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Adsorption-Intergrated-Reaction Process

DESCRIPTION OF THE TECHNOLOGY

With support from the Environmental Protection Agency's (EPA) Small Business Innovation Research (SBIR) Program, KSE, Inc., has developed a novel technology that economically destroys airborne contaminants. The Adsorption-Integrated-Reaction (AIR) Process employs a proprietary photocatalytic adsorbent that traps airborne toxic contaminants on its surface. When illuminated by ultraviolet (UV) light bulbs, the photocatalyst converts volatile organic compounds (VOCs) and microorganisms to environmentally safe products at ambient temperature. The AIR Process is a selective, energy-efficient, and economic technique for indoor air quality control.

The use of UV light bulbs to photocatalytically destroy pollutants provides simple controls. The unit can be turned on or off with the flip of a light switch. The ambient operating temperatures result in low energy consumption and low-cost operation. Ambient temperature AIR units can be constructed of fiberglass-reinforced plastic, rather than the expensive exotic alloys used in alternative high-temperature technologies.

Contaminated groundwater can be cleansed by air stripping, and contaminated solids may be remediated by soil vapor extraction. However, these methods lead to emissions of toxic air pollutants. Industrial facilities also produce emissions of hazardous air pollutants. KSE's AIR Process destroys these emissions, at low cost and at ambient temperature. Contaminated ground-water first must be stripped with air, and contaminated soil must be thermally desorbed or vacuum extracted, all of which are cost effective in combination with the AIR Process.

SIGNIFICANCE OF THE TECHNOLOGY

The AIR Process has advantages over alternative air emissions control options. The process has been dem-onstrated to achieve 99.99 percent destruction efficiency of air emissions in commercial applications and produces benign products and completely destroys the contaminants, avoiding the production of seconary wastes, as is frequently found in activated carbon treatment.

The cost of the new emissions technology dependson gas flow rate, contaminant type, and destruction efficiency. Operations and maintenance costs at one operating site are estimated at $6,000, compared with $355,000 for disposable carbon. It also can destroy contaminants that are not economically treated by conventional technology, such as vinyl chloride. No secondary wastes are produced, other than spent caustic for high-concentration chlorinated hydrocarbons. The project-life cost of the AIR unit can be less than one-tenth the cost of activated carbon, depending on inlet concentrations. The innovative air purification technology offers orders of magnitude reduction in costs compared to conventional control methods.

The photocatalysts developed for this technology are significantly improved compared to the conventional titania photocatalyst used historically for photocatalytic applica-

SBIR Impact

- **KSE's AIR Process uses a photocatalytic adsorbent to trap airborne toxic contaminants on its surface. When illuminated by UV light, the photocatalyst converts VOCs and microorganisms to environmentally safe products at ambient temperature.**
- **The AIR Process achieves 99.99 percent destruction efficiency of air emissions in commercial applications and offers orders of magnitude reduction in costs compared to conventional airborne contaminant control methods.**
- **The AIR technology can effectively destroy anthrax spores in heating, air conditioning, and ventilation systems.**
- **AIR units have been used at the Stamina Mills Superfund Site in Rhode Island, and in the International Space Station.**

Photograph of the first commercial photocatalytic unit for the destruction of chlorinated hydrocarbons at the Stamina Mills Superfund Site. The AIR Unit reactors are in the foreground; the groundwater strippers and the soil extraction vacuum pumps are in the background.

tions. When destroying formaldehyde and carbon monoxide, back-to-back comparison tests found that these catalysts were orders of magnitude more active than titania. For formaldehyde, for example, the Phase I photocatalyst was shown to be 48 times more active than titania. For carbon monoxide, the same photocatalyst was shown to be 257 times more active than titania, at the same operating conditions. The technology also is effective for the destruction of anthrax spores in heating, air conditioning, and ventilation systems.

COMMERCIALIZATION SUCCESS

A 700 ft^3/min at standard conditions commercial unit has been demonstrated at the Stamina Mills Superfund Site in Rhode Island, and destroyed 99.99 percent of entering contaminants. Another AIR unit has been used in the International Space Station to destroy ethylene (KSE partnered with Orbital Technology Corp., in Madison, WI, to develop an AIR Process unit capable of withstanding travel to and from space). Currently, AIR Process units are commercially available for the elimination of chlorinated and mixed non-chlorinated materials. A unit for removal of benzene, toluene, and xylene will be available soon.

AWARDS AND COMPANY HISTORY

The AIR Process has been recognized by the 1997 SBIR Technology of the Year Award for Environment, Energy, and Resource Management, as an innovative, new technology that results in the improvement of everyday life and the betterment of mankind. The technology also has been recognized by the 1998 U.S. EPA Environmental Innovator Award and the 1997 R&D Award as one of the 100 most technologically significant new products of the year.

What is the SBIR Program?

EPA's Small Business Innovation Research (SBIR) Program was created to assist small businesses in transforming innovative ideas into commercial products. The SBIR Program has two phases—Phase I is the feasibility study to determine the validity of the proposed concept and Phase II is the development of the technology or product proven feasible in Phase I. EPA also offers Phase II Options to accelerate the commercialization of SBIR technologies and to complete EPA's Environmental Technology Verification (ETV) Program. For more information about EPA's SBIR Program and the National Center for Environmental Research, visit http://www.epa.gov/ncer/sbir.