



# A Citizen's Guide To Bioventing

Technology Innovation Office

Technology Fact Sheet

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### What Is Bioventing?

Bioventing is an in situ (in place) process of injecting air into contaminated soil at rates low enough to increase soil oxygen concentrations and stimulate indigenous (native) microbial activity.

Bioventing is one of several bioremediation technologies and makes use of a naturally occurring process. Microorganisms multiply when food and oxygen sources are abundant and they decrease in number when the contaminant is degraded.

### What Is Bioremediation?

Bioremediation uses naturally occurring microorganisms (bacteria, yeast, and/or fungi) to degrade — break down— hazardous substances into less toxic or nontoxic substances. Microorganisms, just

like humans, use organic substances for nutrients and energy. Certain microorganisms can digest organic substances that are hazardous to humans. Some organic contaminants can be degraded into harmless products consisting mainly of carbon dioxide and water. Some examples of organic contaminants that microorganisms can degrade include fuels, such as oil spills, and solvents.

Microorganisms must thrive at the site in order for bioremediation to take place. In addition to the food source provided by the organic contaminants, microorganisms require nutrients. Microorganisms that require oxygen to survive are called aerobic microorganisms. Those that do not require oxygen are called anaerobic microorganisms. The specific bioremediation technology used is determined by the type of microorganisms present, site conditions (such as nutrient and

### Bioventing Profile

- Bioventing is a process of injecting air into contaminated soil at rates that increase soil oxygen concentrations and stimulate microbial activity.
- Bioventing is most effective on organic contaminants, such as fuels and solvents.
- Bioventing is an in situ technology that is conducted on-site.

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oxygen levels), and geological factors. For example, if aerobic microorganisms are present at a given site and if the amount of oxygen available to them is limited, then bioventing would be an appropriate way to enhance bioremediation at this site.

## How Does Bioventing Work?

Figure 1 illustrates the bioventing process. It begins by drilling injection wells into the ground where the contamination exists. The number, location, and depth of the wells depends on many geological factors and engineering considerations.

An air blower delivers air from the atmosphere into the contaminated soil through the injection wells. Air (containing oxygen) flows through the soil and is used by the microorganisms. In addition to oxygen, other nutrients may be pumped into the soil through the injection wells. For example, nitrogen and phosphorous may be pumped in amounts appropriate for optimizing the growth of microorganisms. The microorganisms will use the contaminants in the soil as a food source and convert them to nonhazardous substances. The main end products of this conversion reaction are carbon dioxide and water.

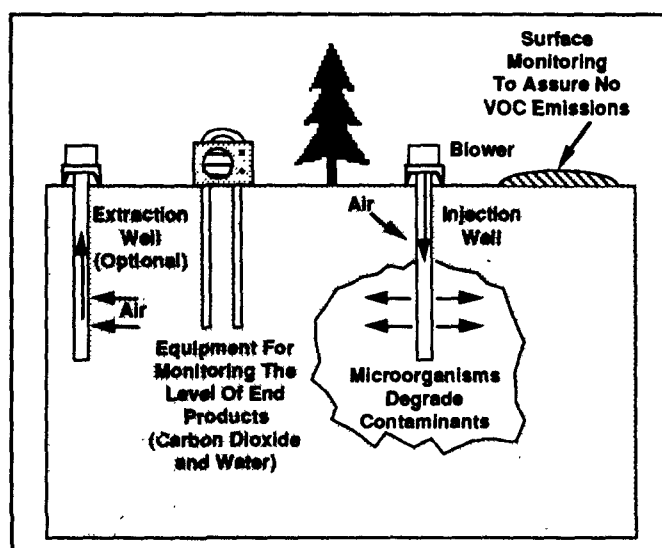
The level of these end products is monitored to see if the bioremediation reaction is indeed occurring. If it is not, factors such as nutrient and oxygen levels in the soil may need adjusting.

During bioventing, surface soils are monitored continuously to detect volatile organic compounds (VOCs). VOCs represent some of the organic contaminants that the bioventing process degrades. Before degradation occurs, VOCs may escape from the soil, and then contaminate the air. This may occur when the air from bioventing flows through the soil at rapid rates. This potential side effect is prevented by injecting air into the soil at low rates. A balance must be achieved between injecting the soil at rates high enough to deliver oxygen to the microorganisms, but low enough to prevent VOCs from escaping. If VOCs are detected, the air blower is adjusted downward.

Bioventing may be used in conjunction with air extraction. With air extraction, extraction wells are installed in addition to injection wells. In this case injected air moves slowly through the soil to the extraction well. At the extraction well, the air is pulled out of the soil. Whether bioventing will be used with air injection alone or in conjunction with air extraction is determined by site characteristics such as surface, soil and geologic conditions.

It may take several months to several years, depending on the types of compounds present, for microorganisms to completely degrade organic contaminants. At a site in Traverse City, Michigan, it took four months for 463 cubic yards of soil contaminated with gasoline to be decontaminated by bioventing. Once the degradation of the contaminants is completed, the microorganisms will die because they have used all of their food source. The dead microorganisms pose no contamination risk because they have already degraded and therefore converted the contaminants into nontoxic substances.

Figure 1  
Bioventing



## Why Consider Bioventing?

An advantage of bioventing is that it eliminates the need to transport the original contaminated waste. Of all the oxygen-delivering bioremediation technologies that exist, bioventing is one of the most cost effective. Lastly, bioventing is ecologically sound and successful at destroying target contaminants.

## Will Bioventing Work At Every Site?

In order for bioremediation to be successful, soil conditions must allow the microorganisms to live. Bioventing is needed only at those bioremediation

sites where additional oxygen would help the microorganisms thrive.

Bioventing is most effective on the unsaturated soil above the water table. Since bioventing pushes air through the soil, it is used on porous soil in the unsaturated zone.

### Where Is Bioventing Being Selected?

Bioventing has been selected as a treatment method for the Cliff/Dow Dump Superfund site in Michigan. This site contains waste disposal from a charcoal manufacturing plant. Bioventing is also being used for jet fuel clean-up at several demonstration sites, including Tyndall Air Force Base in Florida, Eielson Air Force Base near Fairbanks, Alaska and Hill Air Force Base, just north of Salt Lake City, Utah.

### What Is An Innovative Treatment Technology?

Treatment technologies are processes applied to the treatment of hazardous waste or contaminated materials to permanently alter their condition through chemical, biological, or physical means. Technologies that have been tested, selected or used for treatment of hazardous waste or contaminated materials but lack well-documented cost and performance data under a variety of operating conditions are called *innovative* treatment technologies.

### For More Information

EPA prepared this fact sheet to provide basic information on bioventing. Additional technical reports are listed below. The documents containing a "PB" designation are available by contacting the National Technical Information Service (NTIS) at 1-800-336-4700. Mail orders can be sent to:

National Technical Information Service  
Springfield, VA 22161

Other documents may be obtained by contacting:

Center for Environmental Research Information  
26 West Martin Luther King Drive  
Cincinnati, OH 45268  
(513) 569-7562

There may be a charge for these documents.

- Understanding Bioremediation: A Guide Book for Citizens, EPA/540/2-91/002.
- Bioremediation in the Field, EPA/540/2-91/027.
- Bioremediation of Contaminated Surface Soil, PB90-164047.
- In-Situ Bioremediation of Spills From Underground Storage Tanks, PB89-219976.

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