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.
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
\( \lambda \) = Air exchange rate
C = Concentration
\( V_d \) = deposition Velocity
A = Area

(L) (Background Loss)
Deposition Velocity

\[
\frac{dC_{\text{in}}}{dt} = \lambda_{\text{in}} C_{\text{in}} - \lambda_{\text{out}} C_{\text{out}} - L C_{\text{out}} - V_d A_i C_{\text{out}}
\]

- \( L \): Loss term
- \( \lambda \): Air exchange rate
- \( C \): Concentration
- \( V_d \): Deposition Velocity
- \( A \): Area
Deposition Velocities

- More fibrous insulation had large deposition velocities.
- Rigid insulation had smaller deposition velocities.
- Background loss varied due to environmental conditions.
PTR-TOF-MS Emission Spectra

Example Spectra

Raw Signal

m/z (mass/charge)
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
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
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