DIY Awareness of Ozone in Urban Desert Climates

Jennifer Weiler

School of Arts, Media and Engineering, Arizona State University
Tempe, Arizona USA
jjweiler@asu.edu

Abstract

The purpose of this work was to explore a potential low-tech DIY means of members of a community to track and mitigate the impact of pollution in their daily lives. For this project, we chose to focus on the presence of ozone in an industrial area located within a desert climate. We then describe a preliminary test in which volunteer participants from the community place pieces of ozone reactive material (copper) outside their residences in order to determine if the pieces would successfully oxidize over a relatively short period of time. We conclude with a discussion of where this technique may be helpful, as well as possibilities for future concerns and interests.

Keywords

Pollution, Air-quality, DIY, Analog-Recording, Air-Filtration, Ozone, Oxidation, Copper

Introduction

Industrialization and urbanization have increasingly brought large groups of people into close contact with the potentially dangerous byproducts of manufacturing and metropolitan pollution. Because of this, we feel it is important to empower individuals to detect pollutants in ways that don't require access to specialized or costly technology, such as electronic pollution detectors or air readers. By focusing on the use of low-cost, DIY methods of detecting and mitigating pollution, we hope to find more accessible means for larger amounts of people to gain evidence of and possibly mitigate the existence of pollutants.

Background and Related Work

We specifically focused our research on the Phoenix Metropolitan Area, a dry desert climate that is currently ranked 12th in worst quality in the United States [1]. Like many large population centers, Phoenix is set in a flat valley surrounded by more rugged geography. Because of this, air and air pollution can become trapped over the metro area.

Ozone

Ozone, the most widespread air pollutant, is created when sunlight interacts with car exhaust and other emissions [1].Ground level ozone is largely formed from photochemical reactions between volatile organic compounds and nitrogen oxides, both of which are largely formed by industrial activity. Because ozone is not water-soluble, the respiratory tract has a hard time filtering it out of inhaled air. Once deep inside the lungs, ozone starts to oxidize organic tissue, causing damage to the lung tissue and blood vessels [5].

Designing for Community Involvement

A common theme when trying to encourage community involvement is the need to present information in ways that the user finds easily accessible [2]. Often, this takes the form of using physical or analog objects, which the user can interact with in a way that they cannot with a completely digital item [2, 3].

In hopes of creating a detector that could accurately record the presence of ozone, we wanted to find accessible materials that could visually show its presence.

For our experiment, we chose to use copper foil as the oxidized agent [6]. When copper is oxidized, it absorbs a single oxygen atom, turning the ozone (O_3) molecule into an oxygen (O_2) molecule. Pure copper, which is a shining orange-bronze color, will darken to black-brown, and then turn a pale green when completely oxidized [4].

$$O_3 + 2Cu \Rightarrow O_2 + Cu_2O$$

Other particles, such as water, which has some mix of unattached oxygen and hydrogen atoms in it, can also act as oxidizing agents. However, given the low amount of humidity and precipitation in Phoenix, the vast majority of oxidation that will occur will be the result of the city's oversupply of ozone [6, 7].

Study

In order to ascertain the effectiveness of copper as an oxidizing material, we gave sample pieces to 6 individuals living within the southeastern part of Phoenix with instructions for them to leave the pieces outside during a period of several months. Ideally, the copper would show the result of oxidation within the period of a few months without suffering any structural damage.

Design

In order to have the pieces of copper have as much surface area as possible (and as such have a greater area exposed for oxidation), we used copper foil, which was then cut to increase its surface area even more cord (fig. 1). The cut foil was then lightly folded and attached to a piece of cord so that it could be easily hung outside during the study.

We gave the pieces out to five people living within south-west Phoenix and instructed the participants to leave the pieces outside in a shaded area from mid -May to mid-August, when ozone levels would be at their highest due to the elevated temperature of the surrounding area [5]. Although rain is uncommon in this climate during the summer months, we requested that the users hang the pieces under an awning or porch roof in order to insure that there would be no direct contact with any precipitation.

Figure 1. left: An example of the cut and folded copper foil before being placed outdoors; center: example location of where the pieces were located outside; right: The copper pieces after being placed outside for several months.

Results

All of the pieces left outside show clearly show the results of oxidation. After the three months, thee bright, shiny orange of the copper foil has turned to variations of dull dark brown, without causing any notable damage to the structural integrity of the copper foil (fig. 1) . Due to the rate of oxidation over this three-month trial period, it is possible to assume that the copper foil would be able to absorb and display the presence of ozone for 1-3 years before it is completely oxidized [4].

After the three months outside, the copper pieces were not drastically different from each other in terms of how much they oxidized. This is likely due to the fact that all the participants hung their test pieces in residential areas within the southeastern section of the Phoenix-metropolitan area. While the similarity in oxidation could be a result of air pollutants dispersing relativity evenly over several neighborhoods, we would be interested to do further tests to compare the results from areas near highways, industrial centers, and residential areas in different parts of the city. It would also be interesting to see how these results compare to the speed of oxidation in other similarly polluted cities with differing climates.

Conclusion

In order to help insure health and longevity, we need to remain aware of the pollution around us. In this research, we chose to specifically target ozone by using copper foil, since it can be used to create lightweight models that offer plenty of surface area for ozone to oxidize while still maintaining a physical structure. These pieces provide a visual example of the presence of ozone while simultaneously helping to neutralize the potential health threat. Our initial experiments have shown that the resulting oxidation is visible after only a few months and can show distinctions in the amount of ozone present in an urban, desert environment.

References

D'Angelo, A. N. (2015, April 30). Report: Valley's Air Quality Suffers, Drought Blamed. *AZ Central*. Retrieved from http://www.azcentral.com/story/news/local/phoenix/2015/04/29/phoenix-air-quality-report-abrk/26608289/

DiSalvo, C., Illah Nourbakhsh, D., & Louw, M. (2008). The neighborhood networks project: A case study of critical engagement and creative expression through participatory design. *Proceedings of the Tenth*

Anniversary Conference on Participation Design 2008: 41-50.

Kuznetsov, S., Odom, W., Pierce, J., and Paulos, E. (2011, Sept). Nurturing natural sensors. *UbiComp 2011:* Beijing, China.

Metal Copper and Zinc. 2014. *DACA Roofing.* Retrieved from http://dacaroofing.com/metal-copper-and-zinc/

Ozone and Your Patient's Health: Training for Health Care Providers. (2016, Feb 22). *United States Environmental Protection Agency.* Retrieved from https://www3.epa.gov /apti/ozonehealth/what.html

Ozone Compatible Materials. (2015, December 15). *Ozone Solutions.* Retrieved from http://www.ozonesolutions.com/info/ozone-compatible-materials

Phoenix Temperatures: Averages by Month. 2016. *Current Results: Weather and Science Facts.* Retrieved from https://www.currentresults.com/Weather/Arizona/Places/pho enix-temperatures-by-month-average.php