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Microbiology Laboratories

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Sampling Surface Char in Residential Properties Impacted by Wildfire Smoke
This week we are going to talk about Sampling Surface Char in Residential Properties Impacted by Wildfire Smoke.

Eugenia Mirica, PhD is the Laboratory Director of the Materials Science Laboratory at EMSL Analytical in Cinnaminson, NJ. She earned her doctoral degree in Materials Science from Stevens Institute of Technology.

Franco Seif is President and Chief Executive Officer of Clark Seif Clark, Inc. (CSC). In 1996, Mr. Seif joined forces with Brian Clark and Robert Clark to form CSC. Mr. Seif hold a bachelor's degree in civil engineering from Northeastern University, Boston, Ma, and a master's of science degree in engineering management from Drexler University, Philadelphia, PA. He holds a professional engineering registration in the State of California.

Dr. Spurgeon has a multidisciplinary doctorate degree in Analytical Chemistry and Environmental Health from the University of Pittsburgh; and was a Certified Industrial Hygienist from 1993 – 2013. His career has included working as a research chemist on the NBS Lead-Paint Poisoning Program, directing the FAA's Combustion Toxicology Laboratory, performing Health Assessments for CDC/ATSDR, implementing US EPA's Laboratory Exposure Assessment Project, and working as a consultant specializing in microbial indoor air quality for US PHS.

Nuggets mined from today's episode:

Franco Seif's firm began doing wildfire investigation in their Arizona office 15 years ago. Like other investigators at that time, they used cellular rubber sponges

AKA “chem sponges” to sample for soot. Frustrated by visually seeing residues which weren’t captured by the “chem sponge”, the firm began experimenting with other sampling methods (e.g. micro vacuum, wet wiping, tape lifting, etc.). Franco’s relationship with Dr. Mirica at EMSL enabled him to refine his approach. Franco had gathered data from hundreds of residential wildfire inspections and asked Dr. Spurgeon to logically put the statistical information together. Their cooperative efforts resulted in a peer reviewed wildfire paper which was published in the CIRI Journal of Cleaning Science, and a second wildfire paper is in review by CIRI.

Franco’s investigators took side-by-side tape lift and wet wipe composited samples on horizontal surfaces (interior & exterior) in 48 homes exposed to wildfires (4 composited samples per house= 192 composite samples).

They concluded that the tape lift sampling method underestimated results char concentrations on interior window sills, and that soot and ash rarely found in the samples of the study; which is not uncommon for wildfire samples.

FRANCO SEIF SLIDES

- Different methods for different objectives
- If the objective is to determine if
  - The structure was exposed to a wildfire plume
  - The interior was exposed to wildfire residues
    - Then may sample interior window sills using either tape lifts or wet wipes, for example
- If the objective is to evaluate the impact of wildfire smoke residues
  - Then may prefer to sample interior hard surfaces using wet wipes, for example

- Char was the primary wildfire smoke residue
  - Soot and Ash were not detected in any of the 192 samples
- Sample preparation of the wet wipe samples by the laboratory did not affect the concentration of char

    - %-char for wet wipes and tape lifts was the same for interior window sills
- Background char was “less than 1%”
    - %-char was less than 1% in 63% of wet wipe samples and 71% of tape lift samples

- The wet wipe sampling method detected higher levels of char, and in a higher percentage of houses on interior hard surfaces
    - %-char of 5% or greater for 27% of wet wipe samples compared to 6% of tape lift samples
- The wet wipe sampling method was no less effective than the tape lift method for detecting char
    - Essentially identical results for interior window sills
    - May have had an advantage for evaluating the impact of char when sampling interior hard surfaces

Joe Spurgeon reviewed the sampling results from 22 wildfires, a total of 343 houses in which 2058 wet wipe composite samples were collected. All homes were potentially exposed to wildfire plumes.

- Frequency of detection was related to distance from the wildfire. Higher levels were found in homes closest to wildfires. 40% of the homes had Char levels of 1% or more. Char found in 18% of homes, Ash found in 1.8% of homes and Soot found in .2% of homes.
- Elapsed time is a factor. Lower levels of char found over time. Adjustments need to be made for elapsed time.
- There are no current guidelines for background Char levels, suggests that 1% be the threshold.
- Composite wipe sampling allows multiple surfaces to be sampled cost effectively.
- Concept of Residue Impact Areas is at a minimum useful and may be necessary.
- Can’t use % of Char from one location to another to evaluate the impact of Char for other areas.

JOE SPURGEON SLIDES

SIMILAR RESTORATION AREAS

% Char*	SRA	IMPACT	Restoration Work Plan
< 1%	1	None	Background; Control Area
1% - 2%	2	Low	Wiping, HEPA-Vac
3% - 10%	3	Moderate	Restoration Methods
>10%	4	Heavy	Aggressive, Systems, Occupants

SUMMARY

- The wet wipe sampling method detected higher levels of char, and in a higher percentage of houses compared to the tape lift method
  - The wet wipe sampling method resulted in a higher evaluation of the impact of char in 88% of the smoke-impacted houses
- Collecting composite samples was a reasonable methodology for sampling a large number of surfaces at a reasonable cost
  - Samples, or sample results, are typically composited for assessment either prior to, or following, analysis

- Char was the only wildfire smoke residue that was useful for evaluating impact since Ash and Soot were not detected with sufficient frequency to be useful
- 63% of the 48 houses and 42% of the 343 houses had a %-char of “less than 1%”, which was a reasonable definition of background concentration in the two studies
- The concept of Conditional Areas was useful, even necessary, for properly evaluating the impact of wildfire smoke residues in the inspection of the 343 houses
  - %-char was not correlated between sampling locations, and each sampling location was an independent Conditional Area

Dr. Mirica

Compared the advantages and disadvantages of sampling options (Micro Vacuum, Wipes, Tape Lifts).
Each sampling method has advantages and disadvantages.

EUGENIA MIRICA SLIDES

MICRO VACUUMING
Advantages - Efficient sampling method for collecting particles from porous and uneven surfaces with medium and heavy loading; - The samples represent bulk amount of particle material, often of many different sizes; - A variety of optical and electron microscopy methods can be used in the identification analysis; - The TEM confirmatory identification of aciniform soot, as indicated in ASTM D6602-13, can be applied using the drop-mount technique; - Chemical analysis of organic compounds associated with the fire deposits through bulk spectroscopy and/or chromatography (such as PAH's) can be applied; - Corrosivity analysis via pH measurement or anions scan by Ion Chromatography can be applied; -

Disadvantages- Poor efficiency for collecting particles from relatively smooth non-porous surfaces with low loading; - It does not preserve the relative positions of the particles on the original surface and the population per unit area*; - Can induce damage to brittle particles such as char and ash**;
*this is a limitation when the agglomerate size and the distribution over the collection surface is of interest
**if proper sampling and sample preparation procedures are applied, the damage can be greatly minimized

TAPE LIFTING
Advantages- Efficient sampling method for collecting particles from relatively smooth non-porous surfaces with typical monolayer loading; - It preserves the relative positions of the particles on the original surface and the population per unit area; - A variety of optical microscopy methods can be used in the identification analysis, with minimal preparation; - SEM/EDX methodology can be applied for comprehensive characterization of char and ash and presumptive identification of soot clusters.

Disadvantages- Poor efficiency for collecting on porous, uneven or heavily loaded surfaces, showing preferential sampling from the top layer particles; - Application of overpressure during sampling can obscure or damage the brittle particles of char and ash; - Limited sampling area; - For particles part of large agglomerations, many not be correctly identified by applicable methods due to overlapping - The TEM confirmatory identification of aciniform soot cannot be applied; - Chemical analysis of organic compounds associated with the fire debris through spectroscopy and/or chromatography (such as PAH's) cannot be applied; - Corrosivity analysis via pH measurement or anions scan by Ion Chromatography cannot be applied.

WET WIPING

Advantages - Efficient sampling method for collecting particles from relatively smooth non-porous surfaces with low or heavy loading; - A variety of optical and electron microscopy methods can be used in the identification analysis; - The TEM confirmatory identification of aciniform soot, as indicated in ASTM D6602-13 can be applied using the drop-mount technique; - Particle dispersion techniques for breaking up the agglomerates may enable more accurate identification of individual grains, necessary when environmental interferences are suspected; - Chemical analysis of organic compounds associated with the fire deposits through bulk spectroscopy and/or chromatography (such as PAH's) can be applied; - Corrosivity analysis via pH measurement or anions scan by Ion Chromatography can be applied;

Disadvantages- Poor efficiency for collecting on porous and uneven surfaces; - It does not preserve the relative positions of the particles on the original surface and the population per unit area*; - Can induce damage to brittle particles such as char and ash; - There can be variance in what particles are successfully transferred from the wipe and therefore isolated for analysis.
*this is a limitation when the agglomerate size and the distribution over the collection surface is of interest

Using actual photos of samples under microscopy she demonstrated and compared the capabilities of different types of Microscopy: Light Microscopy, Polarized Light Microscopy, Transmission Electron Microscopy, Energy Dispersive X-Rays, Scanning Electron Microscopy Energy Dispersive X-Rays.

RoundUp

Franco Seif

- This is the tip of the iceberg on wildfire sampling. He seeks to open up the conversation on the subject.
- There is no universal best sampling method for all surfaces.
- Suggests that you have 3-4 different methods in your sampling tool box.
- Recommends cleaning of dwelling when 1% or more Char, soot or ash is found, when using composite sampling method.

Joe Spurgeon

- Franco sent Joe the data to analyze. He did not have input into the sampling plan or method selection.
- Joe is not endorsing a method.

Eugenia Mirica

- The lab can pick-up inconsistencies and anomalies among samples that can indicate something unusual may have occurred such as potential spoliation of evidence.

Z-Man signing off

Trivia
Question: According to U.S. EPA 2014a; U.S. EPA 2016, name the sampling method where several samples are physically mixed together into a larger sample?

Answer: Composite sampling

Answered By: Derrick Denis