THE PRACTITIONER'S TOOL KIT

The Small Talk on Dust

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Editor's Note: The National Environmental Health Association (NEHA) strives to provide relevant and useful information for environmental health practitioners. In a recent membership survey, we heard your request for information in the *Journal* that is more applicable to your daily work. We listened and are pleased to feature this column from a cadre of environmental health luminaries with over 300 years of combined experience in the environmental health field. This group will share their tricks of the trade to help you create a tool kit of resources for your daily work.

The conclusions of this column are those of the authors and do not necessarily represent the official position of NEHA, nor does it imply endorsement of any products, services, or resources mentioned.

In a recent edition of *The New Yorker*, David Ostow penned a cartoon titled, *The Creation of Dust*. The cartoon shows two impish angels talking to god. With a smile on his face and great enthusiasm, one of the angels suggests, "They tidy and they neaten and they straighten and they walk away all proud of themselves. And then, when they get back—BAM!—this crap is all over the place." Well, at least now we know where it originated. Dust!

Regardless of what we say about it, dust can be a remarkable tool in assessing airborne contamination, the presence of allergens, the condition and efficiency of a ventilation system, and tracking people's activity. Since dust is a mixture of tiny particles of solid matter, it is fairly easy to sample and is stable for analysis.

What Is Dust?

Approximately 40 million tons of dust settle on the U.S. every year, with approximately 40 pounds of dust in every home (Ashlett, 1999). Dust can include bacteria, smoke, volcanic ash, salt crystals from the ocean, microplastics, tiny fragments of plants and animals, dust mites (*Arachnida*), plant trichomes, pollen, fungal spores, and small bits of dirt or rock, including sand. Dust that is generated in the indoor environment can also contain bacteria, hair, fungal spores, pet dander, cat litter, body powder, household chemicals, food (e.g., flour), and airborne food allergens. Dust is anything small that can become airborne.

Dust particles range in size from 1 to 400 µm (1 µm = 0.001 mm or approximately 0.00004 in.). Particles larger than about 100 µm (0.1 mm or 0.004 in.), which is about the width of a human hair, are visible to the unaided eye. By identifying various particles and estimating size and mass, we can infer its origin. While dust identification cannot be equated to disease transmission, it does give us a clue to the environmental conditions that might preclude disease.

We all know that dust-free environments are crucial to retail success and reflect professionalism, particularly in restaurants, grocery stores, and medical facilities. A dust-free environment conveys a message of diligence and respect for customers and patrons. If customers see dirty surfaces and dusty shelves, they leave, and in many cases, they complain. When we note dusty conditions, we make a fair assumption that other environmental health-related issues await our discovery, resulting in more detailed and probative inspections. Dust has even found its way into the institutional environmental health lexicon via the courts, where its visible presence or absence are now part of the sanitation evaluation metric.

Sampling dust is straightforward and provides answers in real-time rather than waiting for growth in some culture medium. Identifying the specific particles in dust to determine their source takes a bit of practice. Once mastered, however, it makes our work much easier in determining contamination controls and preventive measures. There are two basic approaches to sampling dust. The first is sampling air and horizontal surfaces, which we will discuss in further detail. The second is examining the contents of a vacuum cleaner. Both applications provide a wealth of information.

Creating Your Dust Tool Kit

Surveying, sampling, identifying, and classifying dust in the field only needs a few things added to our regular inspection tool kit (Photo 1). There are, however, three additional essential components or tools needed to complete a dust survey and to examine and catalog the samples.

The first and most essential component is an air quality monitor. There are several on the market that meet or exceed our needs and are quite reasonable in cost (approximately $500), as well as easy to operate. The preferred air quality monitoring system ideally measures two particle size parameters: particles that are >0.5µm and >2.5µm in size. It should measure for both particle concentrations and mass concentrations, the latter being the most frequently mentioned in the popular literature and most readily understood by the public. A particle sam-

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Photo 1. Basic field dust sampling tools. Outer circle: ATP luminometer and kit, UV flashlight, inspection mirror, and LED white light flashlight. Inner circle: Plain glass microscope slides, thread counter or linen tester, clear adhesive tape, and airflow detection powder. Photo courtesy of Dr. Robert Powitz.

pler should also provide flexibility for both continuous and intermittent operation. This feature is particularly useful in monitoring dust loading generated during construction in schools, medical facilities, and custodial care facilities. These features, in addition to allowing a correction factor that is provided by the closest U.S. Environmental Protection Agency (2023) air quality monitoring station, offer a wide range of sampling and interpretive options depending on the environmental conditions (both activity and structural) found at the site.

The second essential component is an illustrated particle atlas (McCrone et al., 1973). A good used copy can be found through online book sellers. The atlas provides both images of dust particles as well as insights into sampling methods and classifying dust particles by using various basic optical and simple spot test analyses (Jungreis, 1996). While we do not have to be exacting in identifying specific dust particles, the particle atlas helps categorize dust into classes (i.e., biological and chemical), from which we can infer its origin as well as postulate its potential for contamination.

The third essential component is a basic optical microscope (any type) with a polarizing lens or polarized light.

A basic dust sampling field kit consists of an ATP (adenosine triphosphate) fluorescence detector and surface testing swabs. The ATP kit measures biological "dirt" and is an essential tool for classifying dust, among other applications (Powitz, 2007, 2009). A UV (365 nm) flashlight and an LED white light (>200 lumens) flashlight show contrast and shadows of dust on surfaces, as well as those particles that are airborne. Clear microscope slides and transparent adhesive tape are used for lifting dust from the surface and affixing it for counting and characterization. A thread counter or linen tester with a scale plate is used to measure the actual area on the slide. A good magnifying glass or loop magnifier can also be used. Lastly, an inspection extension mirror and some means to check air flow and air current help characterize the environment for interpreting air quality monitor data.

Sampling Dust

To take a dust sample from any solid surface, press a short piece of transparent adhesive tape to the surface and then mount the tape (sticky side down) on a glass slide (or another strip of tape if a slide is not available). Count and characterize (e.g., thin, round, filamentous, granular, cubic) and count visible dust particles using a 10x magnifier (thread count or linen tester). Since linen testers have a 1/2 × 1/2 in. (1.27 × 1.27 cm) scale plate field for counting, it is a reproducible template and therefore easy to make real-time objective comparisons before and after cleaning, or for any other parameter under study.

To aid in characterizing dust on the slide, illuminate the slide with the LED white light and UV flashlights. The tape-on-microscope slides can easily be used to further characterize the dust using a microscope. Further characterization of dust particles can be done under white light, a polarizing filter, or polarized light and UV light. Simply characterize what you see using *The Particle Atlas* comparison.

In taking initial samples, try to find the cleanest and dustiest place (strictly subjective) to give an idea of dust–mass concentration limits that can subsequently be used to develop a gradient in establishing cost-effective cleaning protocols, ventilation maintenance schedules, or contamination control strategies. Use an inspection mirror to locate dust accumulation on high sills and dust bunnies (yes, that is the proper term) in areas with little air movement.

For simplicity after counting, set either a two-, three-, or four-point gradient of the count to illustrate strategies and establish protocols. Gradients are a good indication of air patterns and people's movement. It will provide some ideas about the air cleaning capability of ventilation systems over time and verify where most dust is generated and hopefully, from where it comes. After further sampling, use either a stratified or random pattern for a reasonable statistical assurance of repeatability (U.S. Department of Defense, 1989).

Because of ventilation and activity, dust counts should not be used to measure the effectiveness of cleaning. Rather, these counts are used to demonstrate where extra cleaning efforts are directed in developing

an acceptable labor and time-saving cleaning strategy, as well as lowering the risk of airborne contamination.

Last Words

Dust tells an environmental health story. Assessing dust in a built environment allows us to assign and suggest mitigation of risk of airborne disease transmission, reduce allergen levels, develop airborne contamination control strategies, and not surprisingly, help improve the quality and aesthetics of the immediate environment. Similar to learning any skill, once mastered, it becomes one of the most valuable tools in our tool kit. Trust us on this one.

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