Name(s)
Jibiana Z. Jakpor

Project Number
J2109

Project Title
Combatting Wildfire Smoke: A Comparison of the Efficacy of Various HVAC Filters

Abstract

Objectives/Goals
My science project is about reducing particulate air pollution from fires using HVAC filters. This is an important issue because 5,000-25,000 people in the U.S. die from particulate air pollution caused by wildfires each year. The recent Northern California wildfires produced as much particulate in 2 days as California's cars make yearly. Although there has been much success reducing emissions from cars, I am not aware of any efforts to address particulate pollution from house fires and wildfires. During a brainstorm, I imagined a fleet of drones carrying a large sheet of HVAC filters over a fire. As the first step towards my dream, I designed an experiment to test 2 hypotheses: 1. an HVAC filter suspended over a fire will capture a moderate amount of soot, and 2. filters with higher MERV ratings will be more effective than those with lower MERV ratings.

Methods/Materials
Three types of 3M filters were tested: the Basic Pleated Non-electrostatic filter (MERV:5), the Fiberglass Filter (MERV:6), and the Elite Allergen Extra Electrostatic Filter (MERV:12). I did 12 trials for each type of filter test, each with a simultaneous control. I made a test apparatus with 2 cake pans lined with white flannel, one of which was covered by a filter. I held the apparatus in the smoke from a wood fire. I used digital photography to get the Mean Gray Value (brightness) of white flannel fabric after exposure to soot with/without a filter.

Results
A paired Student's t-Test showed that all 3 filters suspended over a fire were effective at reducing the soot that lands on a piece of fabric on the other side of the filter ($p<0.01$). However, ANOVA testing showed all 3 filters performed the same.

Conclusions/Discussion
All 3 filters resulted in a statistically significant reduction in the amount of smoke that was able to pass through the filters. I have developed a new test method using digital photography to evaluate the effectiveness of filters. This experiment is the first step towards a broader goal of active measures to reduce particulate air pollution from fires. My dream is to create a filter apparatus with negative pressure to draw in smoke to be suspended by large drones over house fires and wildfires. Even capturing a small portion of the smoke could help save lives.

Summary Statement
My experiment revealed that three types of HVAC filters suspended over a wood fire are effective at capturing soot ($p<0.01$).

Help Received
I designed and conducted the experiment myself. My mother paid for supplies and kept a watchful eye on the fires. My sister guided me to the correct statistical tests. I taught myself how to do those tests by watching YouTube videos.