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Airborne Contaminant Control in a Medical Examiner Facility

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The electrical fields that exist in all spaces interact with airborne charges, particulates, water droplets, as well as absorbed and adsorbed gases. These interactions, in large part, determine the deposition of contaminants in and on people, objects, and walls in a room. In addition to the normal electrical fields in a room, specific complex electrical fields can be created in supply ducts which can help reduce the concentration and deposition of both gaseous and particulate contaminants in a room by accelerating the normal coagulation that occurs in all rooms. The physics theory and laboratory research supporting these facts have been detailed in a number of published papers and summarized in Hinds (1982) and Liebtag (1989). Their implications for indoor air quality in the real world situation are illustrated by the results of tests reported here. The testing was done in a building which provided a worst case scenario for odors and irritants. Before providing the details of the methodology and results of the testing, I will first, briefly, summarize the relevant aspects of the physics theory and lab data.

Submicron particles are typically 98% of the particles in a room. Because their cross sectional area is so small, these particles tend not to be entrained by and moved by air currents. Their motion is determined, in large part, by the normal electrical fields that exist in all rooms. They tend to run down the electrical field lines and plate-out on people and objects. Thus, relatively few are returned to the ducts and, as a consequence, relatively few reach the filters.

As submicron particles in the air age, many collide, forming larger particles. This natural process is called coagulation. The coagulated particles are more readily moved by air currents because they have a large enough cross sectional area to be seen by air currents. Thus, these micron or larger size particles tend to be returned to the ducts. Once they are in the duct system, they can be carried to and trapped in the filters.

Volatile organic compounds (VOCs) and odorants tend to absorb and adsorb onto particles. Many particles are carbonaceous in nature and can act as though they are microminiature carbon beds; and as carbon beds they can absorb and adsorb VOCs. Thus, where VOCs end up, plated-out on people or trapped in the filters, is also influenced to a large extent by the normal electric fields in a room.

Theory and lab data, as noted above, indicate that the effectiveness of filters in removing odors and irritants can be enhanced by accelerating coagulation. One way to accelerate coagulation is to use equipment to set-up a complex electrical field within a section of the supply duct. In this paper, I report data on the effectiveness of this technique in a building with an intense odor and irritant situation. The building used is a County Medical Examiner facility in a major American city.

MATERIALS AND METHODS

The testing was done in an 88,000 sq. ft. building which processes approximately 3500 bodies per year. The air handling systems use 30-35% pre filters and 90-95 final filters. Twenty percent outside air is used. The in-duct complex electrical field was generated within the supply duct by use of a pair of quarter inch mesh hardware cloth screens placed perpendicular to the air flow in each air handling unit. The screens were 3 inches apart. An electric field generator supplied a 600 V rms 150 kHz signal to the downstream screen and a 25 kV dc signal to the upstream screen. Tests with a Mast Oxidant monitor show that this system does not produce ozone.

Five areas of the building were tested. One was the autopsy area which has an air change rate of thirty per hour. The others were the histopathology lab, the chemistry lab, the hallway outside the weapons test room, and the organ storage room. These have air change rates of 20, 20, 12 and 30, respectively.

A variety of test instruments were used to assess the diversity of contaminants expected. A Photovac model 10S70 gas chromatograph with a photoionization detector (PID) was used with a 10.7 eV lamp and a column coating of dimethyl polysiloxane. Oxidants were measured with a Mast model 724 Oxidant Monitor. An HNU trace gas analyzer with PID was used with a 10.2 eV lamp. Methane and sulfur dioxide sensors were used with a QEL gas detector. A Royco model 218 particle counter was used to measure particles in the following size ranges: < 0.5, 0.5-1, 1-3 microns.

Five days, Monday thru Friday, were available for this testing. Monday was used as a pre-test day for working out procedures and locations. The following four days were the actual test days. Inasmuch as this was a real world working building, for purposes of experimental design extraneous variables were considered randomized. There was a concern that as the building was used during the week, odors and irritants could build up. An experimental design was used to null out this possible confounding variable, i.e. the in-duct electrical fields were off the first and fourth test days and they were on the second and third test days. The data was prepared for statistical analysis by combining the days one and four data and the days two and three data. All statistical analyses were done comparing the combined electric field off data against the combined electric field on data.

All the test equipment was placed on a wheeled cart. On each test day, after twelve noon, the test cart was wheeled to each measurement area, in a set order, and a sequence of measurements were taken. After all measurements were completed each evening, the in-duct electrical field was switched either on or off in accordance with the test condition to be used the following day.

RESULTS AND DISCUSSION

The total concentration of volatiles, measured in each area with the gas chromatograph, were compared area by area. The median concentrations with the in-duct electrical fields off vs on are presented in Table 1. The randomization test for matched pairs was used to assess the significance of the differences. The differences were significant ($p < .05$).

Table 1. Median concentrations, in ppm, of total volatiles measured in each area with in-duct fields off and on. The concentrations were measured by a gas chromatograph with a photoionization detector. The differences between in-duct fields off vs on for all areas, taken as a group, are significant at the .05 level (Randomization test for matched pairs). Also noted are the significances of the differences between off vs on for each individual area (Binomial test).

Area	In-duct fields off	In-duct fields on	significance
Autopsy	7.93	1.26	<.01
Histopathology lab	6.93	4.35	<.05
Chemistry lab	9.15	1.98	ns
Weapons test area	1.87	0.92	<.05
Organ storage room	10.85	9.13	ns

Table 2. Differences for each area as a function of whether the in-duct electric field was off or on. **X** means a lower concentration with the field on, = means the same concentration.

Area	GC	Oxidant	Trace gas	Methane	Sulfur dioxide	< 0.5	0.5 - 1.0	1 - 3
Autopsy area	x	x	x	=	x	x	x	x
Histopathology	x	x		x	x	x	x	x
Chemistry lab	x		x	=		x		
Weapons test	x		x	x	x	x	x	x
Organ storage	x	x	x	x			x	x

The overall pattern of results is shown in Table 2. As may be seen in the table, in general, the measured concentrations of contaminants were lower when the in-duct electrical field was on.

The County Medical Examiner facility used in this testing is an intense odor and irritant situation. The decomposing bodies and chemicals used in such a facility present a difficult indoor air quality control situation. The use of in-duct electrical fields to accelerate the normal process of particle coagulation clearly improved the air quality in the facility. This is consistent with both physical theory and the results of laboratory research.

The apparent influence of the in-duct electrical fields in improving indoor air quality was substantial. The differences were statistically significant without the need to collect large amounts of data. If the effect of the in-duct fields were weak, large amounts of data would have been required to tease out an effect statistically. Clearly, the enhancement of contaminant control with the use of complex in-duct electrical fields is quite strong.

REFERENCES

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