Summer 2017





Figure 2 from paper by Bergen et al., *Environmental Science and Technology Letters*. Partially cleaned solar cells in India (top) and the effect on efficiency from periodic cleanings over the course of 2 months (bottom).

Where Air Quality Meets Renewable Energy

Particulate pollution crimps solar energy production

Atmospheric particle pollution gets a lot of bad press for its effects on human health, climate, and visibility. New research shows how particles can literally cast some shade on solar cells, which in the world's most polluted regions may lose 30% or more of their output as they accumulate atmospheric particles.

Michael Bergin of Duke University was touring solar facilities in India when he noticed the dirt that had deposited on the cells. He and his coauthors used modeling and measurements to quantify the effects.

Studying the dirt that accumulated in detail, they found that over 90% was ordinary dust. But the smaller amount that contained carbon and other pollutants

from human activities was more potent at blocking light, and its overall effect was about equal to that of the dust. In addition the researchers accounted for the fact that the particles still in the air also block light from the solar cells.

The solution? Clean up the air, or... get out the mop. Cleaning the solar cells monthly helps keep the efficiency losses below 25%, though it's challenging to remove the sticky pollution component without damaging the cells.

"Large reductions in solar energy production due to dust and particulate air pollution," Mike Bergin, Chinmay Ghoroi, Deepa Dixit, Jamie Schauer, and Drew Shindell. *Environmental Science & Technology Letters*, June 26, 2017. DOI: 10.1021/acs.estlett.7b00197

Link to ES&T Paper

2B Tech Sells 5,000th Instrument

Company celebrates at Colorado Rockies game

This spring, 2B Tech reached a milestone when the company's total instrument sales topped 5000. To celebrate, 2B Tech President John Birks took the entire company out to the ballgame! And we were pampered--the private box seating and constant flow of food/drink helped the Rockies' loss go down a little easier.

The next day it was back to work, starting on the next 5,000!

2B Tech sold its first instrument (a



Model 202 Ozone Monitor) in 2000. Total sales in the first 12 months were 43 instruments. Typical annual sales in recent years are now more than 500 instruments. 2017 is on track to be the biggest year yet, with over 350 instruments already sold. We thank you, our customers, for your continued support!



Case Study: Remote Monitoring with 2B Tech Instruments

2B Tech instruments play a big part in a multi-channel gas system for autonomous, real-time monitoring of air quality in remote locations. Alert Plus LLC, a company in Pinedale, Wyoming, has developed the Aegis 400 Continuous Remote Emission Monitoring System (CREMS) to monitor for gas leaks and air quality in oil and gas fields. Safety and health concerns motivated the development of the product. Escaping methane can be an explosion hazard for workers in the industry, and fugitive emissions can contribute to air quality concerns for workers as well as the public downwind. The system provides

options for the possible analyzers that can be included in the weather proof NEMA enclosure of the Aegis 400, among them 2B Tech's Model 205 Dual Beam Ozone Monitor and Model 405 nm NO2/NO/NOx Monitor. Both are EPA-approved Federal Equivalent Methods.

Alert Plus Website

2B Tech's Student Interns

High school and college-bound students excel at 2B Technologies

It's a win-win situation for 2B Tech and a group of four talented students this summer. From mechanical engineering to instrument construction

to software programming, their work is helping to advance several 2B Tech projects. One such project is <u>AQTreks</u>, 2B's educational initiative that will bring air pollution sensor technology to 60 high schools across the country this fall. Boden Lanham (senior, Northglenn High School) and David Kopala (freshman, University of Colorado, Boulder) are working to develop the data gathering and display



Boden Lanham, David Kopala, Thomas Kopala, and Daniel Green

features of AQTreks, while Daniel Green (freshman, University of Colorado Boulder) is working on the calibration process for the Personal Air Monitors that will be used in the high schools. Thomas Kopala (freshman, University of Colorado Boulder) has been working on manufacturing for several of 2B's instruments. 2B Tech has a long history of providing opportunities to students in the Denver area, many of whom have pursued careers in science and engineering (including at 2B Tech!).

<u>AQTreks</u>



Figure 9 from the AMT paper shows apparent ozone observed upon addition of ~1.3 ppm of p-xylene to ozone-free air. Initially, the ozone analyzer was equipped with the standard Hopcalite scrubber, giving an apparent O3 concentration of 67 ppb. The Hopcalite was replaced with the heated graphite scrubber at 5 min, and apparent O3 fell precipitously. Over the next 95 min, the relative humidity of the air was varied, as designated by the red vertical dashed lines, with no significant change in apparent ozone.

Publication: 2B Tech's Graphite Scrubber Described in Atmospheric Measurement Techniques Scrubber reduces interferences in ozone measurements

Scientists at 2B Tech have published a paper, "Use of a heated graphite scrubber as a means of reducing interferences in UV-absorbance measurements of atmospheric ozone," in the journal Atmospheric Measurement Techniques. When heated to 100-130 degrees C, the tubular

graphite scrubber efficiently removes up to 500 ppb of ozone while efficiently passing other interfering species. In side-by-side tests, the authors show that ozone monitors using a graphite scrubber are less susceptible to interferences from water vapor, mercury vapor, and aromatic volatile organic compounds (VOCs) compared to conventional metal oxide scrubbers. Data are currently being collected with Models 202, 205 and 211 ozone monitors to qualify them for retention of their FEM status when modified to use the new heated graphite scrubber.

Turnipseed, A.A., P.C. Andersen, C.J. Williford, C.A. Ennis, and J.W. Birks, Atmospheric Measurement Techniques, 10, 2253-2269, doi:10.5194/amt-10-2253-2017, 2017.

Link to AMT Paper

2B Tech Awarded Phase I SBIR Grant from NIH

The National Institutes of Health/National Institute of Environmental Health Sciences has awarded a Phase I Small Business Innovative Research grant to 2B Technologies for the project, "Personal Mercury Monitor for Exposure Measurements." The project will improve upon the currently available <u>Hermes Personal Mercury Monitor</u>, a pocket-sized monitor with precision and accuracy comparable to much larger fixed-location monitors. The aim is to improve the safety of workers in the oil and gas, chlor-alkali and other industries where exposure to mercury vapor is a potential hazard.



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