BIOFILTERS for Emission and Odor Control



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Overview

- Why Biofiltration for Odor Control?
- What is the Biofilter Process?
- What key issues should we consider when Designing and Operating?
- What are the typical H_2S and odor removal rates of a biofilter?

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Introduction

- **Biofiltration - sustainable treatment technology**
  - uses natural biological processes
  - uses natural media materials
  - no environmentally harmful by-products
- **Examples in So Cal:** LVMWD, IEUA, LACSD, and others

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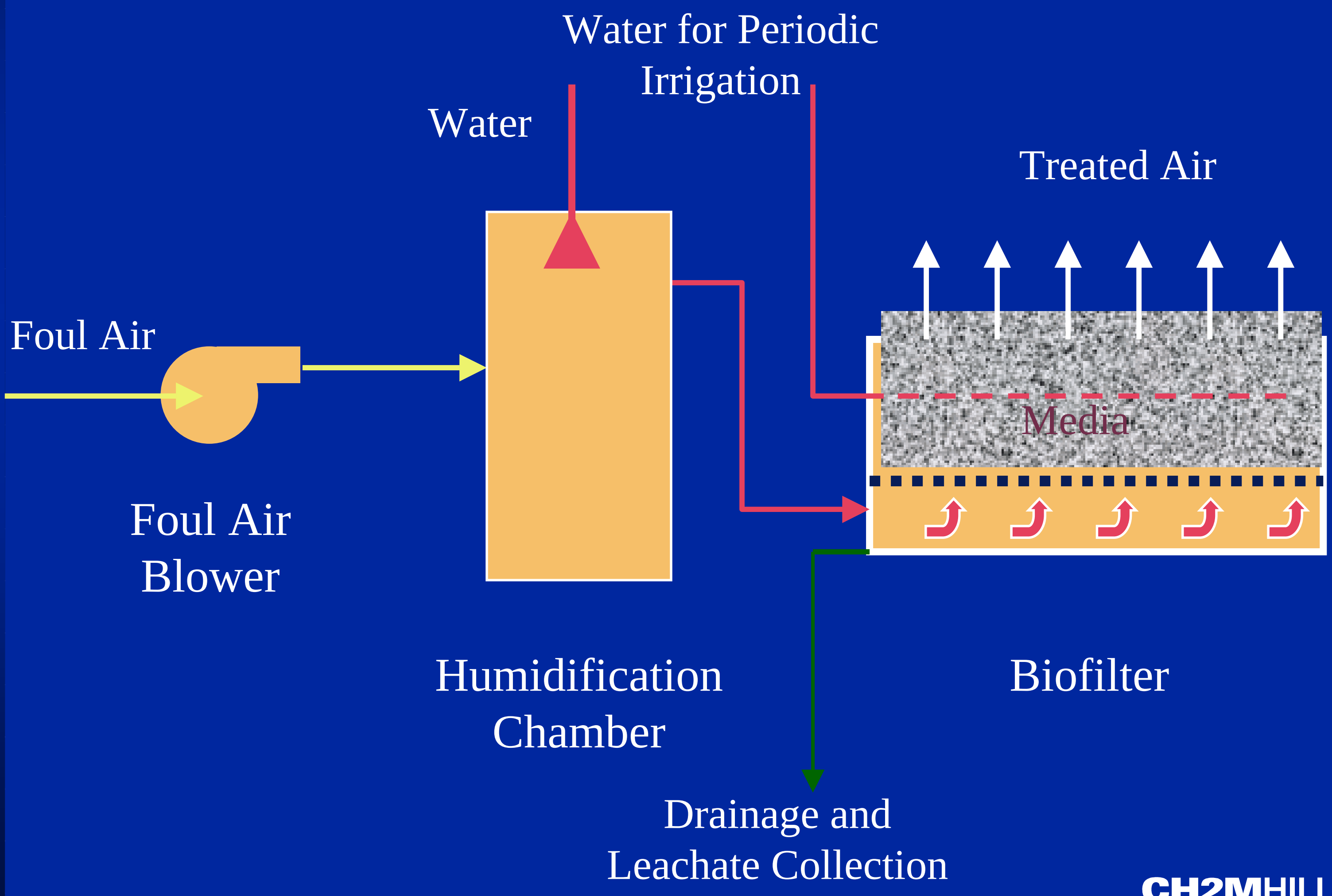
Why Biofilters?

- **Environmentally friendly compared to other odor controls:**
  - chemical scrubbers use hazardous chemicals (e.g. caustic, hypochlorite)
  - spent activated carbon may require disposal as hazardous waste
  - thermal oxidizers use fossil fuels which generate greenhouse gases

Simplified Biofilter Schematic



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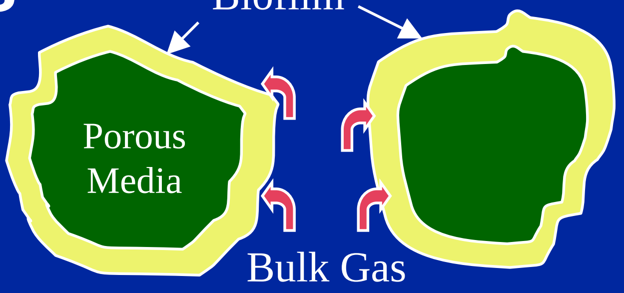
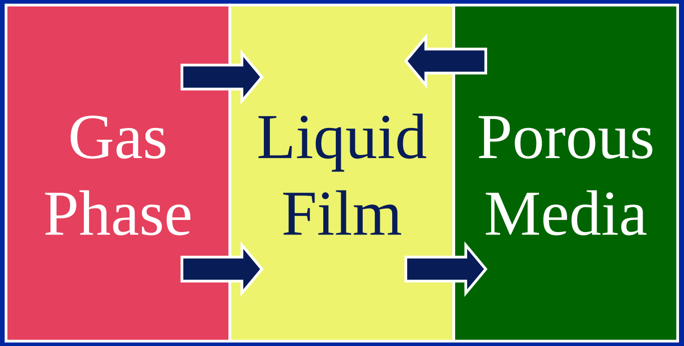
The Process in the Bed

- **Three-phase Process**
  - Transfer of contaminants from gas to liquid
  - Biodegradation in liquid
  - Transfer of nutrients from media to liquid
  - Transfer of contaminants from liquid to solid





Process Description

- **In simple terms: Biofilters are described as a biofilm system**
- **Behind the scenes: Biofilters are a complex adsorption, absorption, biological oxidation system**
- **Take home: Biofilters are a system designed and operated to support a healthy microbe colony that consumes odorous compounds**

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Biofilter Examples

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Design and Operating Considerations

- Sizing a Biofilter
- Media Selection
- Air Distribution
- Moisture Control
- Pre-engineered systems

Sizing a Biofilter

- **Empty Bed Residence Time (EBRT)**
  - EBRT required depends on the odorous compound (s) and type of media
  - Typical WWTPs = H_2S, low level reduced sulfur organic compounds

$$EBRT = \frac{A \times D}{Q}$$

$$LR = \frac{Q}{A}$$

A = surface area of biofilter

D = depth

Q = flowrate

LR = Volumetric Loading Rate

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Example EBRTs

- **Simple Organic Media systems = 45 to 60 seconds**
  - 3 to 6 cfm per square foot volumetric loading rate (LR)
- **Simple Soil based systems = 60 to 120 seconds**
  - 1.5 to 3 cfm per square foot
- **High rate Organic Media systems = 30 to 45 seconds**
  - 5 to 15 cfm per square foot surface

Biofilter Media Selection Has Major Impacts

- Microorganisms
- Moisture Control
- Nutrient Supply
- Media Stability
- pH (buffering)
- Foul Air Residence Time Requirements
- Pressure Drop

Media Selection

- **Types of media**
  - soil
    - *long life, relatively low loading rates*
  - organic
    - *replacement 2 to 5 years, higher loading rates*
  - synthetic
    - *usually component of mix, site specific*

Air Distribution

- **Air Flow Distribution**
  - Plenum with distribution plate
  - Perforated piping

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Checking Air Distribution in Constructed Biofilter

- Smoke Test to show even distribution of air stream

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Moisture Control

- **Moisture Control**
  - Typical range - 50% to 65%
  - Prehumidification
    - *humidification chambers*
    - *duct sprays*
  - Bed irrigation
    - *soaker hoses*
    - *surface sprays*

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Moisture Control (critical)

- **Top irrigation alone is not considered sufficient, preconditioning the air as it enters is recommended**

- **If moisture is not controlled, then organic based media can have the following tendencies:**
  - can be prone to shrink and swell
  - crusting, short circuiting, dead zones
  - can be hydrophobic if dried (difficult to rewet)

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Vendor Biofilter Systems (Modular Pre-engineered)

- Ambio
- Bay Products
- Biocube
- Bioreactor
- Biorem
- Bioton
- Envirogen
- Zabocs
- others

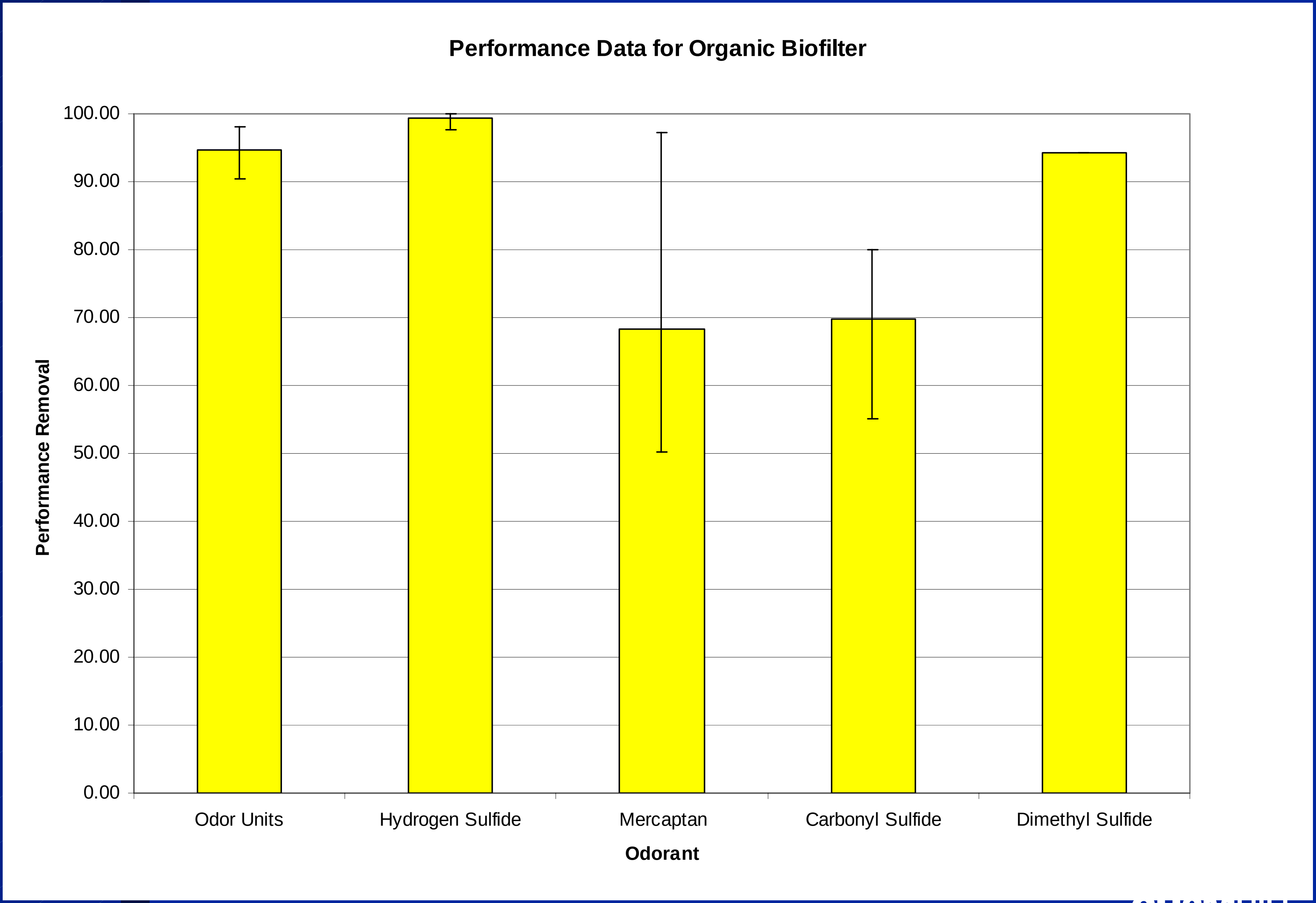
⇒Typically for smaller applications.

⇒ Proprietary media

⇒ Specialized moisture control system

⇒Modular design for biofilter containers.

Performance Data for Organic Media



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Biofilters

Advantages

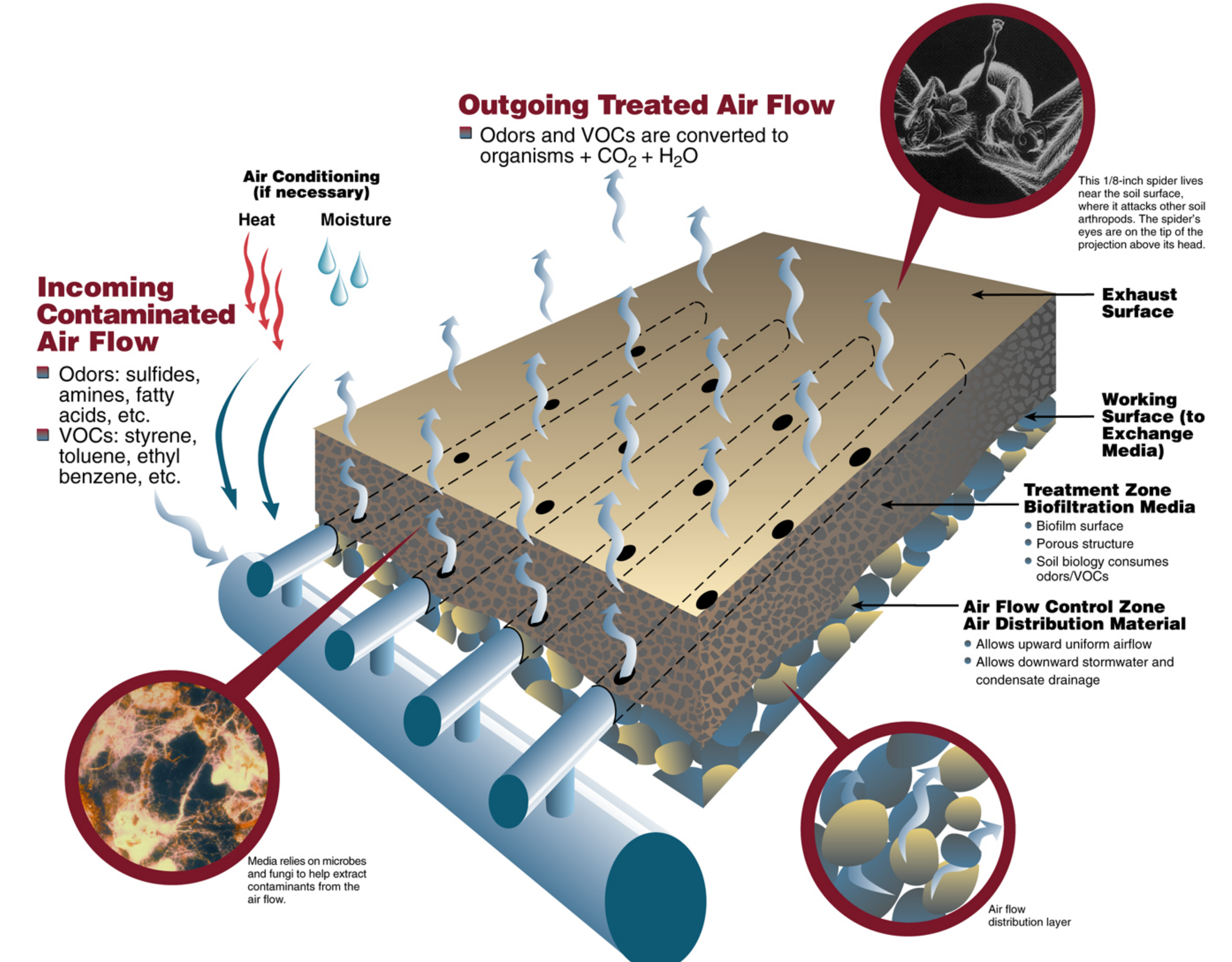
- Low maintenance
- No Chemicals
- Very effective for a wide range of compounds
- Low Cost relative to other odor control technologies

Disadvantages

- Can be land intensive
- Can short circuit if poorly designed
- Organic Media will decay and compact over time
- Difficult to completely avoid musty biofilter smell

Conclusions

- **Successful biofilter requires careful:**
  - Media selection
  - Moisture control
  - Airflow distribution
- **Correctly designed and maintained biofilter will provide:**
  - High removal efficiencies for odor and H_2S
- **Biofilters are routinely selected as technology of choice due to ease of operations and proven performance**


Outgoing Treated Air Flow
Odors and VOCs are converted to organisms + CO_2 + H_2O
Air Conditioning (if necessary)
Heat
Moisture
Incoming Contaminated Air Flow
Odors: sulfides, amines, fatty acids, etc.
VOCs: styrene, toluene, ethyl benzene, etc.
This 1/8-inch spider lives near the soil surface, where it attacks other soil arthropods. The spider's eyes are on the tip of the projection above its head.
Exhaust Surface
Working Surface (to Exchange Media)
Treatment Zone Biofiltration Media
Biofilm surface
Porous structure
Soil biology consumes odors/VOCs
Air Flow Control Zone Air Distribution Material
Allows upward uniform airflow
Allows downward stormwater and condensate drainage
Media relies on microbes and fungi to help extract contaminants from the air flow.
Air flow distribution layer