Cleaner Air for Home and Office

If often happens that an improvement in one direction spawns difficulty in another. Take, for instance, the U.S. trend of recent years toward superinsulated homes and offices, which has undoubtedly increased energy efficiency substantially but has heightened the problem of indoor air pollution.

The problem is that sealed buildings have less exchange of fresh outdoor air for stale indoor air. This causes higher concentrations of toxic chemicals in indoor environments, brought about by emissions from a great variety of building constituents such as synthetic wallboard, synthetic fibers and glues, cleaning products and insecticides, and gas or woodburning appliances. The result is a notable increase in allergic reactions and other toxicity-occasioned illnesses.

Natural air purification systems based on space technology lead a sampling of environment related spinoffs

Space technology offers an answer to this problem, a solution based on Nature's process of photosynthesis in plant life. Plants generally "breathe in" carbon dioxide and give off oxygen and water. But recent NASA research shows that certain plants can absorb other gases from the air and thereby reduce indoor air pollution. Further, NASA studies show that combining plant foliage with a bed of activated carbon creates a filtration system with a cleansing capability significantly greater than plants alone. This opens the door for commercial marketing of home/office filtration systems.

Why did NASA get into plant studies?

Because plants offer a possible solution to a problem associated with future interplanetary manned spacecraft, space stations or space colonies. The occupants of such spacecraft are protected from the airlessness and extreme temperatures of space by an airtight artificial atmosphere in a sealed vessel. But the spacecraft could not carry enough oxygen and water for normal supply of a large crew for months or even years. Therefore, the initial supply of oxygen and water must be cleansed, detoxified and used over and over.

For more than 15 years, Dr. Billy C. Wolverton and his aides in the Environmental Research Laboratory of John C. Stennis Space Center (SSC), Mississippi, have been conducting innovative research employing natural biological processes for air and water purification. The long range goal is development of a bioregenerative life

support system for long duration spacecraft. But Wolverton and his SSC team are also playing an important part in NASA's Technology Utilization Program, which seeks to expand spinoff applications of NASA-developed technology; they have been notably successful in that regard.

In 1974, Wolverton began exploring "aquaculture," the use of aquatic plants to remove pollutants from wastewater at relatively low cost. Initial focus was on use of the water hyacinth which literally thrives on sewage and can absorb astonishing amounts of pollutants. After successful tests at SSC, the facility's neighboring community of Bay St. Louis became — in 1975 — the nation's first municipality to employ an operational aquaculture filtration system. Since then, a number of U.S. towns have adopted hyacinth-based aquaculture as their year-round primary method of treating wastewater. Other towns — and one major city, San Diego — use aquaculture as a supplementary process in sewage treatment.

While the water hyacinth is highly effective means of purifying wastewater on Earth, its utility in space applications is limited. So Wolverton's group developed a more effective technique for in-space water reclamation and toxic chemical removal: the artificial marsh filtering system, which employs a combination of sewage-digesting microbes living in a rock bed and pollutant-absorbing plants such as bulrushes, reeds and canna lilies.

This second generation aquaculture system offers a bonus in Earth applications: where water hyacinths are warm climate plants, which restricts their use to southern U.S., the types of plants used in the artificial marsh system are cold- and salt-tolerant, thus capable of being used in wastewater systems in colder climates. The artificial marsh has already been adopted by some communities and it seems likely that this new technique will spread as widely as its predecessor.

Branching off from aquaculture for wastewater treatment, SSC began exploring the use of foliage plants for air filtration and purification in both space and Earth applications. Wolverton's group evaluated the ability of certain plants to remove the three most common pollutants in tightly insulated buildings: formaldehyde, benzene and carbon monoxide. They found that philodendrons, golden pothos, the common spider plant, Chinese evergreens and others are particularly effective. But this work is still in progress and Wolverton states that any conclusions are premature until all the plants are tested against a wide range of pollutants.

However, another NASA study indicates that a carbon/plant filter system — wherein a bed of activated carbon helps plant roots absorb pollutants — can remove high levels of toxic chemicals and tobacco smoke. Entrepreneurs are borrowing this NASA technology and at least two companies are offering such filtering systems in the commercial marketplace.

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Exterior and interior views of the Bio-Home at Stennis Space Center, where NASA researchers are exploring the capabilities of certain plants to absorb gases and reduce pollution in long duration spacecraft or in superinsulated homes and offices.

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A research assistant is conducting an absorption test; the plant is placed in a sealed chamber into which a gas is injected, then the amount of gas absorbed by the plant is measured. Stennis' Environment Research Laboratory is testing a variety of plants against a wide range ofindoor pollutants.

"Energy-efficient structures are often 10 times more polluted than the air outside," says sales literature from Bio-Safe Inc., New Braunfels, Texas, manufacturer of hybrid plant-microbe filters based on technology developed by the NASA Environmental Research Laboratory at Stennis Space Center.

The reason is that a score or more of interior-use products, from insecticides to shoe polish, plywood board to paper towels, fire retardant materials to permanent press clothing, exude a variety of synthetic chemicals that might not be found in the outside atmosphere.

Bio-Safe's products go a step beyond the growing practice of "interiorscaping" homes and office buildings, hotel lobbies, restaurants, hospitals and other structures, improving the visual aspect by use of decorative live plants. Bio-Safe's systems are designed to remove from indoor air the principal toxic substance formaldehyde, which is present in virtually all modern living environments; tobacco smoke (carbon dioxide) that cannot be entirely removed by plants alone; and large quantities of other pollutants.

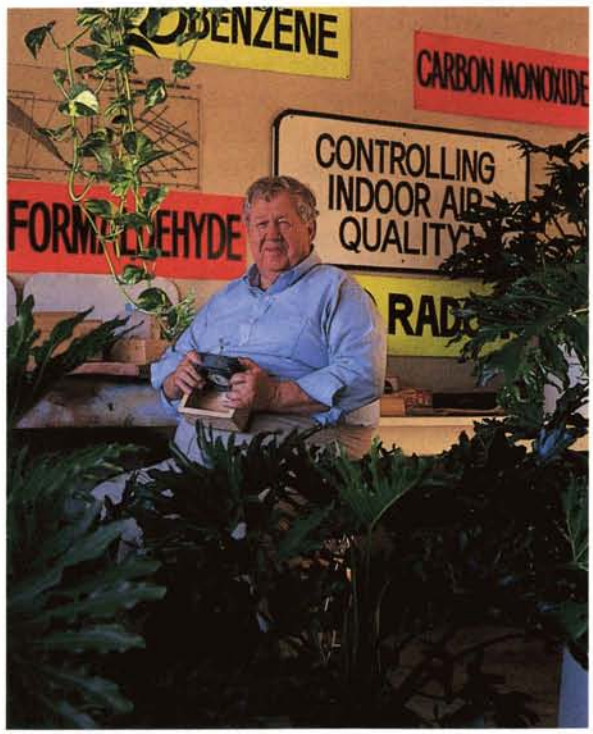
The Bio-Safe design consists of a stone white matt finished pot; a plant, such as the split leaf philodendron; a bed of activated carbon (charcoal); and an air pump, or fan, installed near the root system of the plant.

The pump draws room air into the plant-microbe system, pulling it through the charcoal and over the roots of the plants. The pollutants are trapped by the charcoal and digested by the plant's roots or broken down by microorganisms living in the roots. The pump then directs purified air back into the room.

Applied Indoor Resource Company, Tampa, Florida, also used the NASA technology as a departure point for a bioregenerative air purifier but came up with a slightly different approach.

Marketed under the label Bio-Pure, the system includes a foliage filter plant in a planter and, beneath the plant, a layer of patented soil medium — called Dandy Dirt — with activated carbon, legumes and mosses serving as air filtering agents. A mechanical blower moves air through the filtering system for cleansing by microorganisms. Bio-Pure effectively deals with formaldehyde, smoke, food and animal odors and is being tested for radon removal capability. Bio-Pure portable purifiers come in four planter sizes from eight to 20 inches.

Both Bio-Safe and Applied Indoor Resource Company began marketing their filters in 1988. Both reported good initial public reaction.

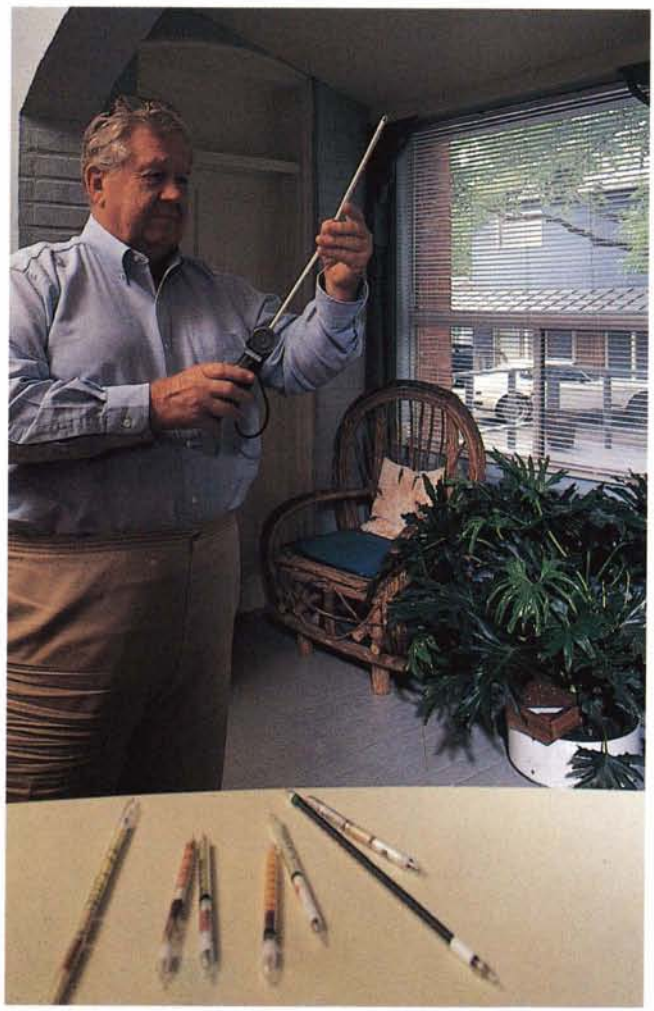


Shown in his workshop is Jack Reber, president of Bio-Safe Incorporated, who is using NASA natural filtration technology to produce plant systems that remove hazardous pollutants from indoor air. Modern building materials toxic chemical and these pollutants build up in superinsulated sealed environments.

Dr. Wolverton and his group at Stennis Space Center are continuing their exploration of natural air purification systems, testing a variety of plants in a windowless, highly-insulated quonset-like facility. The Associated Landscape Contractors of America are participating in the plant research and the results will be passed along to the association's member companies.

In time, the bioregenerative air purification system may be applied to cleansing whole office buildings. Wolverton's group has explored the possibility of scaling up the system and drawn up some concepts of "atmospheric revitalization" by natural purification. Example: on the roof of an office building is a large penthouse green garden. Stale air from the offices below is drawn into the garden through an intake, channeled through the garden for cleansing, then returned through a series of ducts to the offices. Such a system would enable architects to design buildings for high energy efficiency without worrying about the toxicity effects of superinsulation.

Mrs. Doug Reber is assembling a Bio-Safe Plant system, topping a layer of dirt with a layer of charoal that helps the plant—next to go into the container—absorb contaminants. The system includes an air pump that pulls in room air, routes it through the charcoal and the plant's roots, where the pollutants are trapped and idgested; the pump then sends the cleaned air back to the room. Below, a typical Bio-Safe system.



Here Jack Reber is using a special instrument to check the level of contamination in a client's office.