REDUCING GREENHOUSE GASES THROUGH BIO-OXIDATION

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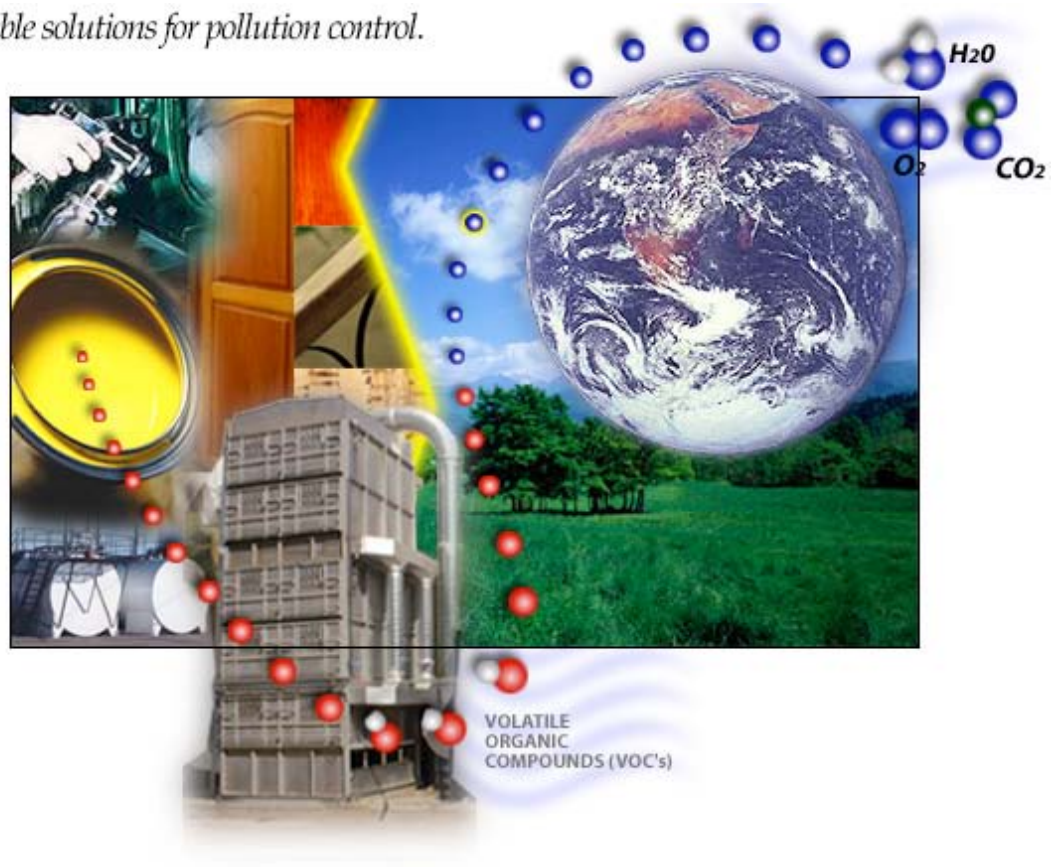
What is Bio-oxidation?

Sustainable solutions for pollution control.

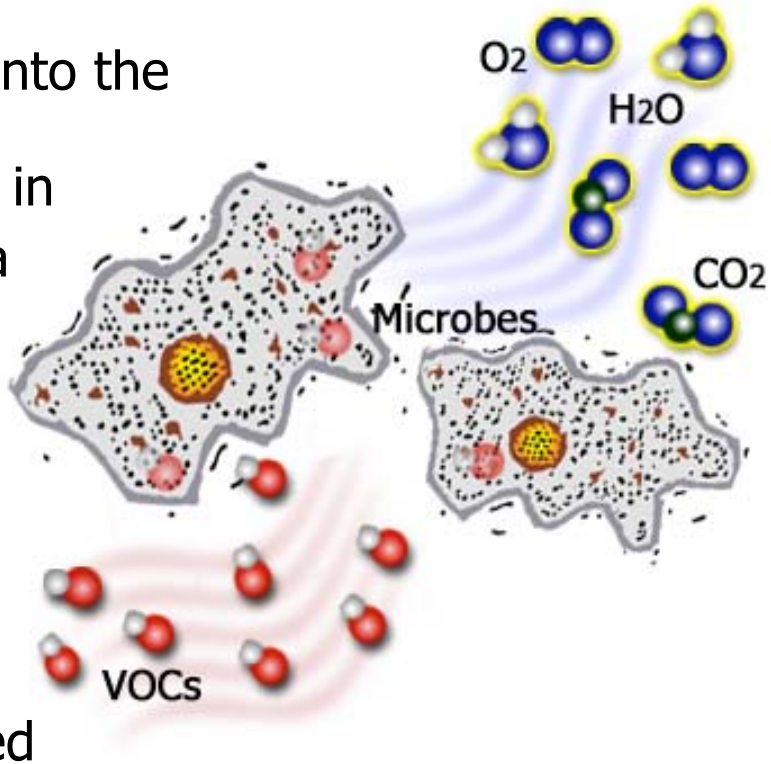
Bio-oxidation is a biological air pollution control technology

that utilizes bacteria & fungi to biologically absorb and digest vapor phase VOCs and odorous compounds commonly found in industrial and municipal applications.

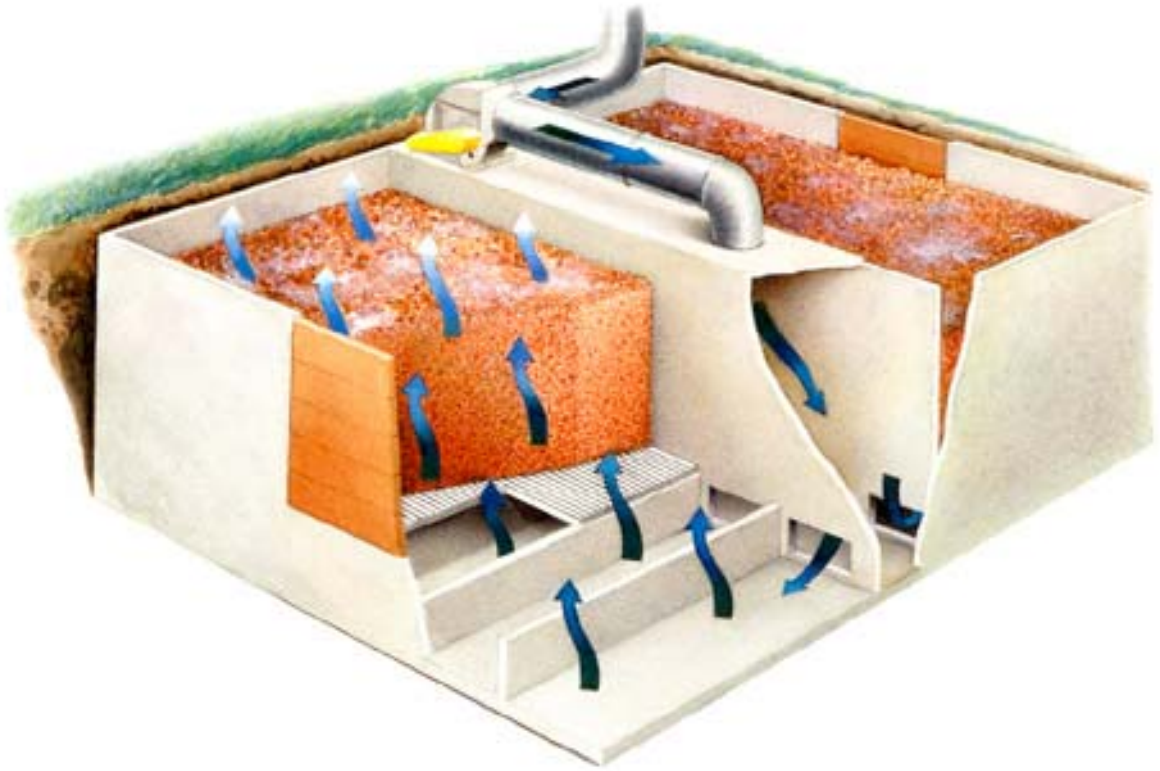


How They Work?

Contaminated air streams are pulled into the system via induced-draft fans, the contaminants first encounter bacteria in an aerated sump and inorganic media with biofilm growth. The final treatment occurs in a compost media, where they are captured and digested by a community of naturally-occuring microbes. The contaminants are utilized as a food source for the microbes and exhausted into the atmosphere as small amounts of carbon dioxide and water vapor.



"Conventional" Biofilters



System Design

- Very Large Footprint
- Bed Compaction & Replacement
- Limited Surge Loading Capability/Efficiency
- Limited Upper VOC Concentration Capability (<2,000 ppm)

BRI Engineered Bio-oxidizers

Multiple Treatment Stages

- Aerated sump to capture and treat water-soluble compounds
- Inorganic media for biofilm growth to harbor additional bacteria
- Organic compost to capture and digest remaining VOCs

Structured Compost Media

- Increases effective surface area
- Eliminates compaction and channeling
- Significantly reduces the size over conventional biofilters

Design and Controls

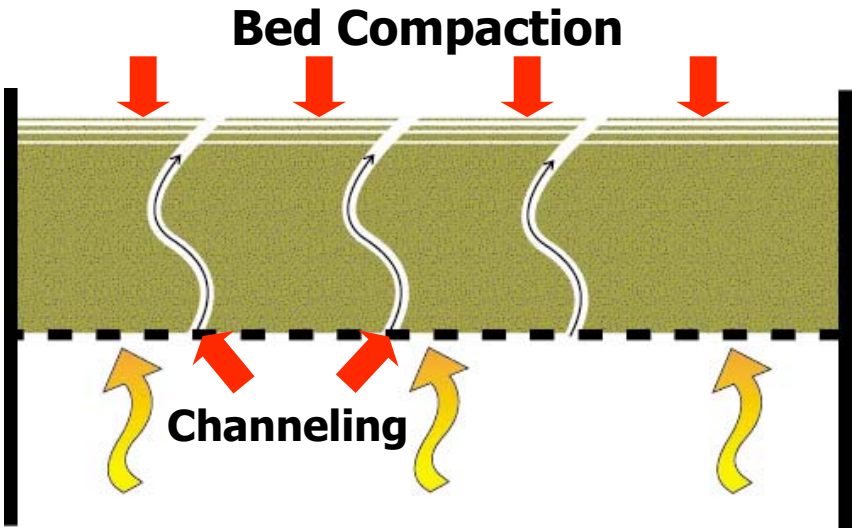
- Common sump for nutrient distribution
- Biotrickling filter for conditioning the airstream
- Automated controls

Footprint Comparison

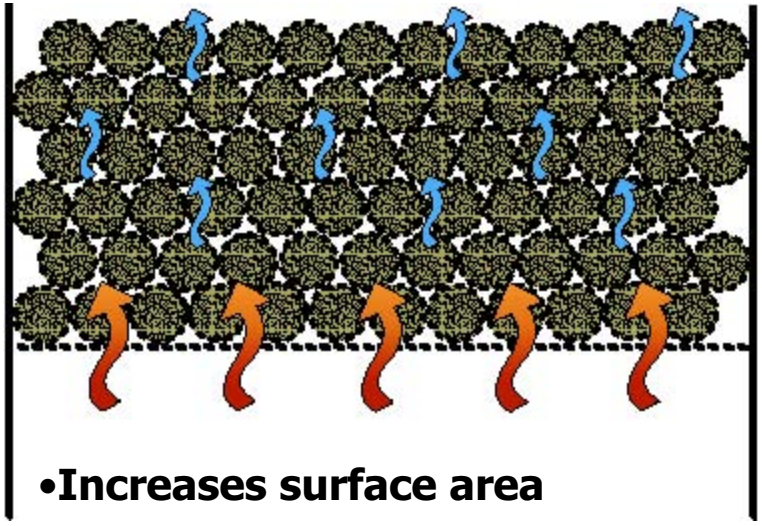
When you compare a traditional biofilter to a Bio_Oxidizer it's like comparing a **parking lot** to a **parking space**

MEDIA MATTERS!

Conventional Biofilter Media

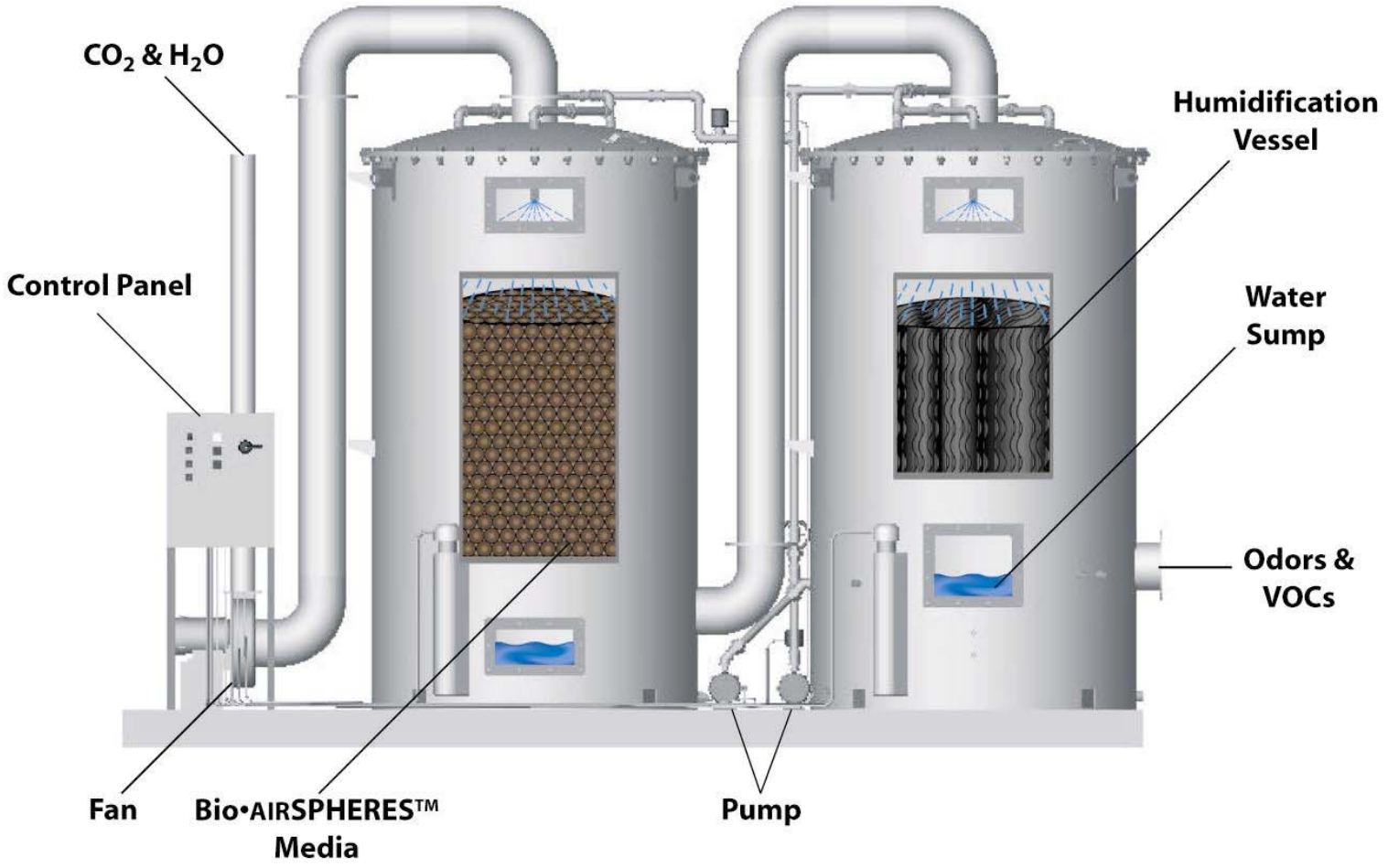


BRI Patented Bio•AIRSPHERES™



- **Increases surface area**
- **Prevents Compaction**
- **Reduces channeling effects**
- **Ensures even moisture distribution**

Sample Dual Vessel System

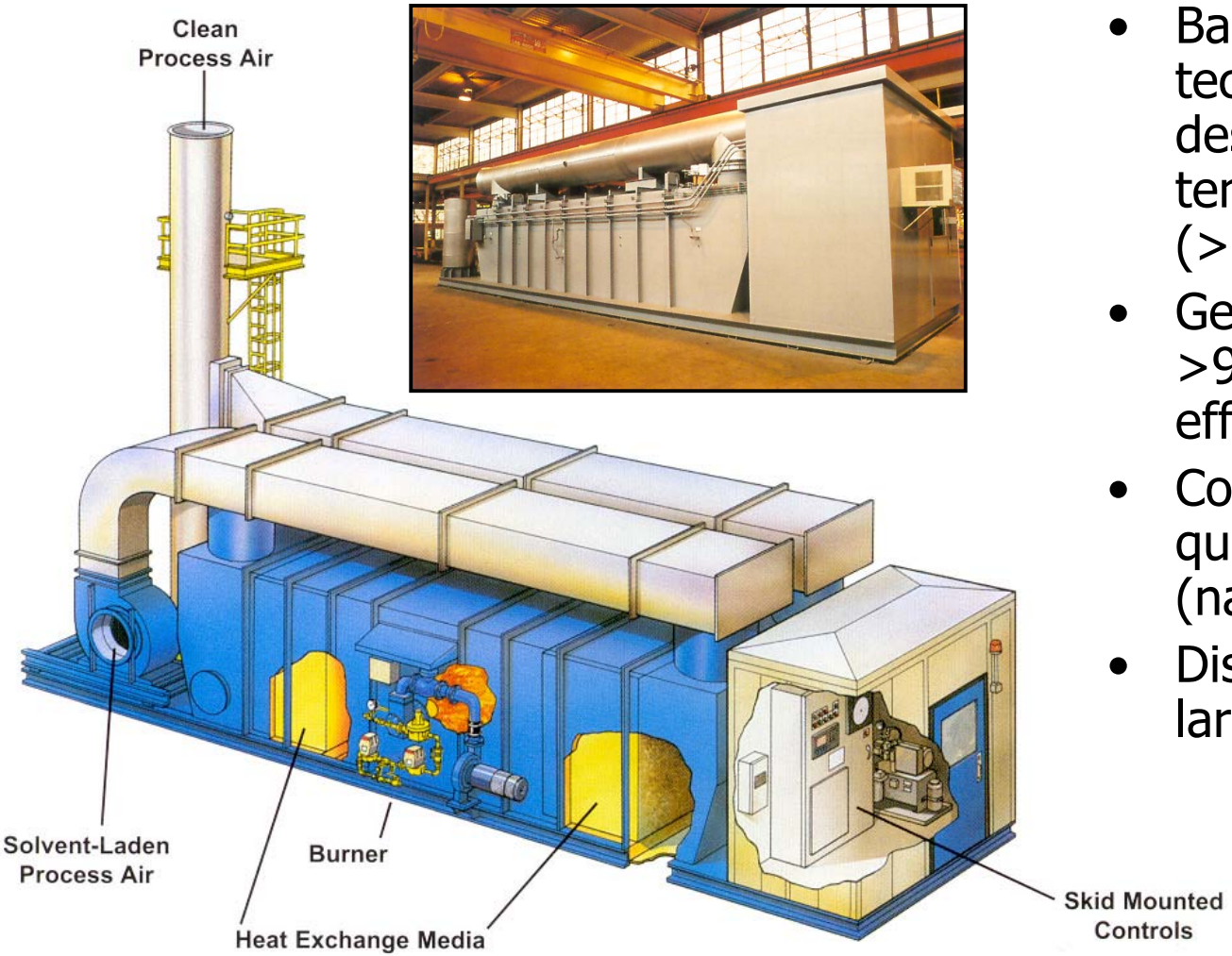


System Internals

- Sprinkler Heads and Cross Flow Media
- Bio_AIRSPHERES™

Alternative Technologies

Thermal/Catalytic Oxidization



- Basic Incineration technology, VOC's destroyed at high temperatures (>1400° F)
- Generally achieves >95% destruction efficiency.
- Consumes significant quantities of fuel (natural gas).
- Discharges NOx and large quantities of CO_2.

Carbon Filtration

- Absorbs VOC's.
- Requires "offsite" regeneration of carbon which is expensive and generates NOx.
- Humidity reduces absorption
- Not suitable for water-soluble compounds

Summary of BRI Bio-oxidizer Advancements

- Small Footprint, Compact
- Fungal Based Microbial Ecosystem
- Surge Loading Capability
- Modular, Flexible & Expandable Design
- Few Moving Parts
- Low O&M - Easy Operation
- Easy Installation
- Decentralized VOC Treatment

Bio-Oxidizer for Soil Vapor Extraction

GC Analyses of 'Off-gases'

	Non-BTEX VOC (PPMV)	BTEX (PPMV)	Total VOC (PPMV)
Mean	51,466	18,382	69,467
Std. Deviation	± 103,182	± 21,805	± 123,012
Min	8,540	70	17,240
Max	520,310	104,100	624,410
N	23	23	23

Results from GC Analyses

	Contaminant	ppm in (avg.)	ppm out (avg.)	Dre
March	BTEX	100	16	
	MTBE	11	5	
	TPH (Gasoline)	1700	720	
	TOTALS			396.44
April	BTEX	78.5	13	
	MTBE	9.7	5	
	TPH (Gasoline)	1700	770	
	TOTALS			370.25
May	BTEX	89.8	7.4	
	MTBE	5	3	
	TPH (Gasoline)	750	490	
	TOTALS			156.95

NATURAL GAS PROCESSING FACILITY

Situation:

- Solution needed in anticipation of upcoming regulatory change
- Reduce BTEX compounds to below 10 tons/year HAPs
- Airflow under 10cfm
- VOC loadings in excess of 80,000ppm

Approach:

- System installed: 3 biofilters in series with 9 layers of Biomatrix
- Total footprint, 4 x 12’

Results:

- 94% removal of non-BTEX compounds
- 99% removal of BTEX compounds
- 95% total VOC removal efficiency

Vent Gas Analysis Summary

94.3% average removal of Non-BTEX VOCs

Methane	**Ethane**	**Propane**
i-Butane	**n-Butane**	**i-Pentanes**
n-Pentane	**i-Hexane**	**n-Hexane**
Heptanes+	**Iso-Octane**	

99% average removal of BTEX compounds

Benzene, Toluene, Ethylbenzene, Xylenes

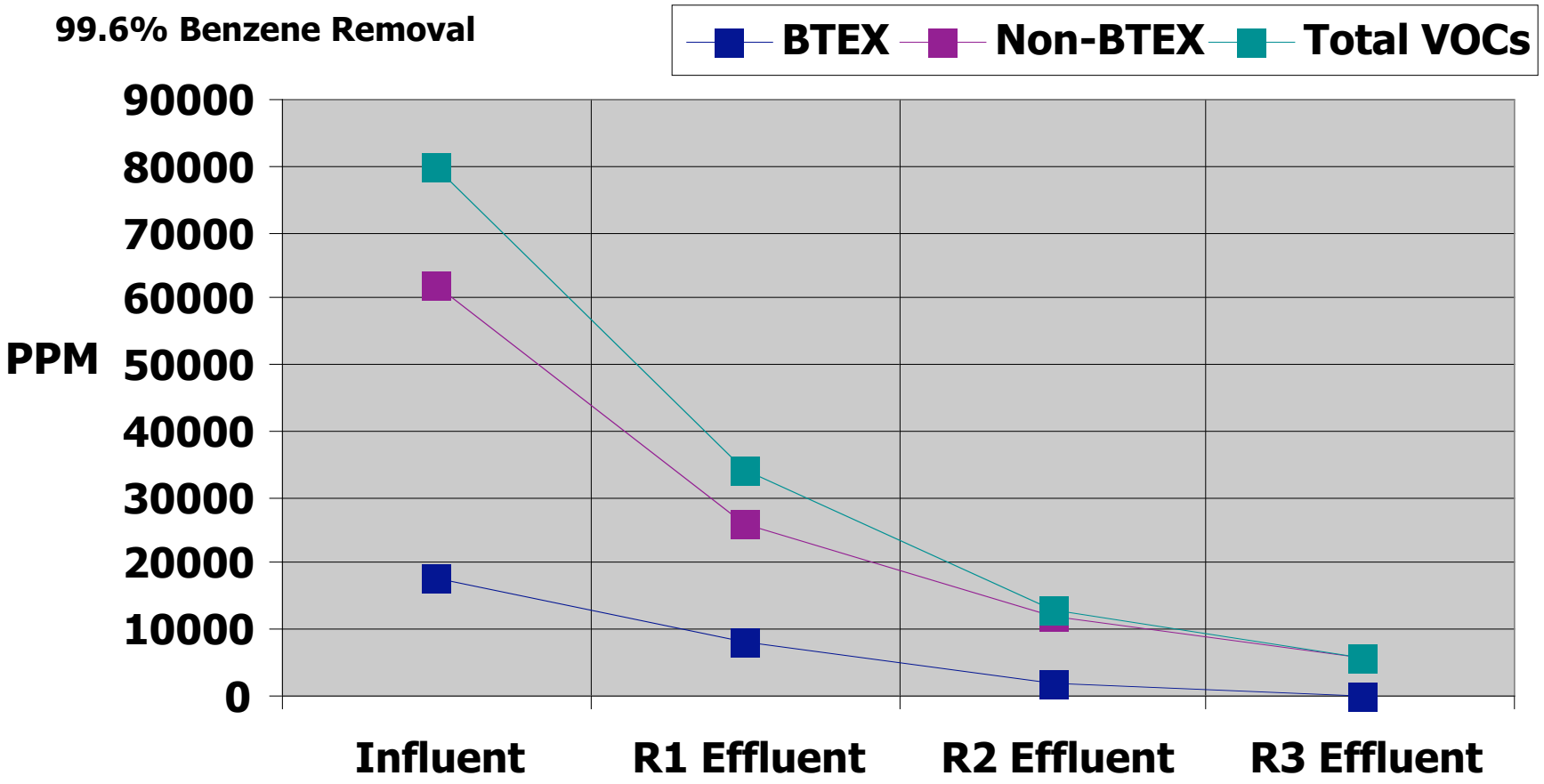
TOTAL VOC removal average = 95.1%

Glycol Dehydrator Vent Gas - GC Analysis

Compound (PPMV)	Influent	Effluent	% Removal
Methane	166,260	0	100.0 %
Ethane	18,190	60	99.7 %
Propane	267,130	28,270	89.4 %
i-Butane	6,360	0	100.0 %
n-Butane	13,170	350	97.3 %
i-Pentanes	14,730	280	98.1 %
n-Pentane	1,900	110	94.2 %
i-Hexane	7,760	60	99.2 %
n-Hexane	3,260	30	99.1 %
Heptanes +	17,520	360	97.9 %
Iso-Octane	4,030	50	98.8 %
Total - Non BTEX VOCs	**520,310**	**29,570**	**94.3 %**
Benzene	78,880	570	99.3 %
Toluene	25,220	450	98.2 %
Ethylbenzene	0	0	
Xylenes	0	0	
Total BTEX	**104,100**	**1,020**	**99.0 %**
Total VOCs	**624,410**	**30,590**	**95.1 %**

Glycol Dehydrator Vent Gas

99.0 % BTEX Removal
99.6% Benzene Removal



Other Applications for Bio-Oxidizers

VOC INDUSTRIAL

- Paint Manufacturing Facilities
- Paint Applicators - Spray Booths
- Wood Product Facilities
- High Tech – Chip Manufacturing
- Die Casting – Oil Mist Emissions

ODOR CONTROL

- Pulp & Paper
- Wastewater Treatment Facilities
- Breweries
- Animal Processing/Rendering

Brown Stock Washer Emissions

Situation:

System needed to treat a combined air stream including H2S plus and other organic constituents

Approach:

Provided small footprint system to enable installation inside facility

Removal Efficiencies

Methanol(MeOH) and Formaldehyde(HCHO)

Date	MeOH* Removal (%)	HCHO* Removal (%)	pH
12/13/2001	99	97	7.4
01/10/2002	94.3	88.7	6.7
02/07/2002	99	99	7.3
02/21/2002	99	97	7.4
03/14/2002	85.2	99	6.9
04/10/2002	35.7	94.9	6.1
04/17/2002	60.7	99.7	4.2
05/14/2002	99.9	99.9	7.4
06/04/2002	99.9	99.9	7.1
07/30/2002	99.9	97.5	7.0
08/06/2002	99.9	99.9	7.1
08/20/2002	99.9	N.D.	7.5

Particleboard Facility

Press Vent Emissions

Situation:

Installation to meet Formaldehyde & Methanol removal required for upcoming MACT regulations

System Loading:

Methanol (12-50ppm)
Formaldehyde (4-20ppm)

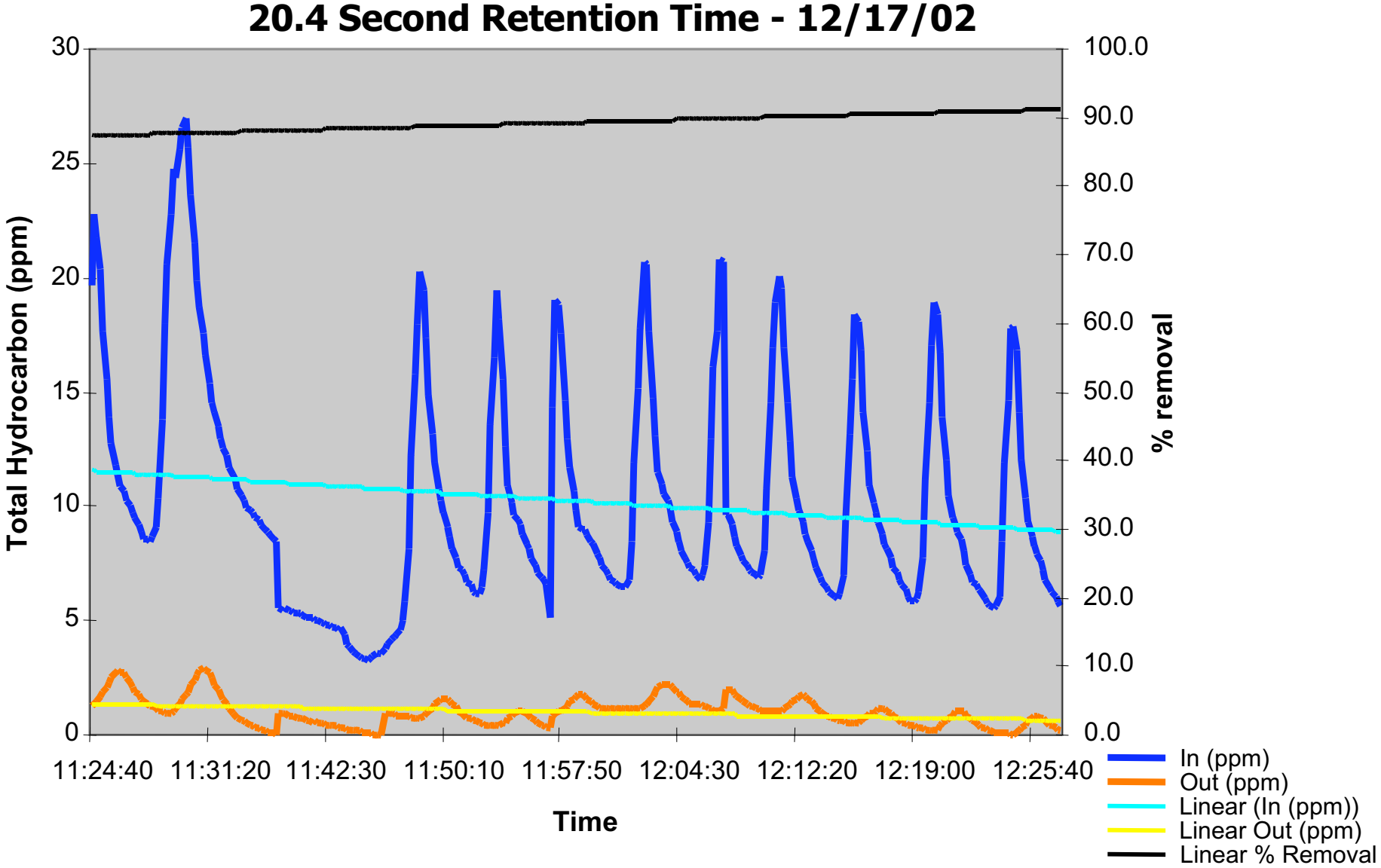
Approach:

40,000cfm in 4 vessels to fit customers available footprint

Results:

Met proposed MACT of >90% removal. Tested bio-oxidizer removal capability for Total VOCs (>80%) by reducing airflow into system.

Total Hydrocarbon Removal -- Particleboard Press



Verification & Sizing

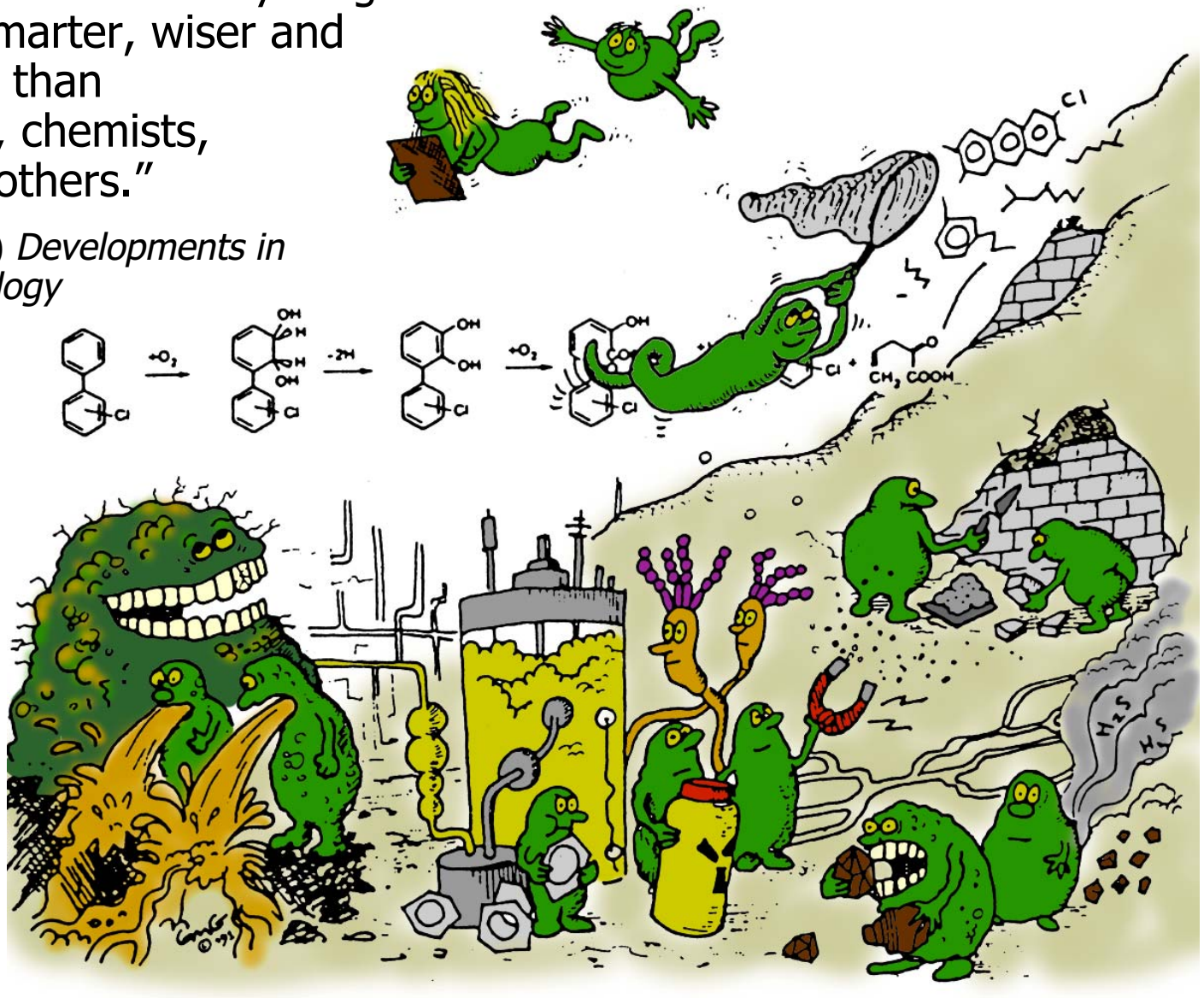
- **Pilot systems available**
- **Slip stream airflows up to 1,000cfm**
- **30-90 day testing at Customers facility**

SUMMARY

- Smaller Footprint than Conventional Biofilters
- Lower Capital Costs
- Significantly Lower Energy Requirements
- Less maintenance, fewer moving parts
- Treats combined air streams of H2S AND VOC's
- No Combustion By-Products (NOx, SOx)
- Significantly lower CO2 generation than incineration-type technologies
- Odor Reduction obtainable in <24 hours
- Systems designed to achieve desired removal efficiencies
- Sustainable Technology

Microbes can and will do anything: microbes are smarter, wiser and more energetic than microbiologists, chemists, engineers and others."

Perlmon, D. (1980) *Developments in Industrial Microbiology*



Questions and/or Comments

THANK YOU!