

# Reduction of Soot Particulate in Automobile Cabins through Electrostatic Polarization

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## *Reduction of Soot Particulate in Automobile Cabins through Electrostatic Polarization*

### A) **Identification of Problem**

With rising levels of outdoor air pollution and increasing concerns of the effects of harmful pollutants, indoor air pollution has not been considered to the extent that it ought to be. More specifically, little research exists on pollution levels within interior cabins of automobiles. Several questions have surfaced in relation to the potential hazards of indoor air pollution in car automobile cabins (Greenguard). Indoor air pollution in car cabins include VOC (volatile organic compounds) of which there are significant numbers of distinct pollutants. For the sake of specificity and the rising levels of internal combustion engine emissions, the pollutant of concern is that of soot (carbon). The levels of carbon soot are very high in automobile cabins (Greenguard). The corporate response to this problem has been the creation of products that are readily available for a wide range of consumers. However, these products are inherently flawed and contradictory in purpose. Two specific kinds of filters have been created by corporations, ionizing electrostatic precipitators and HEPA filters. The problem with ionizing electrostatic precipitators (the most popular one being the Ionic Breeze) is that while they filter 99% of pollutants (including soot) they produce o-zone when they ionize. O-zone ( $O_3$ ) is notorious for its hazardous effects on humans, some of which include coughing, shortness of breath, chest pains and irritation of the throat. If a person already suffers from some sort of respiratory disease, the exposure to ozone can make that disease worsen and cause the symptoms of it to become more severe (“How can air pollution hurt my health?”). The problem with HEPA filters is that they can only filter soot particles that are bigger than their pores, subsequently leaving them flawed because smaller soot particles can always pass through the filter. Secondly, since the pores are so small, the amount of air that passes through it is significantly reduced causing less efficiency. From this it is clear that the corporate response to air pollution inside of car indoor cabins has been poor and that these products are harmful rather than beneficial. Therefore, research is being conducted in order to create a filter that reduces the levels of carbon soot that avoid negative side effects of the ionizing electrostatic precipitator and

the HEPA filter. A unique type of electrostatic precipitator which avoids the hazards of releasing o<sub>3</sub> into the car cabin will be constructed. Instead of electrostatically ionizing the soot particulate, research is being done in order to investigate the possibility of utilizing electrostatic polarization as a potential solution to the problem of current automobile cabin air filters.

**B) Definition of Parameters and Scope**

The scope of this research is limited to automobile air cabin filtration. This is because rather than tackling the entire problem of indoor air pollution, it is much more effective to reduce the area of inquiry into something much more specific. This allows for more detailed research procedures, creativity, and more accurate results (because research can be reduced to one experimental variable).

**C) Those most affected by the problem**

The people who are most affected by the problem of automobile cabin air pollution are people such as yourselves and I who frequently use or are passengers in automobiles. This places this problem at one of the highest environmental concerns for society because it affects practically everyone.

**D) Interviews/comments from key decision makers or experts**

According to expert Larry West, "Indoor air pollution in homes and offices has been studied extensively in recent years--with sometimes alarming conclusions that have led the building industry to rethink many aspects of design and choice of materials. But the health hazards lurking inside car interiors, where most Americans spend 90 minutes on average each day, have largely escaped scrutiny." As such, it is clear that this problem is a reality, and that its importance to our own health and the environment is not recognized. This gives IBM researches and I the unique opportunity to perform research on the potential use of polarizing electrostatic precipitators to solve for this pertinent environmental concern.

**E) Design and/or sketch of innovative solution**

The use of a modified Van de Graaff generator in a unique type of electrostatic precipitator to polarize carbon soot will near the efficiency levels of typical electrostatic precipitators while avoiding the hazardous effects of o<sub>3</sub> production.

The apparatus is going to be divided into two parts. The first part is the part which charges the electrostatic precipitator, the Van de Graaff generator (VdG). A VdG is an electrostatic machine that utilizes a moving belt to carry electrons to a high-voltage collector or terminal. In order to emphasize the importance of practicality in this research, the VdG will be built from scratch using materials that are easily available to average consumers on a budget. This VdG will send electrons to the second part of the apparatus in the chamber, which is the simulated automobile cabin. The apparatus that will be used to simulate the automobile cabin is a modified piece of Tupperware. The electrons will be transferred to a long copper plate in this chamber via a copper wire, and as soot particles pass through the chamber, they will become polarized through a shift in soot particle electron clouds. This will cause the soot particles to be attracted to a copper plate and to precipitate, and thus to filtrate the automobile cabin. The copper wire will enter the Tupperware through a hole made in its side. The soot will enter the simulated automobile cabin through a pipette inserted in the hole made in the side of the piece of Tupperware. The ability/mechanics of the ability of a non-discharging electrostatic precipitator to filter more soot than current discharging ones is being tested.

To power the polarizing electrostatic precipitator, research will be conducted on utilizing the cigarette lighter of automobiles as a potential energy source. This will fall in line with the current method of supplying energy to automobile cabin ionizing electrostatic precipitators, which use the cigarette lighter as well ("Consumer Awareness of Cabin Air Filters Low.")

The way data will be collected is that the mass of the copper plate seated inside of the Tupperware will be measured with a high precision balance before testing. After testing, the mass of the copper plate will be measured again with a high precision balance to measure the amount of soot that was filtrated. The effectiveness of the device will be measured through a t-test (a test that measures statistical significance).

#### F) **Discussion of process for implementation including costs and timeline**

One of my biggest objectives in this project is to appeal to pragmatic application. As such, this device ought to be able to be constructed utilizing easily accessible goods and local home improvement and hardware stores. The total cost should not exceed \$50. The timeline for this project will perhaps take anywhere from a few days to perhaps two

or three weeks of incessant research. As with any innovative idea there is a direct relationship spent between the time spent on research and development and the quality of the end product. However, in this case, a timeline of two to three weeks ought to be more than sufficient to reach the desired ends of this research.

#### G) **Conclusion**

I truly do believe that this is the solution for a problem that has eluded major scientific research within these last few years. I have been able to conduct some research on my own free time with science teachers at my high school who have been kind enough to help me. While their help has been invaluable to me, I feel that by only working with a mentor one on one everyday with the ability to utilize the resources available at IBM for research and development will I be able to truly manifest this idea into reality. I really do want to make a difference in the environment by creating this unique air filter that will benefit almost all of society, because this problem affects nearly everyone. I have sent out emails to professors at local colleges requesting for their mentorship but no attempts have been successful because they are either too busy, or are working with someone else. As such I humbly request the IBM Academy of Technology for this once in a life time opportunity to work with a mentor. This would mean the world to me and those that benefit from this research.

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