PROJECT ID:
571

Innovative Activated Carbon Filters to Address Vapor Intrusion within Commercial/Industrial Buildings

Carbon-based indoor air filter.
(Photo Credit: Austin Air)

Carbon filter used for indoor air filtration.
(Photo Credit: Austin Air)

OBJECTIVE:

This project will demonstrate and validate an air filtration system that will remove trichloroethene (TCE) from indoor air and then provide Remedial Project Managers (RPM) with a guide to the optimal selection, operation and maintenance of air purifying filters for vapor intrusion (VI) mitigation.

PROBLEM STATEMENT:

One of the most challenging health risks facing regulators in recent years is the vapor intrusion of volatile organic compounds (VOC) from soil or groundwater to indoor air. One of the most pressing problems is the presence of trichloroethene (TCE). Toxicological studies have shown that exposure to TCE in indoor air may pose a danger to developing fetuses in the earliest stages of pregnancy, even before a woman realizes she is pregnant. To date, the only effective means of combating TCE exposure is to relocate all women of childbearing potential from affected buildings. This is often impractical and may cause confusion and uncertainty.

DESCRIPTION:

There is no clear evidence regarding the duration of TCE exposure that may cause an acute health effect, but it is likely shorter than the duration of time required to implement a conventional VI mitigation system. The current best practice for VI mitigation is most often an active soil depressurization (ASD) system, originally designed for radon removal, which imposes a vacuum below the floor using a series

SmogStop prototype photocatalytic oxidation filter testing in the laboratory.
(Photo Credit: Envision SQ)

of suction points connected to fans or blowers. An alternative method, sub-slab ventilation, is being researched in the ESTCP project no. ER2013-22 (Demonstration/Validation of More Cost-Effective Methods for Mitigating Radon and VOC Subsurface Vapor Intrusion to Indoor Air). However, both of these methods require months to years to implement.

Indoor air filtration has a potential benefit over both of these solutions, because it works much more rapidly.

Indoor air filtration has a potential benefit over both of these solutions, because it works much more rapidly, and can reduce health risks attributable to VOCs from both subsurface sources and sources inside the building. Unfortunately, most filters have been tested using different chemicals and/or concentrations than are typically encountered in a VI assessment, so there is little or no data with which to decide how many filters are needed, how often the filter bed should be replaced, or what sorbent is most cost-effective for this application.

This project team will perform bench-scale laboratory experiments using columns to demonstrate filtration effectiveness and capacity. Tests will include several filter media, most likely activated carbon, zeolites and photocatalytic oxidation. (Note: Zeolites are crystalline solid structures made of silicon, aluminum and oxygen that are commonly used as commercial adsorbents and catalysts.)

Activated carbon is a demonstrated technology for removal of VOCs from air streams, but the cost-effectiveness for VI mitigation warrants additional study. In addition, carbon filtration is not specific to target chemicals, and the sorptive capacity is often consumed by non-target chemicals, which becomes even more problematic when non-target chemicals are present at higher concentrations than the target compounds – which is likely the case for the situation considered in this study.

Zeolites function in a similar way to carbon filtration but are thought to outperform carbon in some situations. Photocatalytic oxidation works on a different principle (destruction, not sorption) so it does not require periodic change-outs, but there is a cost associated with electric power for the light so a cost-benefit comparison is needed.

Test conditions will include ranges of several factors (concentration of target analyte, concentrations of other competing VOCs, temperature, humidity).

The most promising technology will be demonstrated in the laboratory to determine efficacy and change-out frequency of the product. Then, results will be evaluated to assess scaling effects. Real-time indoor air concentrations will be monitored prior to and during filter deployment operation. Cost, efficacy, timeframe, mass removed and filter change out frequency will be studied.

If air purification is implemented at 100 buildings with an average cost of $30,000 per building, and if this research can reduce costs by 50 percent, the potential savings is $1.5 million.

TRANSITION DESCRIPTION:

The project team will disseminate cost and performance data and transition the technology to both federal and targeted non-federal sectors such as manufacturing and other operations-intensive industries. An electronic planning

tool and user guide will be developed for facilities and environmental managers (including RPMs) to guide to the optimal selection, operation and maintenance of air purifying filters for vapor intrusion mitigation. This guide will contain information on heating, ventilating and air conditioning system fan specifications and operational modes, VOCs present, known ranges of concentration, target concentrations post-treatment and timeframe to achieve concentration reductions. Articles will also be submitted to peer-reviewed publications and information presented at relevant conferences.

CONTACT:

For more specific information about this project, contact the Principal Investigator at 805-982-4454. Contact the NESDI Program Manager at 805-982-4893 for more general information about the program.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Systems Command from the Engineering and Expeditionary Warfare Center in Port Hueneme, CA. The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes and materials and by filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Navy readiness and lethality.

Visit the program's public website at https://www.navfac.navy.mil/NESDI for more information.