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# Air Ventilation Protection System for Building Security

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## The Need

In general and nationwide, indoor environmental quality (IEQ) is an important public health issue. Its absence - often through benign neglect- can lead to widely publicized problems such as sick building syndrome, building-related illness, multiple chemical sensitivity and building security issue as well. IEQ problems are estimated to effect more than 10 million workers in up to 30 percent of buildings in the United States alone, resulting in billions of dollars of decreased productivity, litigation, and adverse publicity. Thus, the air ventilation protection system demand is increasing across a broader spectrum of applications in response to the widening recognition of the vulnerability faced by occupants in less secure governmental, military, and commercial buildings, transportation facilities and, major event venues.

## The Technology

Collective protection equipment (CPE) has traditionally been reserved for protection of military facilities and sensitive government structures, such as the White House. Commercially, CPE has been used for security purposes in high value manufacturing processes, like semiconductor fabrication, and in hospital operating rooms, where mitigation costs are much lower than potential costs associated with infection. CPE systems typically provide protection through overpressurization of the structure itself with the makeup air supply and simultaneous filtration of either the makeup air or the recycle air. Makeup air filtration protects occupants against a chemical or biological agent release occurring outside the structure (external release) while recycle air filtration provides protection against an internal release. In either case, airborne contaminants are removed through some filtration process before any humans or critical operations are exposed to the suspect air stream. Conventional CPE systems generally accomplish chemical and biological agent mitigation through two separate purification steps, particulate and biological warfare agent (BWA) removal with non-woven HEPA (High Efficiency Particulate Air) filters, and adsorption or reaction of chemical warfare agents (CWA) in packed beds of sorbent and/or catalyst pellets. The new technology to solve the limitation of conventional CPE system has been developed as "Combined ESP/ESF/PCO and microfibrous media CPE application". This concept of


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this new technology is the combination of the both systems; 1) Microfibrous Material Technology, and 2) Photocataytic Oxidation Technology.

**Figure 1 Micrograph of Microfibrous Media (Courtesy of BE&K)**

1. Microfibrous Material Technology (MMT) The basic MMT element is a thin sheet of media consisting of a sinter-locked network of micron diameter metal fibers entrapping sorbent and catalyst powders at void volumes between 50% and 95%.The use of sorbent and catalyst powders (ca. 100 µm diameter) virtually eliminates rate-limiting phenomena, namely intraparticle heat and mass transfer, commonly found in packed-bed systems while simultaneously improving contacting efficiency between the sorbent material and contaminants in the air stream.
2. Photocatalytic Oxidation Technology Electrostatic precipitation (ESP) is a well-known technology in which particles in an airstream are ionized in an electric field and collected on a series of parallel plate electrodes in a flow-past arrangement.

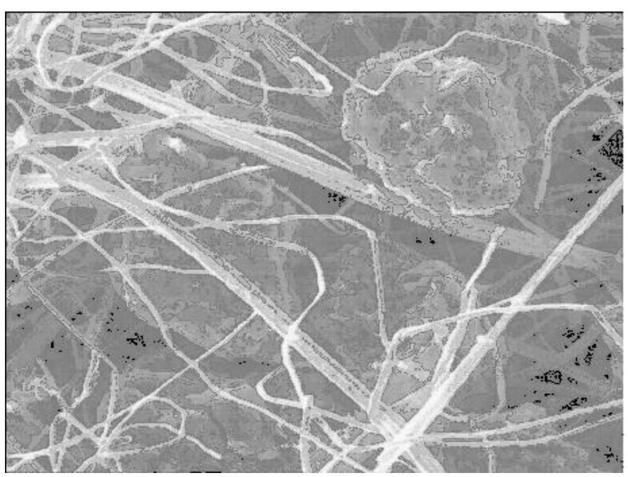

**Figure 2 TiO2-Coated ESP Unita (Courtesy of BE&K)**

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Electrostatic filtration (ESF) is an extension of ESP, except that ionized particles are captured by flowing through a relatively open, non-woven filter element/electrode. Photocatalytic oxidation (PCO) involves illuminating TiO2 surfaces with ultraviolet radiation (less than 385 nm) to produce hydroxyl radicals and O2- ions, which are both powerful oxidation agents. Researchers at the University of Missouri have developed and demonstrated TiO2 spray coating methods (Figure 2) that enable PCO and ESP/ESF to be combined in a single filtration element. By illuminating TiO2-coated ESP and ESF electrodes with ultraviolet radiation, collected particulate biomass, including spores, molds, and biological agents, is continuously oxidized and removed from the system. Units operated in this manner are therefore self-sterilizing and not subject to fouling.

## The Benefits

The several and obvious benefits compared to the typical HEPA filter/packed bed approach are primarily related to operational, maintenance and life-cycle cost savings achieved by reducing the logistical tail associated with constant replacement of disposable filter media and lowering HVAC fan/blower power requirements by removing a substantial amount of pressure drop from the filter system.

Microfibrous media is far superior in stopping hazardous air quality contaminants compared to Commercial Off-The-Shelf (COTS) carbon HEPA filters currently used in HVAC systems.

**Table 1**

| Characteristic | COTS Carbon | IntraMicron (holds patents for technology) |
|---|---|---|
| Active material | Carbon only | Very flexible - variety of sorptive and neutralizing media |
| Pressure drop across the filter | Very high | Far more “breathable” - 1/2 to 1/8th of current filters |
| Utilization of adsorptive media at breakthrough | Approximately 25% | Far more efficient - greater than 95% |
| Regeneration/reuse | Not possible | Can be regenerated / reused by heating the media |
| Capable of new formulations to meet new threats | No | Yes, protective sorptive media can be added to meet new threats or specific threat |
| Ease of manufacturing | Labor intensive | Automated: high speed, "roll-to-roll" on paper machine |

## Status

The mitigation technology consists of front-end $TiO^2$-coated ESP and ESF units illuminated with UV bulbs to provide PCO at the collection electrodes (viz., an ultra low pressure drop HEPA filtration capability for

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biological agents) followed by high efficiency, low pressure drop microfibrous sorbent media to remove CWAs, volatile organic compounds (VOCs), toxic industrial chemicals (TICs) and toxic industrial materials (TIMs). Individual modular components of the ESP/PCO/ESF and microfibrous media technologies were fabricated and tested. Specifically, a 500 cfm(cubic meters / hour) capacity ESP/PCO/ESF unit and a 1000 cfm capacity chemical sorbent canister containing pleated microfibrous media were constructed and tested, both separately and as a complete system. These units are shown in Figure 1 assembled as a complete system for testing.

FIGURE 3 3000 CFM FILTER SYSTEM (COURTESY OF BE&K)

The 3000 cfm unit shown as Figured 3 and 4 is currently being testing in Anniston, AL by the Defense Advanced Research Projects Agancy (DARPA) as part of their immune building program.

FIGURE 4 3000CFM FILTER SYSTEM (COURTESY OF BE&K)

Another unit will be manufactured and tested by the General Services Administration in a courthouse in Key west. FL as soon as they receive budget approval. The capability to manufacture media in commercial

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production capabilities with the necessary quality control is in place. IntraMicron is currently seeking commercial clients willing to conduct prototype tests for their own facilities.

## Barriers

The major hurdles to commercializing this and many other emerging technologies are:

- Risk mitigation/indemnification insurance-as yet there is no "good Samaritan" type legislation.
- An efficient way to show that product meets/exceeds the proliferation of building code requirements.
- Lack of rapid contracting mechanisms to fast track prototype projects.
- Willingness/ability of decision-makers to prioritize threats to enable customized solutions.

## Point of Contact

**C. H. "Stretch" Dunn**, CHD Consulting.
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## References

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2. Papers "Intramicron Regenerable Collective Protection System" and "Innovative Description-Microfibrous Material Ventilation System Filter (MMVSF)"

## Reviewers

Peer reviewed as an emerging construction technology

## Disclaimer

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## Publisher

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