2B Technologies
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2B Buzz

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Monitoring Tip: Effect of Flow Rate on Ozone Measurements - Correction Factors for Slow Flow Applications

Some applications, such as chamber experiments where plants are exposed to ozone, require low sampling flow rates. The small volume of the detection cell featured in our instruments makes them well suited for slow flow applications.

For accurate measurements, the flow rate must be sufficient enough to flush the cell adequately between the Beer-Lambert Law measurements of light intensity "I" (sample air) and "I_o" (ozone scrubbed air). At volumetric flow rates above 600 cc/min, the flow rate used has no significant effect on ozone measurements. When shipped, the Model 202 Ozone Monitor samples air at a volumetric flow rate of typically 800 cc/min. For slow flow applications, the flow rate can be reduced by the use of a needle valve inserted prior to the air pump and a correction factor applied by increasing the slope calibration factor (S) in the instrument menu.

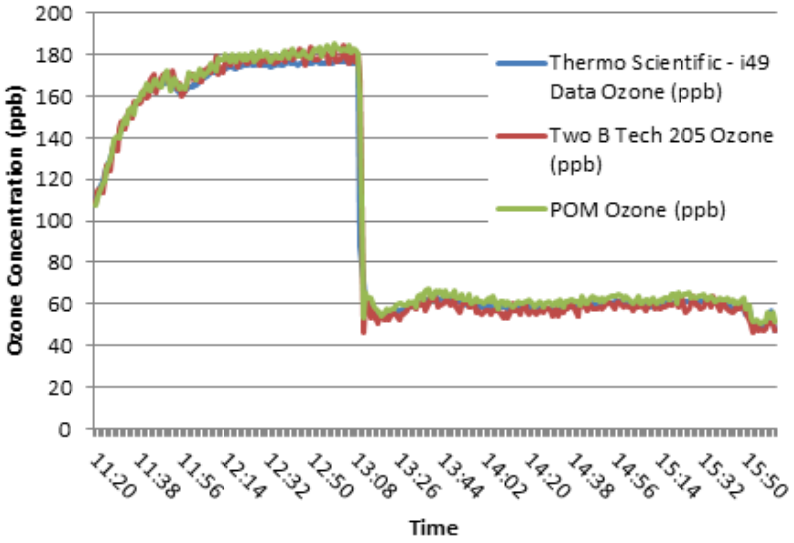
Without software modifications, the Model 202 Ozone Monitor can be operated down to 300 cc/min with no more than about a 12% correction factor.

To obtain the details needed to accurately adjust your monitor for slow flow applications, please see Tech Note 003.

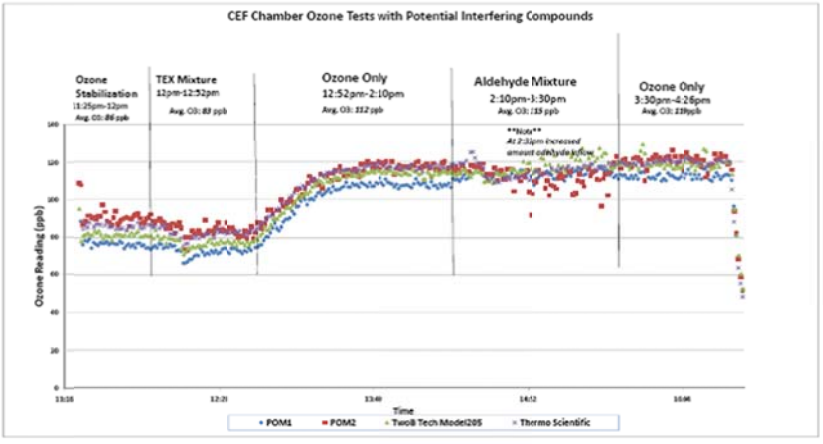
Case Study: Testing of the Personal Ozone Monitor™ (POM™)

Tests of the 2B Technologies POM were recently carried out by Prof. Clifford Weisel and his research group at the Environmental and Occupational Health Sciences Institute (EOHSI) of University of Medicine and Dentistry of New Jersey. Four experiments were carried out. Brief examples from each of those studies are provided here.

1. Comparison of the POM Response to Ozone with Other FEM Ozone Monitors. POM measurements of laboratory-generated ozone in the range of <10 ppb to 10 ppm were compared to the results for a 2B Tech Model 205 Ozone Monitor and a Thermo Scientific Model 49i Ozone Monitor. Example results for rapid changes in the generated ozone concentration are shown below. Extensive results showed that the POM agreed well with the two FEM ozone monitors, with the POM having a slightly faster response time.



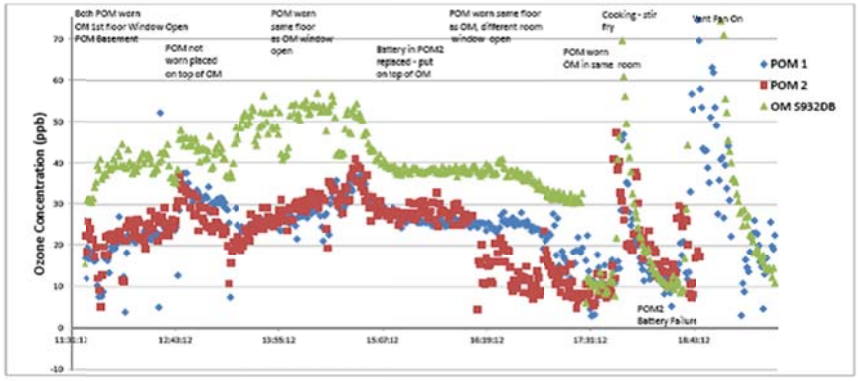
2. Interference Studies in a Controlled Environment Facility (CEF). As a baseline, similar experiments to those described above were carried out in the EOHSI Controlled Environment Facility (CEF) and good agreement found for the three instruments to changing concentrations of ozone. The responses of the three ozone monitors were then compared for challenges from high concentrations of UV-absorbing compounds typically found in urban air. The first of these challenges was a mix of 50 ppb each of toluene, ethyl benzene and xylenes (TEX). Subsequent to the TEX mixture, the ozone monitors were challenged to a mixture of 50 ppb each of a mix of formaldehyde, acetaldehyde and benzaldehyde. These two sets of compounds represent high concentrations of common pollutants that occur both indoors and outdoors. These compounds are associated with traffic emissions and photochemical production and often occur on days with high ozone. The aldehydes also are emitted indoors by cigarette smoke. As can be seen in the graph below, none of the ozone monitors were significantly affected by exposures to these two sets of compounds, although the aldehydes did cause the POM to be nosier during exposure.



Additional experiments were carried out with exposure to 50 ppb each of vanillin and anisole, food additiives that may be found in indoor air. No differences were found in the responses of the three instruments to these potential UV interferences.

3. Field Study with Staff. The POM was used in the field by

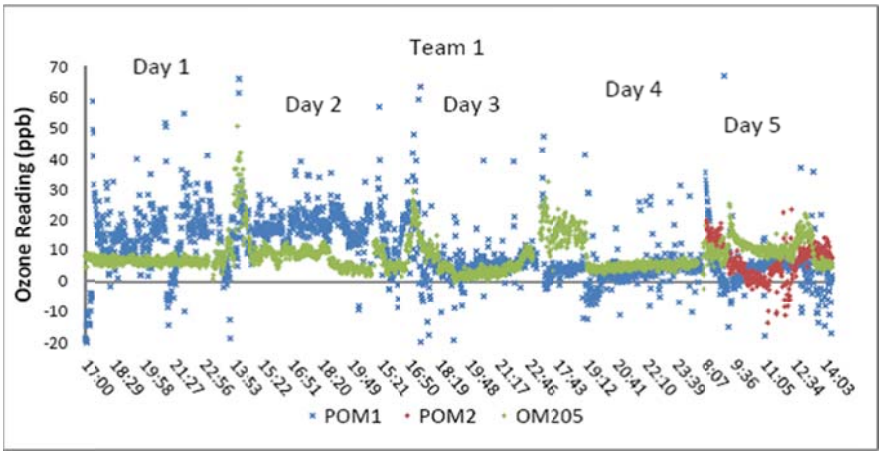
staff members and given to participants recruited through word of mouth who are experienced in air sampling techniques. The participants were asked to complete a questionnaire to evaluate the ease of use of the POM and whether they perceived any problems in being able to wear them during their typical daily activities over several days. During the field study by staff, two POMs and two Model 205 Ozone Monitors were employed. During a portion of the day the POMs were placed directly on top of the Model 205 Ozone Monitors for direct comparison of their readings. At other times of the day both POMs were worn by a single individual and the Model 205 was located either in the same room or in a different room of the same house in order to compare readings when worn to background concentrations. Activities included driving, going to a store, resting indoors and cooking. Some typical results are show in the following graph.



In this experiment there was a 10 ppb calibration offset between the Model 205 and two POMs. Otherwise, the three ozone monitors tracked each other well. The difference between the POMs and the Model 205 appeared to be larger (greater negative bias) when the POM were worn (see above figure) than when placed on top of the Model 205. The probable reason for this is that ozone will react with clothing and skin oils so that the actual ozone levels immediately adjacent to a person is lower than in the open area of the room. Thus, the POM is a better measure of the ozone level of the air being breathed than a monitor placed in a home and is certainly more representative of the exposure than an ambient monitor in a central monitor site. When cooking was being done a spike in the observed ozone with a rapid fall was observed for all three monitors. A similar pattern was observed when the ventilation fan alone was turned on, though the scatter in the data is greater. This is likely do to the greater turbulence of air and more air from outside the home with higher ozone levels being brought into the home.

4. Field Study with Volunteers. A second field study was carried out with volunteers. This study was carried out with five pairs of non-scientist participants living in the vicinity of staff. A set of written instructions, questionnaire and log sheet were provided to the participants along with a demonstration of how the POM and Model 205 were operated. While the staff members were available by phone if problems occurred or questions arose, minimum contact was maintained over the week sampling period to determine whether the participant could independently use the POM. Each participant of the pair was to wear the POM for eight hours on each of five days, two weekend and three weekdays, with both participants spending the majority of the eight hours together. The Model 205 was to be placed in the house where the majority participants spent time for comparison with the POM readings. Each individual received an honorarium

of $25 for each day he or she wore the POM. Four of the five teams collected data for five days and one team for four days. Results for Team 1 are shown below.



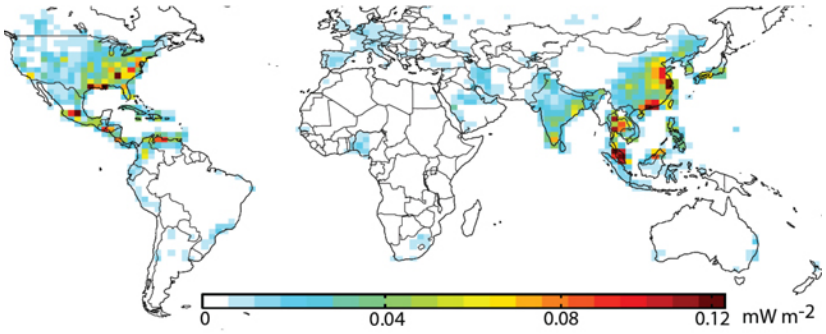
Only one member of this team obtained data over the entire five-day period; however, variability in ozone exposure to that individual is apparent.

An evaluation of the comments and responses to the questionnaires highlights two main complaints: audible noise and size/weight. These are common issues when personnel monitors contain pumps for sampling. In particular the noise made a number of participants uncomfortable when worn in public. Based on this feedback, 2B Tech has added a "quiet" mode in which the duty cycle of the air pump is reduced at the expense of less frequent ozone measurements (every 20 s instead of every 10 s). Also, we have added an internal muffler to the pump outlet. The result is a much quieter POM than those that underwent testing. All test subjects would prefer an even smaller POM but also indicated a wiliness to participate in additional studies wearing the current POM for either financial compensation or out of environmental concern.

Air Pollution News: Recent NASA Ozone Study May Benefit Air Standards

A recent NASA-led study has found that when it comes to combating global warming caused by the emissions of chemicals known to be ozone-forming, location matters.

NASA Jet Propulsion Laboratory scientist Kevin Bowman and University of Colorado, Boulder scientist Daven Henze have set out to quantify, specifically down to the size of large metropolitan regions, how the climate-altering impacts of these emissions vary around the world. They are achieving this by combining models of how chemical emission are transported throughout the atmosphere with satellite observations of how much heat ozone absorbs in the Earth's atmosphere. So far, they have discovered significant regional variability in how efficiently ozone traps heat in the Earth's atmosphere, depending upon where the ozone-forming chemical emissions are located. For example, lower-latitude regions like North America seem to have a higher impact than those regions of higher-latitude, such as Europe. Also, ozone has been observed to be a more efficient greenhouse gas over cloud-free regions in the Middle East and in hot regions like the tropics.



Contributions of nitrogen dioxide emissions - the primary source of ozone- to the global average thermal absorption of ozone as observed by the Tropospheric Emission Spectrometer instrument on NASA's Aura spacecraft in Aug. 2006. High values (red) indicate that emissions in that location contribute more strongly to the trapping of heat in the Earth's atmosphere relative to other locations. Image credit: NASA-JPL/Caltech/CU-Boulder

"When it comes to reducing ozone levels, emission reductions in one part of the world my drive greenhouse warming more than a similar level of emission reductions elsewhere," said Bowman. "Where you clean up ozone precursor emissions makes a big difference. It's all about...location, location, location."

To read the entire article, please click here.

Featured Product: Model 306 Calibration Source

The 2B Technologies Model 306 Ozone Calibration Source™ is a portable source of ozone that allows you to calibrate any ozone monitor - not just those manufactured by 2B Tech. The instrument scrubs ozone from ambient air and produces any mixing ratio of ozone in the range 30 to1,000 ppbv. The desired ozone concentration is chosen from the easy-to-use menu using a rotary select switch. The total output flow rate is 3.0 L/min volumetric, and the ozone mixing ratio is controlled so as to be independent of ambient temperature, pressure and humidity. You can attach the Ozone Calibration Source (OCS™) output

directly to the inlet of any ozone monitor; the excess flow is vented through an ozone scrubber internal to the OCS. Although the instrument comes calibrated against a NIST-traceable ozone standard, the menu allows the user to change the calibration parameters of the ozone output if desired. The Ozone Cal Source™ is housed in the same small, rugged instrument case as the Model 202 and Model 205 Ozone Monitors™. Some applications of the Model 306 Ozone Calibration Source™ include:

- Calibration of ozone monitors in the field. This highly portable transfer standard is especially useful for maintaining the calibrations of networks of ozone monitors.
- Testing of materials such as rubber, plastics and paint for effects of ozone exposure.
- Studies of the effect of ozone on plants where a calibrated source of ozone is required.

To learn more about this product, click here.

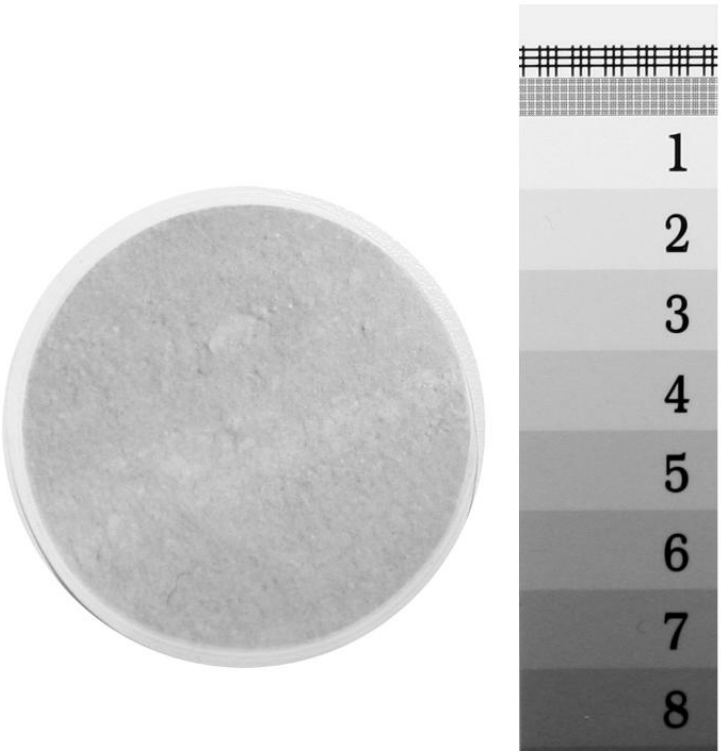
Black Carbon Experiment: Students Visualize and Quantify this Important Air Pollutant

In August 2012, the GO3 Project, founded by 2B Technologies, launched the Black Carbon Experiment. This experiment allows students to not only visualize, but quantify the amount of "soot" or "smoke" in the air they breathe.

Black carbon is the elemental carbon component of atmospheric aerosols and is produced by incomplete combustion. It is found in the exhaust of diesel engines, in the smoke produced in agricultural burning and in cooking fires fueled by wood, coal or animal waste. Black carbon is estimated to be responsible for ~20% of global warming and ~40% of glacier melting that has occurred to date.

In the Black Carbon Experiment, students collect particulate samples on filters for a period of a few days and then measure the mass of black carbon deposited on the filter by absorbance at 880 nm using a inexpensive but accurate nephelometer developed by 2B Tech for the GO3 Project. Students then upload their measurements to the GO3 database for display on Google Earth along with data from other schools around the world. In this "hands on" experiment, students actually see a sample of

the air pollution they breathe daily and learn how to make an absorbance measurement using a simple LED and photodiode. The Black Carbon Package is available for sale on the GO3 website. Because schools have very limited budgets for science equipment, the 2B Tech staff help secure funding for schools. Also, the GO3 Project provides a Green Fundraiser as an educational and fun way of raising funds for schools to participate in the Black Carbon Experiment, Global Ozone Project and CO_2 Experiment.



Typical air filter with particulate sample. Students may also estimate the black carbon concentration using a provided greyscale and compare the results to the more accurate nephelometer measurement.

If you are interested in learning more, would like to purchase a package or become a sponsor for a school in need, please click here.

"We do not inherit the Earth from our ancestors, we borrow it from our children" - Native American Proverb