Lab V-3

Air Pollution Testing

Equipment and Materials

You'll need the following items to complete this lab session. (The standard kit for this book, available from *www.thehomescientist.com*, includes the items listed in the first group.)

Materials from Kit

□ Microscope slides

Materials You Provide

□ Gloves
□ Saucers or similar containers
□ Microscope
□ Petroleum jelly (Vaseline or similar)
□ Plastic wrap (Saran or similar)
□ Spray bottle (optional)
□ Watch or timer

Background

Air pollution takes many forms. It may result from natural processes or human activity. Gaseous air pollutants such as carbon monoxide, nitrogen oxides, sulfur oxides, and hydrocarbon vapors are produced by automobile exhausts and industrial processes, as well as by wildfires and other natural processes. Solid air pollutants, called particulates, are produced by erosion, volcanoes, fires, and other natural processes and by human activities such as construction, road traffic, and diesel exhaust. In fact, some “particulates” are lifeforms, such as insects, spores, and pollens.

Most living things can tolerate significant levels of many common air pollutants without suffering noticeable harm. In fact, low levels of some materials that are ordinarily considered pollutants may actually be beneficial to some organisms, but chronic exposure to higher levels of these pollutants may harm these and other organisms. Even short-term exposure to high levels of some pollutants may cause acute distress or even death, depending on the organism, the pollutant, and the level of exposure.

In short, whether or not a particular material is considered a pollutant depends on the nature of that material, its concentration level, and the organism in question. For example, some people are severely allergic to ragweed pollen. If you are one of those people, there's no question. Ragweed pollen in the air is a pollutant from your point of view. Conversely, most other organisms, including most people, are unaffected by even heavy concentrations of ragweed pollen. To them, that pollen is not a pollutant, but simply a part of the natural environment.

Similarly, some plants tolerate acid environments much better than other plants. The presence of sulfur oxides and nitrogen oxides in the atmosphere causes acid rain, favoring the growth of acid-loving plants at the expense of other plants that do not tolerate acid conditions as well. From the point of view of the acid-loving plants, the gases that cause acid rain are not pollutants, but instead provide them with a competitive advantage against other plants. As long as the levels of sulfur oxides and nitrogen oxides is relatively low, that is. At elevated levels of those pollutants, the rain is so acidic that it kills even the acid-loving plants.

In this lab session, we'll test the air at various locations for the presence of particulates. We'll use particle traps, the same method that environmental scientists actually use in the field. A particle trap is simply a covered vessel that contains a sticky surface. At each of our sampling locations, we'll remove the cover from a fresh particle trap, expose the sticky surface to the ambient air for a measured time, and then replace the cover. Back in the lab, we'll examine the sticky surface with a microscope and observe the numbers, sizes, and types of trapped particles.

Other than collecting household items, no advance preparation is required for any of the procedures in this lab session. You can save time on the day of the lab by preparing particle traps ahead of time. Actual field and lab time will vary according to the number of sampling areas to be tested and the time required to visit those locations. If you limit yourself to half a dozen nearby sampling areas and run the particle traps simultaneously, you should be able to complete the lab in one two-hour session.

Procedure V-3-1: Building particle traps

In this procedure, we'll build as many particle traps as we intend to use. (We recommend four to eight traps as a reasonable number to balance time requirements against data diversity.) Because it's important that the traps contain no particles initially, it's best to build the traps indoors in an area where air is not circulating. If possible, turn off the central heating or air conditioning while you build the traps. If you have a spray bottle available, fill it with tap water and mist the air in your work area to clear the air of particulates.

1. Obtain as many shallow vessels (saucers, dessert plates, shallow bowls, etc.) as you intend to build traps. Label each container, A, B, C, and so on.
2. Label a clean microscope slide to correspond to one of the containers. Place a tiny drop of petroleum jelly about 25mm from one end of the slide, centered on the width of the slide. Use the edge of a second slide to spread the petroleum jelly to cover a 25mm square area in the center of the first slide.

   > It's easy to apply too much petroleum jelly. Use just enough to cover the center third of the slide with an extremely thin layer of petroleum jelly.

3. Immediately place the coated slide, sticky side up, in one of the containers and cover the container to protect the tacky surface of the slide, making sure to allow nothing to contact the surface of the slide.

   > Plastic wrap works well to cover shallow bowls and similar containers. If you're using flatter containers such as saucers or dessert plates, substitute sheets of thin cardboard to avoid the danger of the plastic contacting the slide surface.

4. Repeat steps 2 and 3 to build as many particle traps as you intend to use. It's a good idea to build one or two spare traps in case of accidents.

5. Place the particle traps aside until you are ready to use them.

Procedure V-3-2: Positioning and exposing the particle traps

Choose as many locations as you have particle traps. Aim for diversity in locations. For example, you might want to expose traps in your kitchen, garage, laundry room, and yard or garden. Consider removing the grill from a ventilation duct and placing a trap there (with the central heat or air running). Other possible locations are a busy street or road, perhaps at an intersection, a park or wooded area, a shopping center, and so on.

If your results are to be comparable, it's important to use the same procedure for each trap. Place the trap in the selected position, note the time, and remove the cover from the trap. Record the number/letter of the trap and the location in your lab notebook. After a standard amount of time (we recommend 30 minutes or one hour) has passed, immediately replace the cover on the trap, making sure that no particles present on the cover are transferred to the trap.

Procedure V-3-3: Counting and identifying particles

When you return to the lab, set up your microscope. Use canned air or a puffer to displace any dust present on the microscope or surrounding work area. Again, try to minimize air currents, and mist the air in your work area to help particulates settle out. Handle the particle trap slides with gloves to avoid transferring particulates from your hands to the slides, and avoid breathing on the slides.

1. Rotate the low magnification objective into position, and place the first slide on the stage with the center part of the tacky area under the objective.

> In doing particle counts, the two major factors that must be kept constant are the exposure time and the sampling area in which particles are counted. We've fixed the first of these variables by exposing each trap for the same period. We'll fix the second by observing a standard sampling area for each slide, defined by the field of view of the low-magnification objective. The fact that we must position each slide on the stage before we can count particle densities is sufficient to randomize the sampling area. Don't reposition the slide to look for more- or less-dense particle accumulations, because doing that makes the sampling area non-random.

2. Observe each particle visible in the field of view. Record the count, size distribution, type, and any other data you observe in your lab notebook.

> Most or all of the particles may be difficult or impossible to identify. Others may be identifiable by category. For example, dust particles may appear under magnification like tiny rocks, and it's possible that you'll find tiny insects such as dust mites. Large spores and pollens may be visible at low magnification as tiny dots.

3. After you finish the count at low magnification (but not before), center any unidentifiable small particles in the field of view and observe them at medium or high magnification. You probably won't be able to identify any of them specifically, but you may be able to identify some or all of them by class, such as spores, pollen, and so on.

Review Questions

??? RBT: review questions/answers and add additional material after completing the labs.

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1. Which of your locations showed the highest and lowest levels of particulate pollution?

   Answers will vary. In general residential locations have relatively high particulate pollution, more so than most undisturbed outdoor areas.

2. If one of your particle traps showed no trapped particles, can you conclude that no air pollution exists in the area where you exposed the trap? Why or why not?

   Of course not. An area with very low particulate pollution may have very high levels of gaseous pollutants, which particle traps do not detect. Furthermore, our testing skews toward detecting relatively large particulates. An area where large particulates are rare or absent may be heavily polluted with smaller particulates.

3. What step could we take to increase the reliability of our data for each of the tested locations?

   We exposed only one particle trap at each sampling location, and then observed only one field of view from each trap. This increases the likelihood that our single result for each location is not actually representative of that location. We could minimize the probably of severe sampling error by exposing multiple traps at each location. Alternatively, we could do particle counts for several randomized fields of view from each slide.