Materials

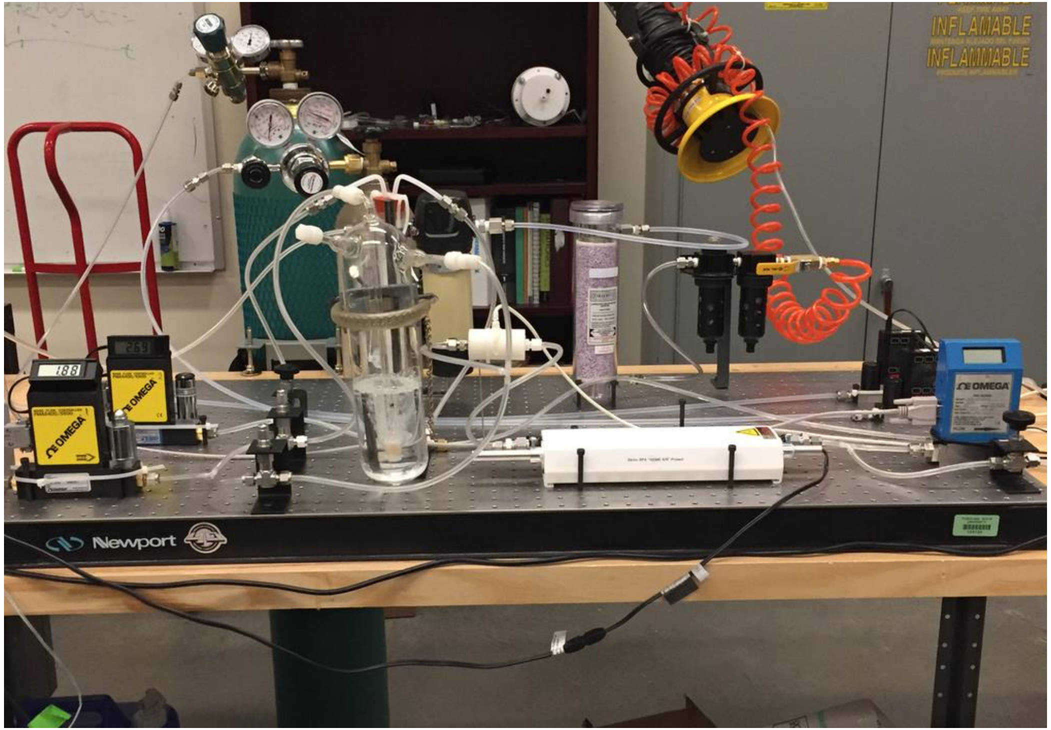
- Fiberglass
- Cellulose
- Stone Wool
- Denim
- Polystyrene
- Polyurethane Spray Foam
- Insulfoam (polystyrene with a thermal backing)
- Polyisocyanurate



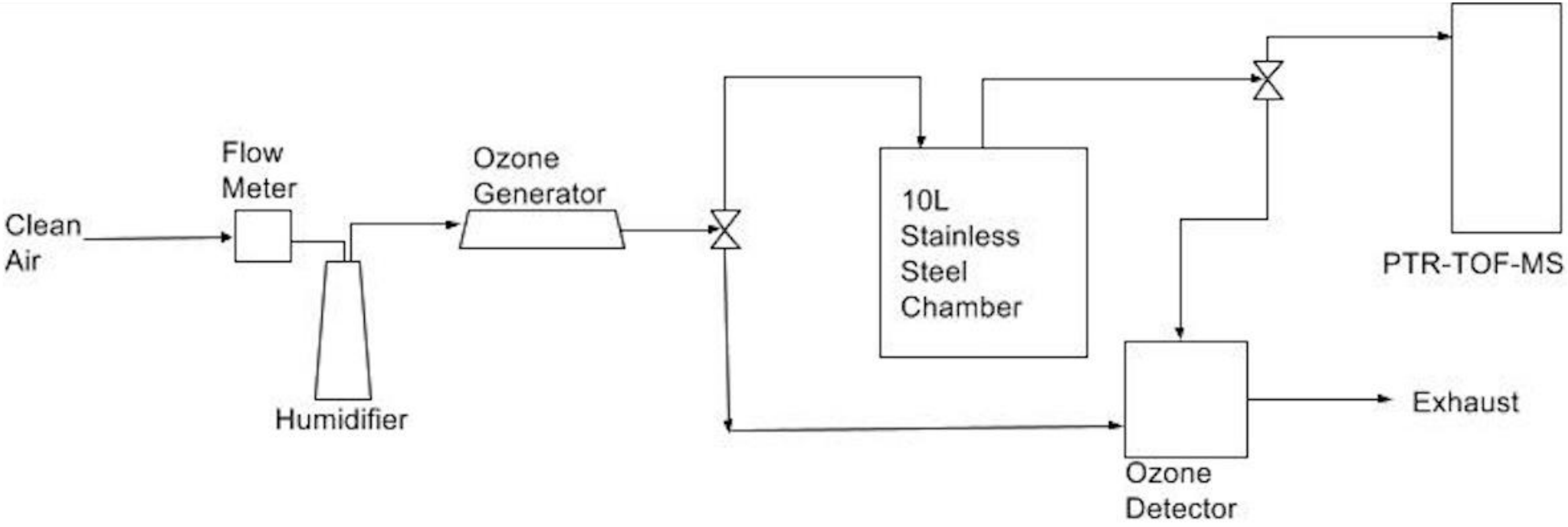


Methods



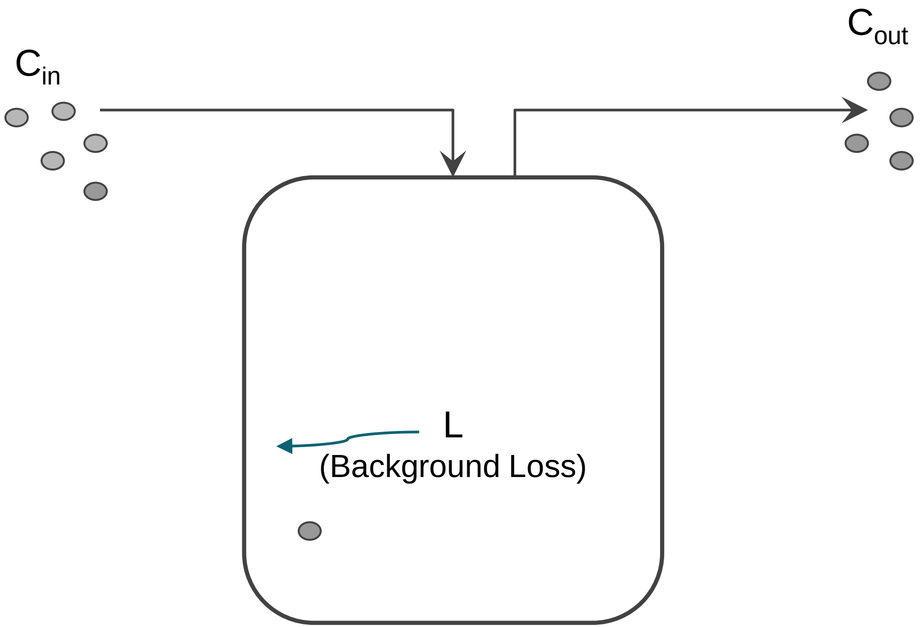
Experimental Setup



Ozone Loss Term

$$\frac{dC_{in}}{dt} = \lambda_{in} C_{in} - \lambda_{out} C_{out} - LC_{out}$$

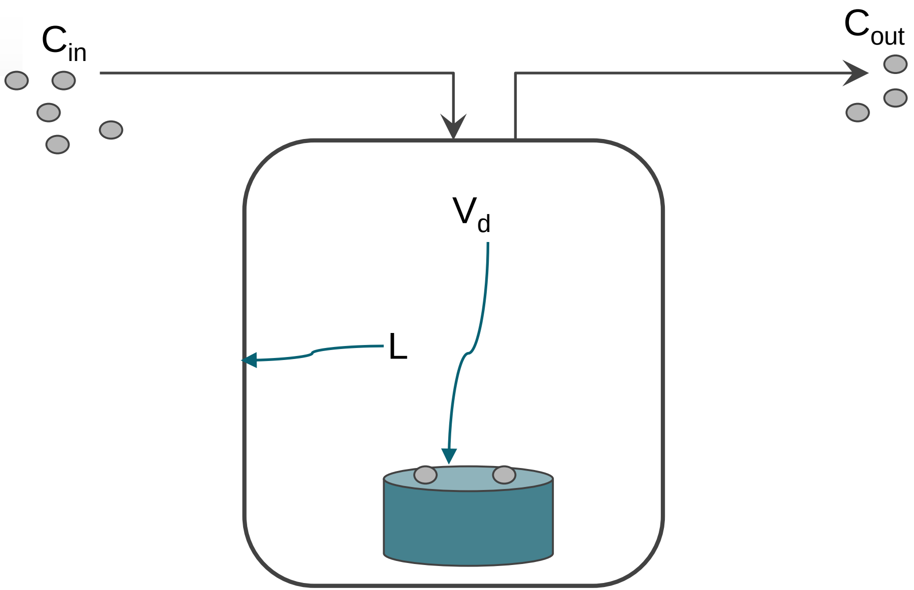
L= Loss term
λ= Air exchange rate
C= Concentration
V_d= deposition Velocity
A=Area



Deposition Velocity

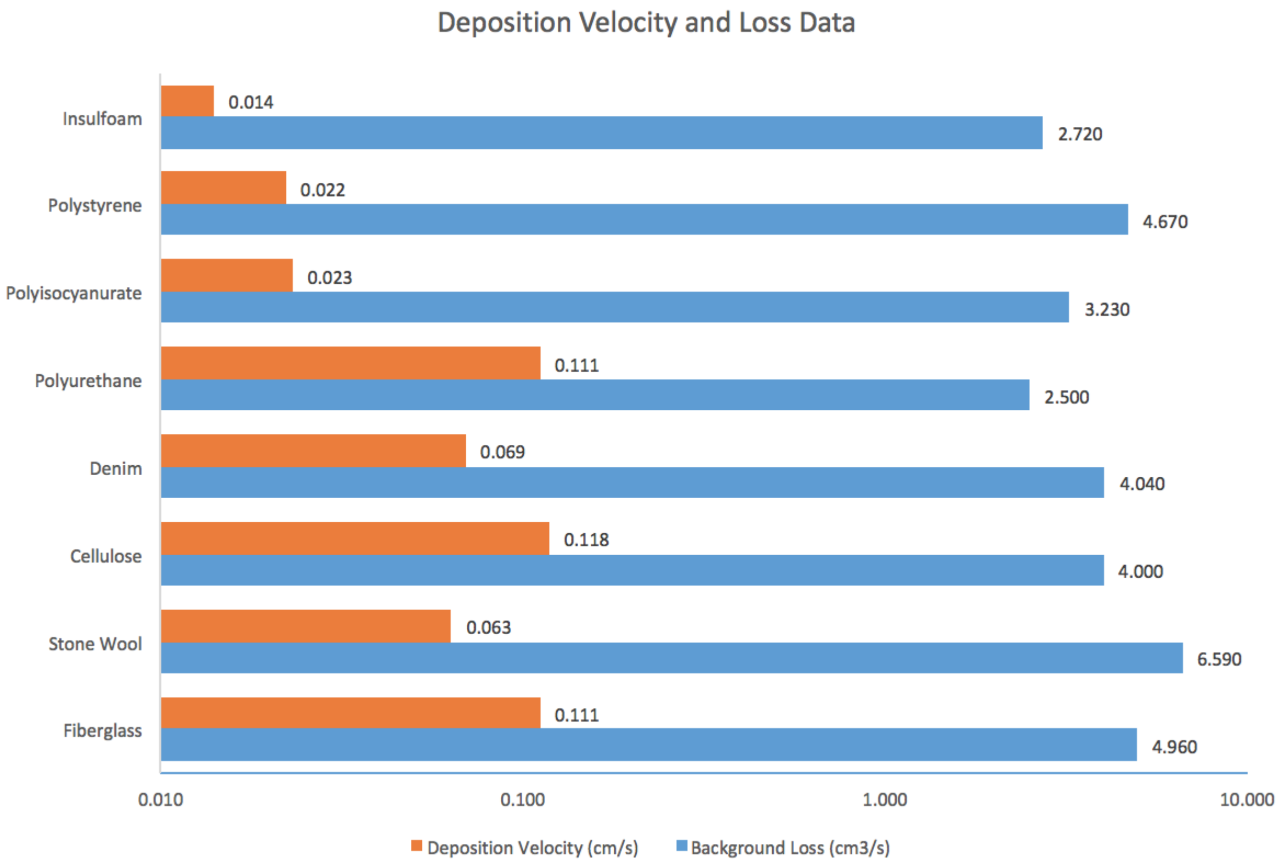
$$\frac{dC_{in}}{dt} = \lambda_{in}C_{in} - \lambda_{out}C_{out} - LC_{out} - v_d A_i C_{out}$$

L= Loss term
λ= Air exchange rate
C= Concentration
V_d= deposition Velocity
A=Area

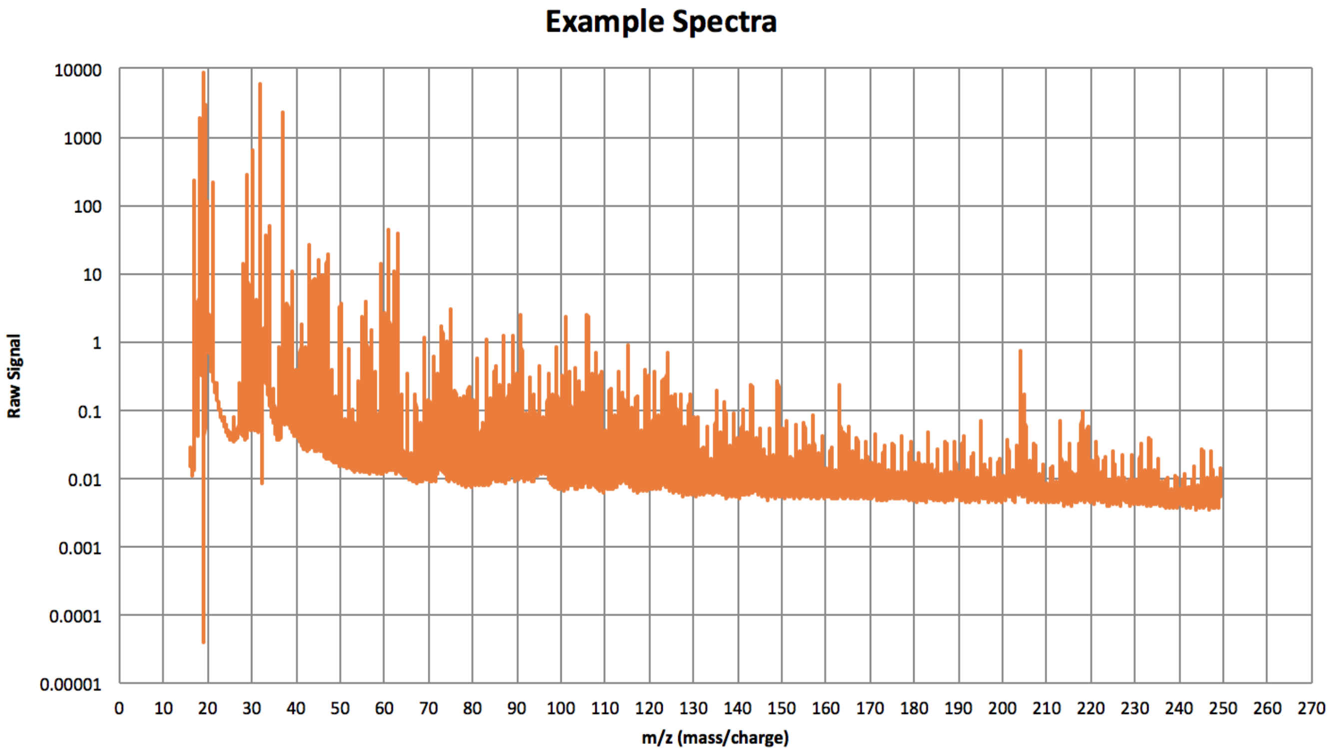


Deposition Velocities

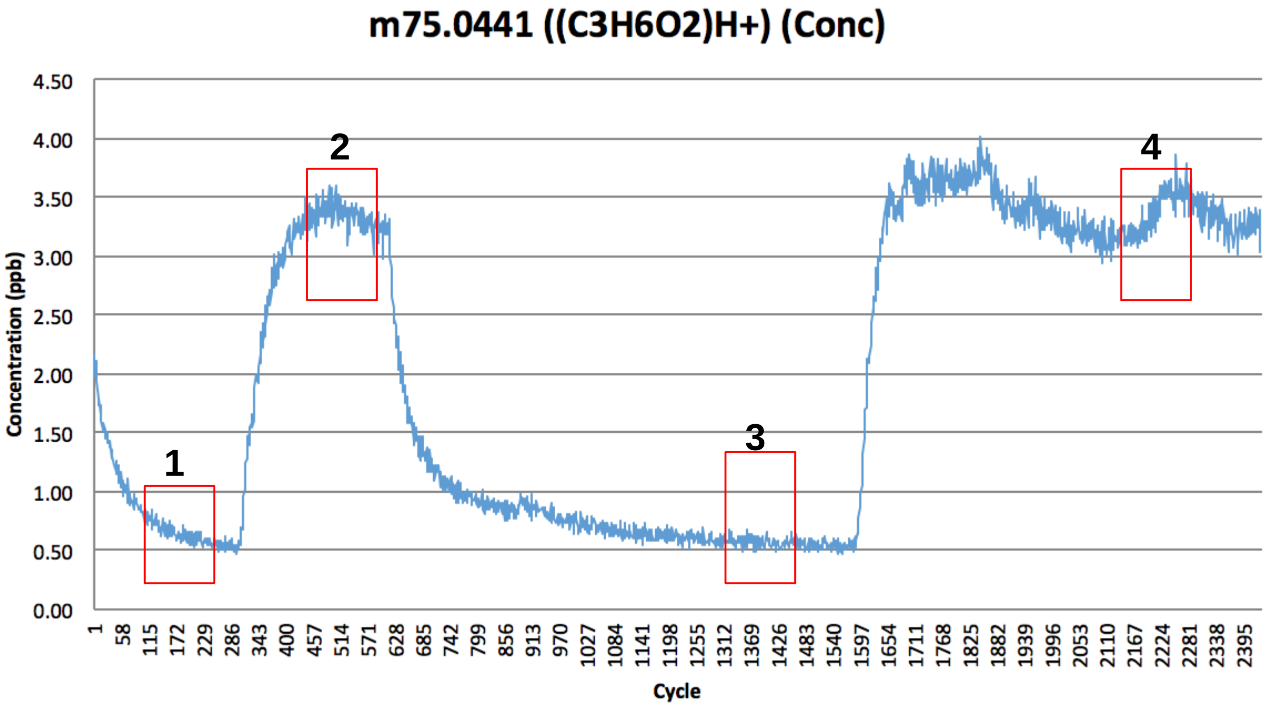
- More Fibrous insulation had large deposition velocitie
- Rigid insulation had smaller deposition velocities
- Background loss varied due to environmental conditions



PTR-TOF-MS Emission Spectra

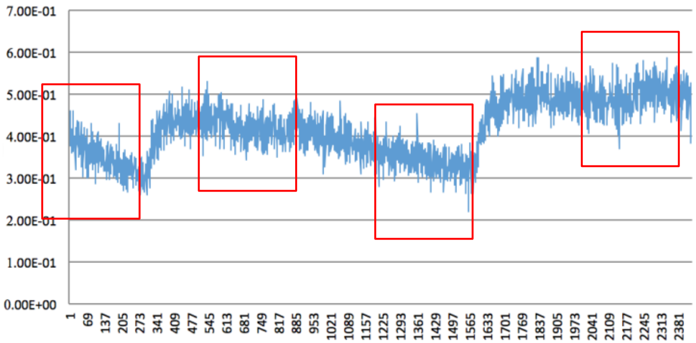


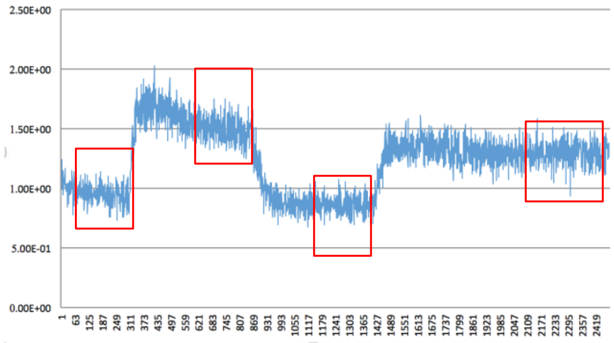
Emission Data

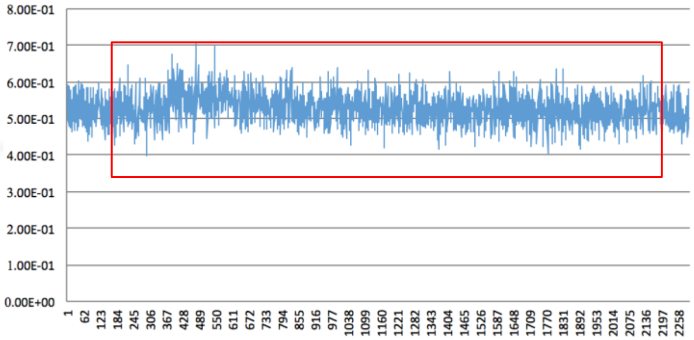


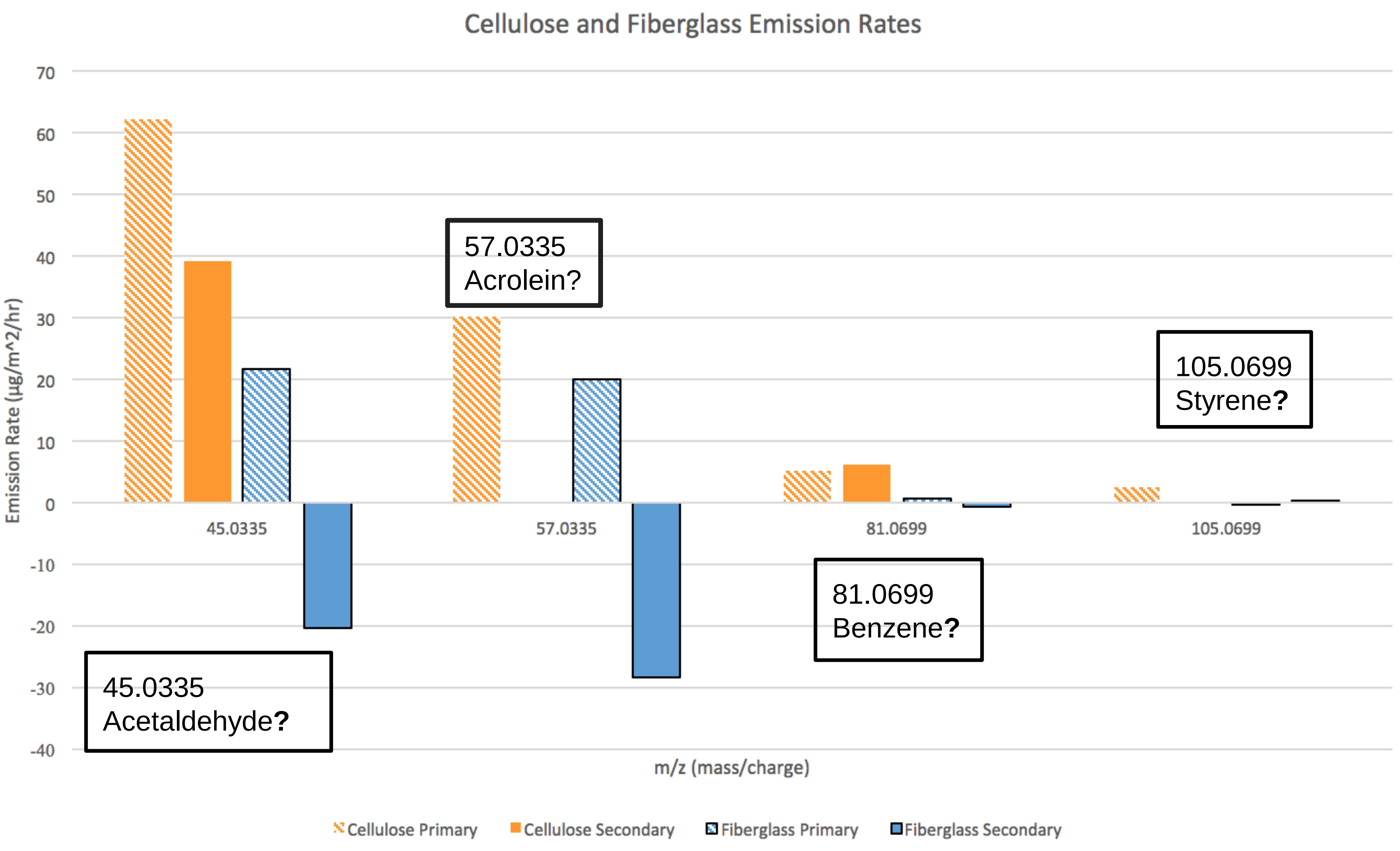
1. Empty chamber with clean air
2. Clean air with sample
3. Empty chamber with ozonated air
4. Ozonated air with sample

Emission Data









Cellulose and Fiberglass Emission Rates
Emission Rate (µg/m^2/hr)
70
60
50
40
30
20
10
0
-10
-20
-30
-40
45.0335
57.0335
81.0699
105.0699
57.0335
Acrolein?
105.0699
Styrene?
81.0699
Benzene?
45.0335
Acetaldehyde?
m/z (mass/charge)
Cellulose Primary
Cellulose Secondary
Fiberglass Primary
Fiberglass Secondary

Conclusion

- Fiberglass had very few emissions
- Fiberglass had the second largest deposition velocity
- Its large deposition velocity and low emissions indicate it may be the best insulation for indoor air quality

Future Research

- More trials to verify current data
- Further analysis of emission data
- Reaction Probability of building insulation materials to better characterize Ozone penetration
- Insulation’s reaction probability dependence on temperature and relative humidity

Acknowledgments

Green Building Research lab

- Dr. Elliot Gall
- Pradeep Ramasubramanian
- David Pleshakov

National Science Foundation (NSF)

Department of Environmental Quality (DEQ)

Portland State University REU

- Dr. Jun Jiao
- Dr. Erik Sanchez
- Hilary Louth