EFFECTIVE VENTILATION OF A RESIDENTIAL HOME SPRAYED WITH HIGH PRESSURE POLYURETHANE FOAM

BY WILLIAM ROBERT & JIM ANDERSEN
AGENDA

• Goal & Hypothesis
• Background details
  – What we sprayed
  – What we looked for and how
• How we ventilated
  – The equipment
  – Things that may impact ventilation on the job site
• The houses
• What we found
• Conclusions
• Open Discussion
HYPOTHESIS

Properly designed economical engineering controls
• reduce chemical migration outside the spray area
• reduce re-occupancy time to less than 24 hours

GOAL

Confirm in a retrofit residential high pressure closed cell foam SPF application
• Application areas can be contained with common materials used for sealing
• Ventilation can be low cost
• Based on this re-occupancy time can be reduced
BACKGROUND DETAILS

What we sprayed
- Spraytite®, Comfort Foam® or Walltite®.
- Medium density closed cell foam,

What criteria used for site (home) selection?
- Retrofit of existing homes
- Attic and wall type applications
- Flexible time schedule
- Centrally located (Minneapolis)
- Able to monitor all items of interest.
THE HOUSES

FIRST HOME
Minneapolis, MN:
Nov. 14-16/11

SECOND HOME
Bloomington, MN
Mar. 27-28, 2012

THIRD HOME
Blaine, MN
June 7-8, 2012

THE HOUSES
3 DIVERSE RETROFIT APPLICATIONS
WHAT, HOW, WHEN TO MONITOR?
What's in the drum that has a possible hazard during spraying and after foam is made?

Liquid Compounds

A ISO

+ Review of MSDS's for liquid compounds

MDI, Isocyanate

Finished Spray Foam

B RES

Flame Retardant
Amine Catalyst
Blowing Agent (245fa)

Note: Gun cleaning solvents were used for minor gun cleaning

MONITORED MDI, TVOC, HFC-245fa, CATALYSTS, FLAME RETARDANTS
WHAT AND WHEN

MONITORED DURING SPRAY

Employee exposure
• HFC-245fa
• Catalyst

Inside spray area
• HFC-245fa

External spray area
• HFC-245fa
• TVOC
• MDI
• Catalyst
• Flame retardant
WHAT AND WHEN

AFTER SPRAY COMPLETED

<table>
<thead>
<tr>
<th>Time, hours</th>
<th>Inside Spray Area</th>
<th>Outside Spray Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td>HFC-245fa</td>
<td>HFC-245fa</td>
</tr>
<tr>
<td>1 hr</td>
<td></td>
<td>MDI</td>
</tr>
<tr>
<td>2 hr</td>
<td></td>
<td>TVOC</td>
</tr>
<tr>
<td>4 hr</td>
<td>Catalyst</td>
<td>Catalyst</td>
</tr>
<tr>
<td>Months</td>
<td></td>
<td>Flame Retardant</td>
</tr>
</tbody>
</table>

EXTENSIVE MONITORING AFTER SPRAY- LOOKING AT DECAY RATE
HOW WE SAMPLED

- TVOC Sampler
- Charcoal tubes, Impingers
- Pumps
- Charcoal badges
- Evacuated air cans
- Direct detectors
# TO-15 TARGET COMPOUND LIST

**Air Analysis Data Summary**

**EPA Compendium TO-15**

**Target Compound List**

<table>
<thead>
<tr>
<th>Target Compounds</th>
<th>CAS#</th>
<th>MW</th>
<th>Result ppbv</th>
<th>RL ppbv</th>
<th>Q</th>
<th>Result inputts</th>
<th>RL inputts</th>
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</thead>
<tbody>
<tr>
<td>Phenol</td>
<td>105-11-5</td>
<td>94.12</td>
<td>54.70</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>78-92-5</td>
<td>78.08</td>
<td>12.09</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>75-09-2</td>
<td>88.13</td>
<td>15.73</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>Chloroform</td>
<td>67-66-3</td>
<td>94.99</td>
<td>14.85</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>Toluene</td>
<td>106-48-3</td>
<td>92.14</td>
<td>15.64</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>107-21-1</td>
<td>62.08</td>
<td>11.20</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
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<tr>
<td>Butyl acetate</td>
<td>110-84-9</td>
<td>152.17</td>
<td>76.75</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
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<td>Benzene</td>
<td>71-43-2</td>
<td>78.11</td>
<td>12.09</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
<td>0.37</td>
</tr>
<tr>
<td>Styrene</td>
<td>100-42-5</td>
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<td>76.75</td>
<td>ND</td>
<td>0.5</td>
<td>0.45</td>
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**Summary**

- 6 Compounds detected
- Result: 0.9
- Recovery: 100%

**Qualifier Definitions**

- ND = Non Detect
- DL = Estimated concentration exceeding upper calibration range
- R = Result reported from diluted analysis
VENTILATION STRATEGY
VENTILATION STRATEGY

Easy Effective ventilation of spray area

Furnace Filter

EXHAUST FILTERED?
And routed to appropriate outside location away from building

FAN
Sized to deliver 0.3 ACH minimum

PASSIVE SUPPLY CONTROL
Adjust window or other opening to generate directional air flow

WORK AREA
Under negative pressure

Monitor billowing of plastic or differential manometer to assure negative pressure

AIR LEAKS
Minimize using plastic sheet and tape

Courtesy of Spray Polyurethane Foam Alliance (SPFA)
VENTILATION EQUIPMENT

The flexible duct comes in 20 ft x 12” diameter sections for approx. $75

The two speed fan, 110 volt, is priced about $180

2905 ft³ per Minute

About $330 total

EQUIPMENT IS READILY AVAILABLE AND ECONOMICAL
WHAT IS THE BEST SET UP?

Option 1
We put the fan with furnace filter over intake and plastic wrap the fan inside the spray area and run duct outside

or

Option 2
We put a flexible duct with a furnace filter at the intake and bring it down to the fan and out a flexible duct with a furnace filter

or

Option 3
We put the fan outside and run the duct inside the spray area with a furnace filter at the duct intake

Lots to consider when setting up ventilation
VENTILATION EXHAUST

Working samples
VENTILATION STRATEGY, YOU NEED TO CONSIDER...

• Natural ventilation

• Where exhaust is placed

• Is exhaust working

• Filter exhaust

Note: Furnace filter at fan intake

Note: We tried cheap furnace filters vs. charcoal filled higher price filters—seemed to be no noticeable difference in chemical measurements

Air exhaust through a standard furnace filter.
SOME SUGGESTIONS

• Try layout before spraying
• Evaluate air movement
• Utilize attic eves or soffit vents and also roof deck mounted vents for air intakes or exhaust
• Be careful to close off any entry points that may breach your ventilation efforts
• Routinely monitor ventilation to be sure it is not obstructed
• Use ventilation equipment with greater CFM than necessary. (Ours was very large for our area)
THE DATA ANALYSIS
OUR DATA COLLECTION...

Was targeted for four major ingredient groups used in our spray foam compounds:

- Blowing Agent, HFC-245fa
- Catalyst Package
- Isocyanate, MDI
- Fire Retardant Package

The data was collected and categorized under these general foam component chemical headings

**Let’s take a look of each category and the general observations**
BLOWING AGENT TESTS AND DATA POINTS FOR HOUSE 2

96 Tests with Gastec, Badge or Grab Sample for one house!
BLOWING AGENT, HFC- 245fa

Goals- Monitor for levels of HFC- 245fa

- In application area during application and ventilation
- In other parts of the home during spraying
- Decay rate of chemicals exposure vs. time from installation

Conclusion:

- Applicator exposure during spray was slightly above or below PEL for HFC-245fa (applicators wore supplied air)
- No HFC-245fa was detected external to the application area during spray
- HFC-245fa concentrations in spray area where below PEL in 1 hour and ND within 4 hours

Conclusions based upon Extensive sampling
CATALYST

24 samples taken for the 3 houses in this project
CATALYST

Goals-Monitor for amine catalysts

• In application area during spray application
• Emissions into other parts of the home during application
• Decay rate of chemicals exposure vs. time from installation

Conclusions

• Applicator exposure during spray was below recommended exposure limits (applicators wore supplied air)
• Concentrations external to the application area during spray were 50 to 100 times lower than amine concentrations measured inside the spray area. Amine concentrations ranged from below detection limits to low ppb levels
• Catalyst concentrations measured 27 min to 1 hour after application in containment areas ranged from below detection levels to low ppb levels

Conclusions based upon Extensive sampling
ISOCYANATE, PMDI

Goals- Monitor for MDI

- Outside of the application area during spray
- Concentration in exhaust from spray area during spray
- Decay rate of MDI one hour after spraying ceased

Conclusions:

- Applicator exposure was not the focus of this study (applicators wore supplied air)
- No MDI was detected at the exhaust fan, external to the application area
- No MDI was detected external to the application area unless the exhaust fan was compromised.
- No MDI was detected one hour after spraying with the high exhaust ventilation

Conclusions based upon Extensive sampling
FIRE RETARDANT, FR

Goals- Monitor for the flame retardant
  • Outside of the application area during spray
  • If a spray area is ventilated; what is the FR concentration exhausted into the community.
  • Decay rate of FR one hour after spraying ceased

Conclusion:
  • Applicator exposure was not the focus of this study (applicators wore supplied air)
  • FR was detected (above recommended limits) at the exhaust fan, external to the application area
  • FR was measured just above detection level (well below OEL’s) external to the application area unless the exhaust fan was compromised.
  • FR was measured just above detection level (well below OEL’s) one hour after spraying with the high exhaust ventilation.

Conclusions based upon Extensive sampling
WHAT WE FOUND
CONCLUSIONS

Ventilation
- Sealing or containing the work area works well
- Ventilate during and after spray reduces re occupancy times

Chemical Monitoring
- MDI was never detected at the exhaust from the home.
- At one to three air changes per minute, there was no observed decay rate of TVOC after the first hour.
- One hour of ventilation after the stop of spray in each home yielded very low concentrations of the flame retardant, amine catalyst, TVOC and HFC-245fa. MDI was never detected.
- Later testing of the three SPF applications from 1 to 6 months later showed no recordable amounts of concerned chemicals
CONCLUSIONS

Work Area Re-occupancy & Practices

• Current PPE and work practices recommended for SPF should be continued. (APR, tyvek, and gloves)

• With usage of adequate ventilation other trades can work external to spray area without PPE for the applications typical of this project

• With ventilation and containment of the spray area, one hour (one air change per minute) appears be a safe recommendation for re-occupancy of the home by other trades. In most cases, more work such as a intumescent coating or drywall need to be applied over the spray foam.
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