Hybrid Bioreactors

Cost Saving Processes For Decontamination of Water and Air

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Energy Research and Technology Applications

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Bioreactors

- **Microbial decontamination of liquids**

Biofilters

- **Microbial decontamination of gases**

Applications

- Animal Feed Houses
- Baking
- Chemical Processing
- Composting
- Fiberboard Production
- Fish Processing
- Food Production
- Groundwater/Wastewater
- Meatpacking
- Metalworking
- Municipal Waste
- Painting and Coating
- Paint Stripping
- Petroleum Refining
- Pulp and Paper Mills
- Printing
- Rubber Production
- Soil Vapor Extraction

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Conventional Methods

- ☒ Stripping creates air pollution
- ☒ Sorption methods transfer pollutants
- ☒ Incineration generates toxic products
- ☒ Generate secondary waste streams
- ☒ High costs at low concentrations

Bioreactors/Biofilters

- ☑ Microorganisms destroy pollutants
- ☑ No secondary waste streams
- ☑ Economical at low concentrations
- ☑ Simple operation, low maintenance
- ☑ Automatic operation, minimal labor

Pollutants Destroyed

Groundwater

- Perchloroethylene
- Trichloroethylene
- Dichloroethylene
- Vinyl Chloride
- MTBE, BTEX
- VOCs

Wastewater

- VOCs
- Hydrogen Sulfide
- Ammonia
- Mercaptans
- Amines
- Odors

Coating/Stripping

- Styrene
- Acetone
- Toluene
- Xylenes
- Methyl Ethyl Ketone
- Methyl Isobutyl Ketone
- Butyl Acetate
- Methyl Alcohol
- Methylene Chloride

Rayon/Fibers

- Carbon Disulfide

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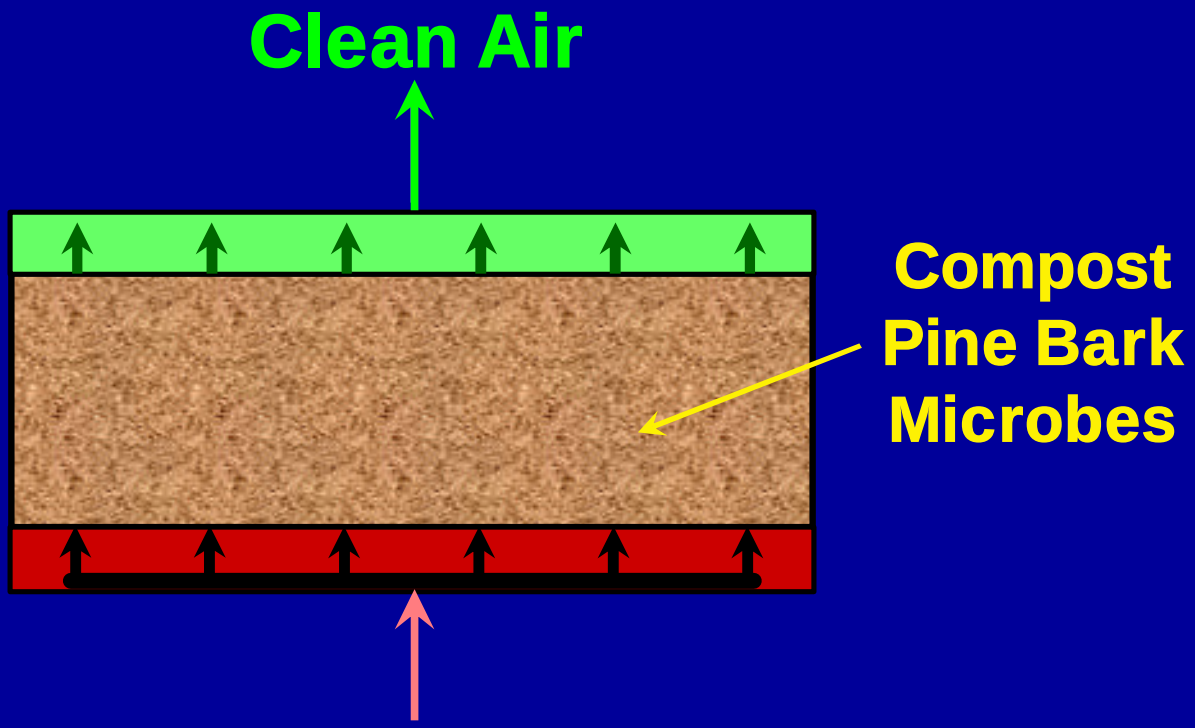
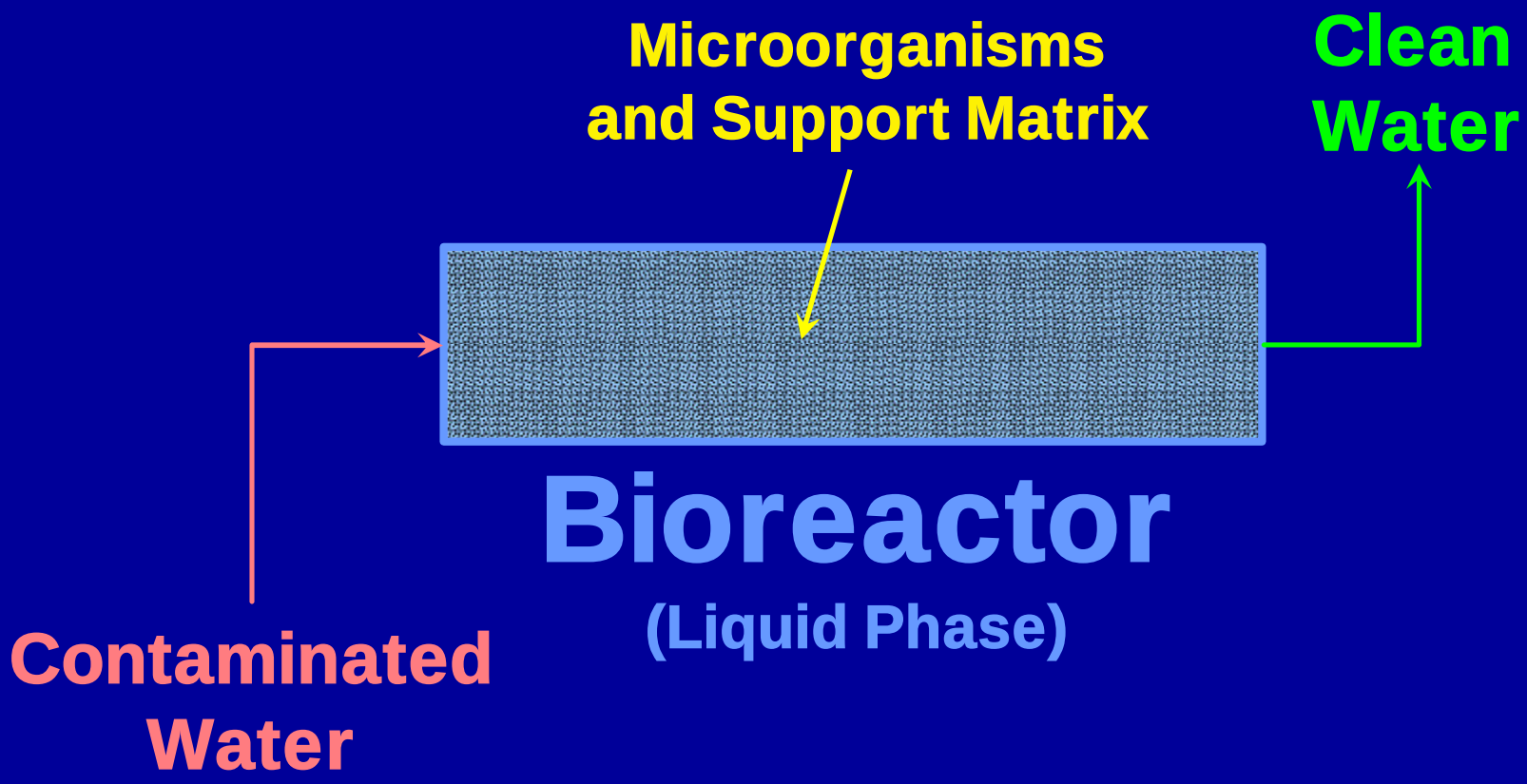
TVA Demonstrations

Location	Application	Contaminants
ANAD, AL	Groundwater	TCE, DCE, VC, MeCl
Murfreesboro, TN	Fiberglass Coatings	Styrene, Acetone, MEK
Starkville, MS	Swine	H_2S, NH_3, Amines, Mercaptans, Odors
Decatur, AL	Wastewater	H_2S, Mercaptans, Odors
Florence, AL	Wastewater	H_2S, Mercaptans, Odors
Bankhead NF, AL	Vault Toilet	H_2S, NH_3, Odors
Muscle Shoals, AL	*Groundwater Wastewater*	*TCE, MTBE, VOCs . . .*

Biofilter

(Gas Treatment)

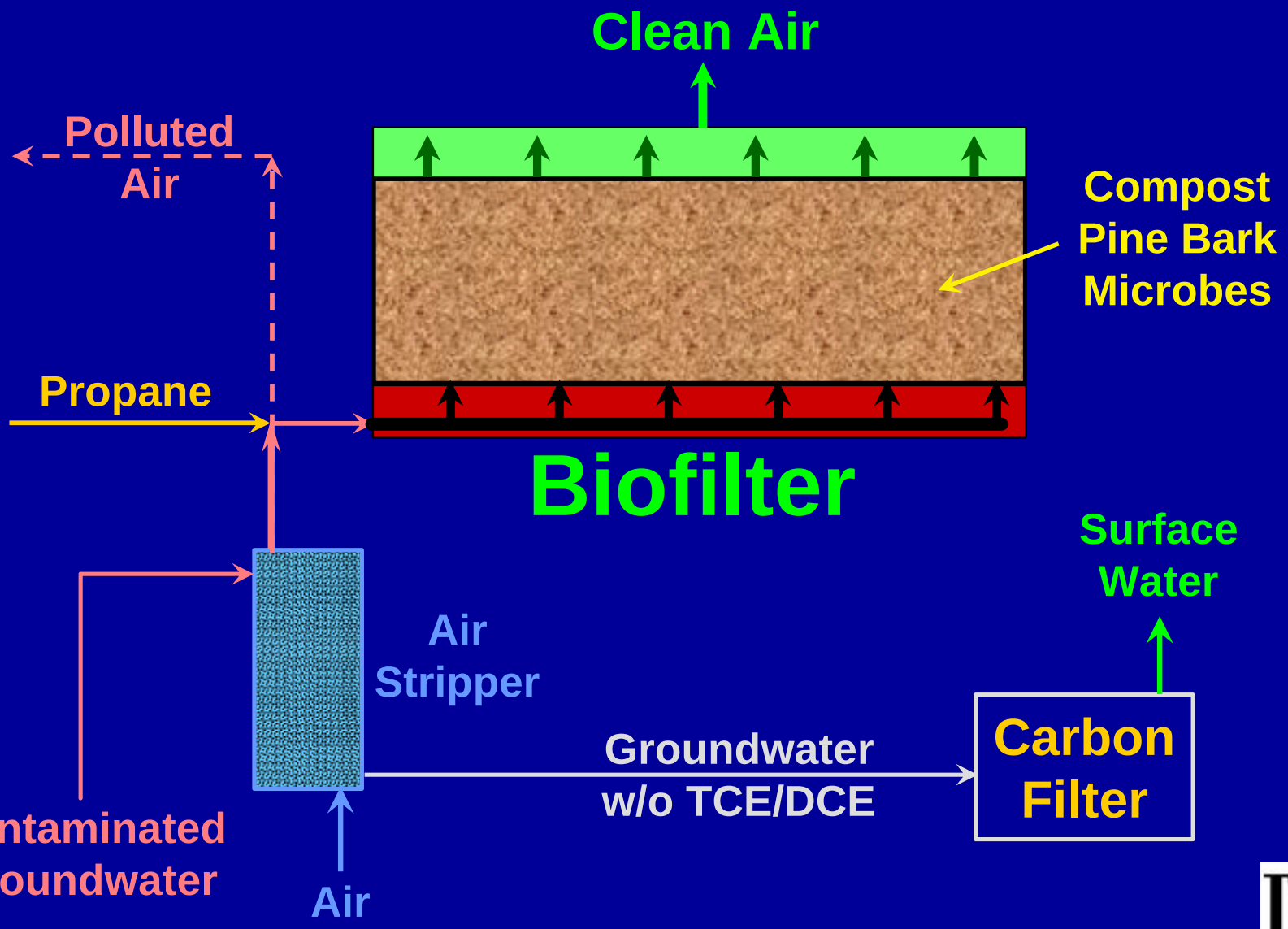



Microorganisms
and Support Matrix
Clean
Water
Bioreactor
(Liquid Phase)
Contaminated
Water

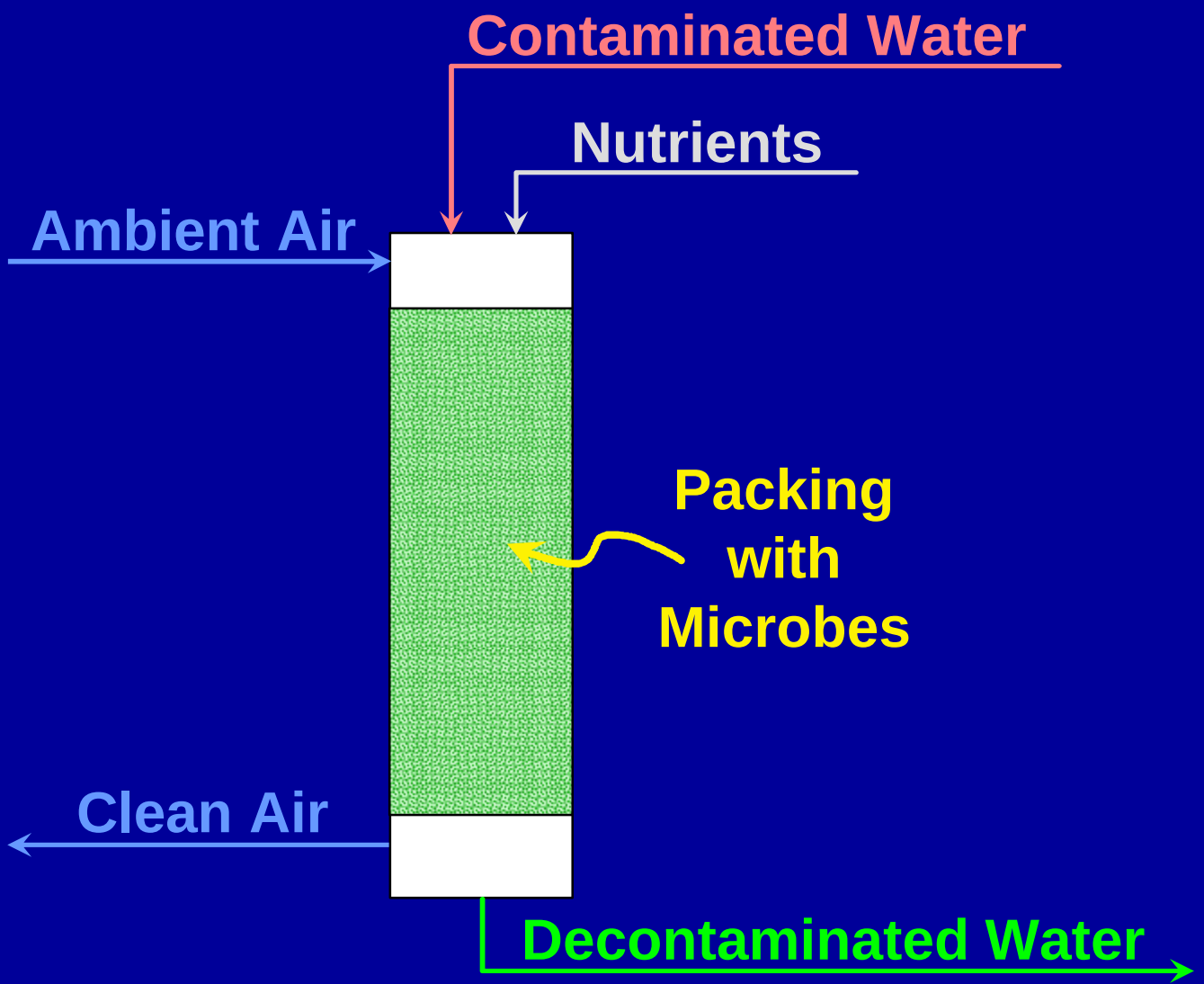
Cometabolic Bioreactors

- ☑*Chlorinated compounds (e.g. TCE)*
- ☑*Pollutants are not consumed*
- ☑*Utilize primary substrate (food)*
- ☑*Enzymatic contaminant destruction*
- ☑*Cyclical process for efficiency*

Destruction of TCE at ANAD



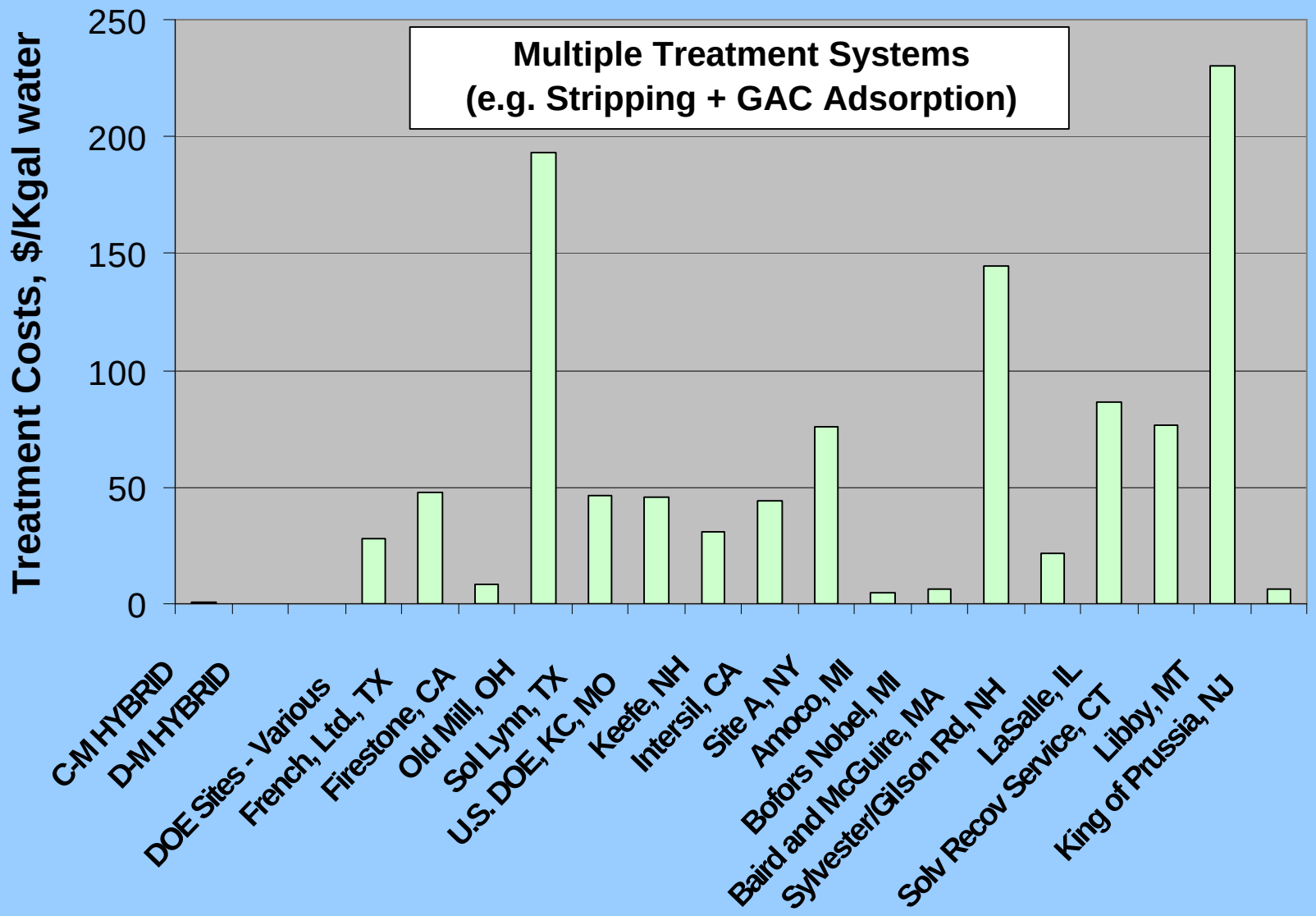
Hybrid Bioreactors



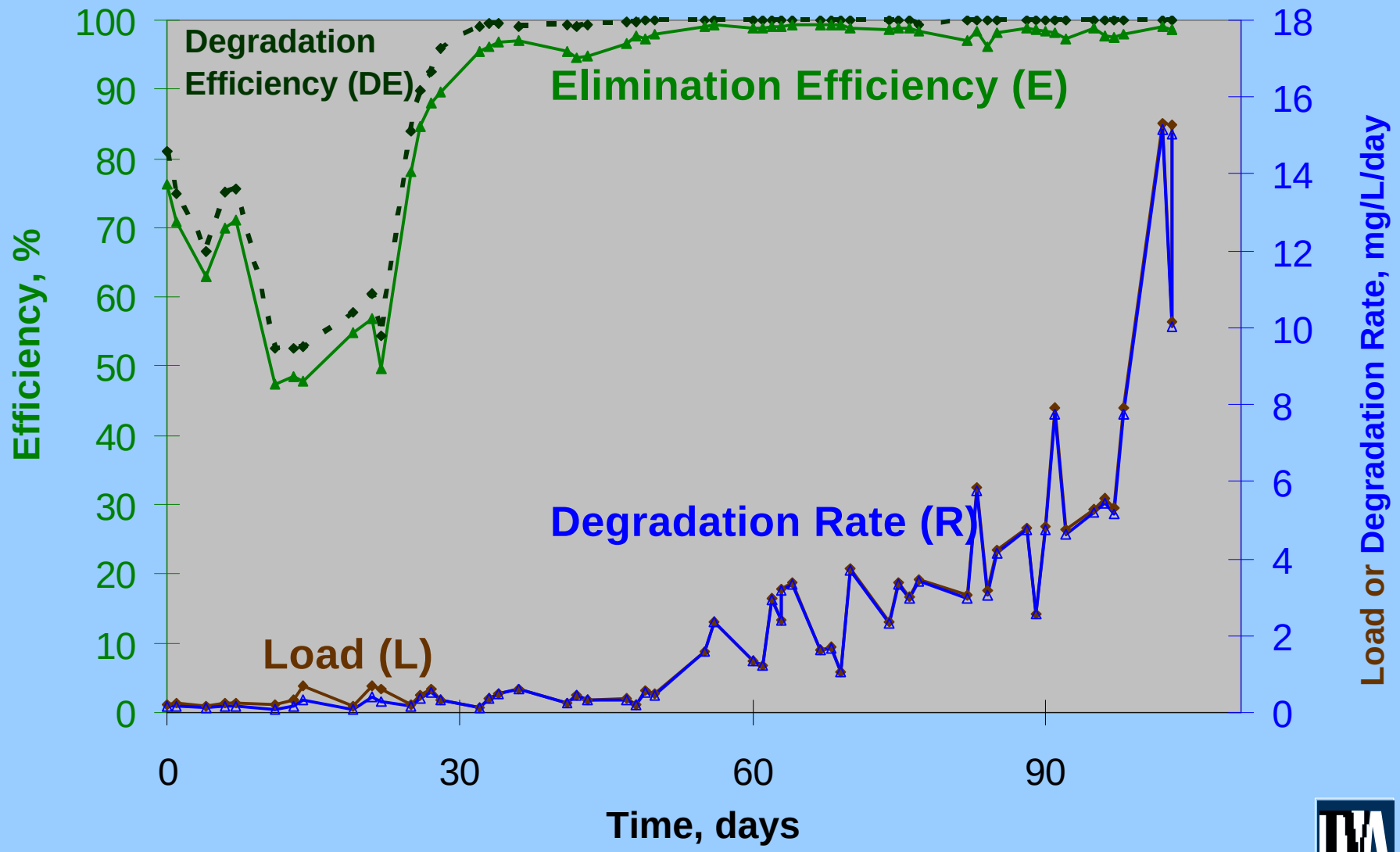
Hybrid Bioreactors

- **TCE, MTBE, VOCs, fuels, odors**
- **Single-step water/air cleanup**
- **Remove *and* destroy toxics**
- **Dramatic cost savings**
- **No contaminated off-gases**
- **No secondary waste streams**
- **Auto operation, minimal labor**

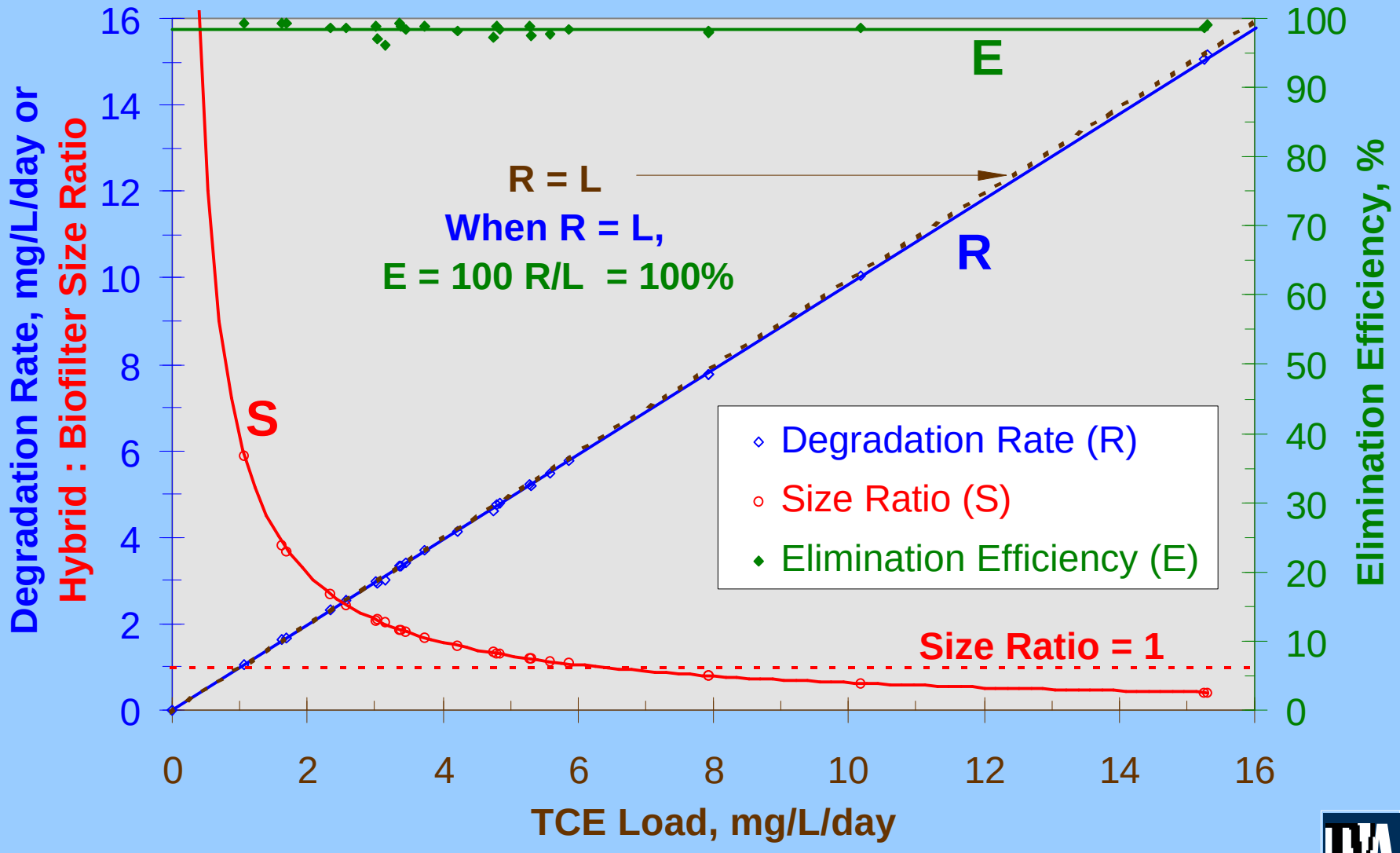
Hybrid Costs < 10% of SF Sites



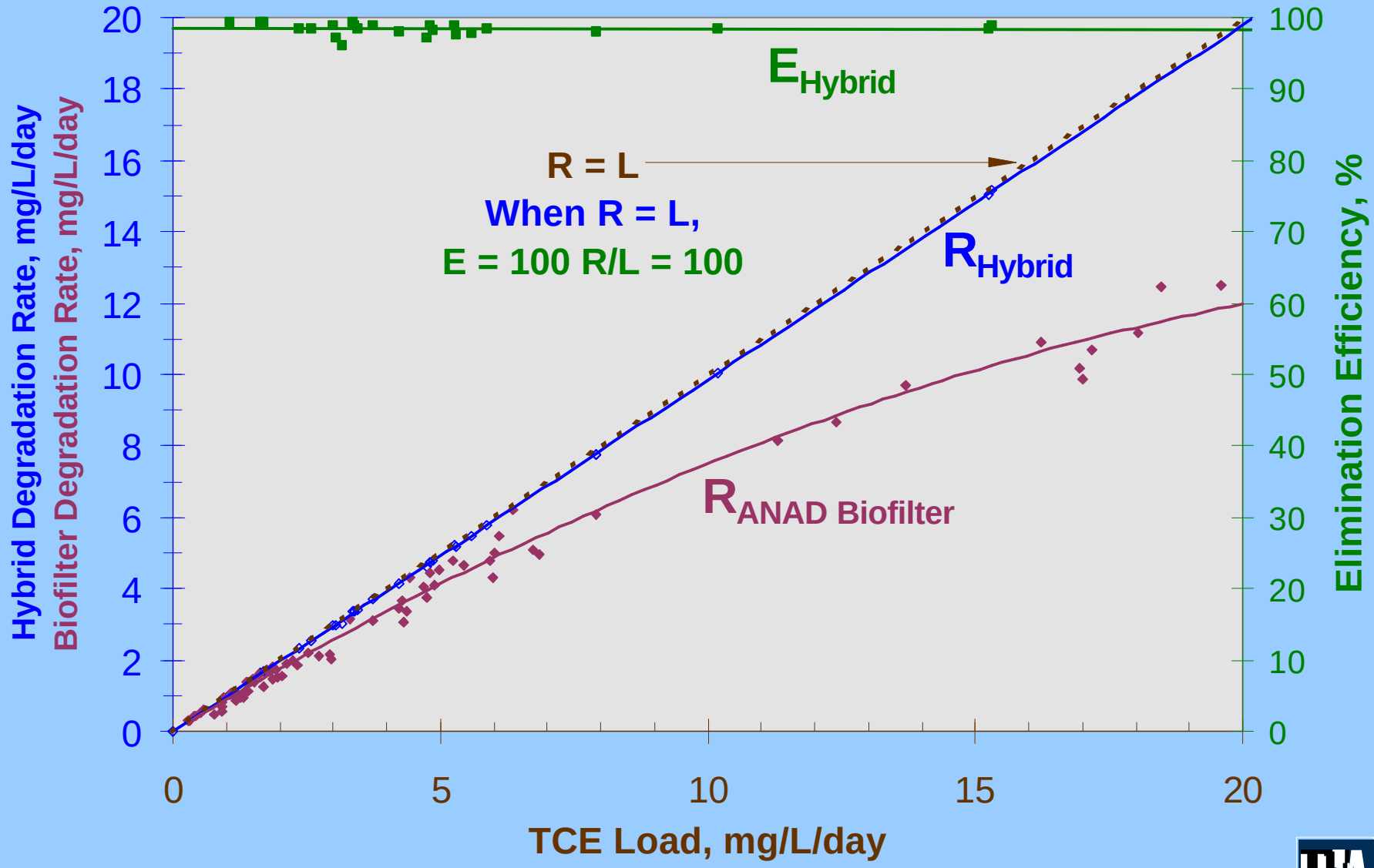
Rapid Performance Improvement



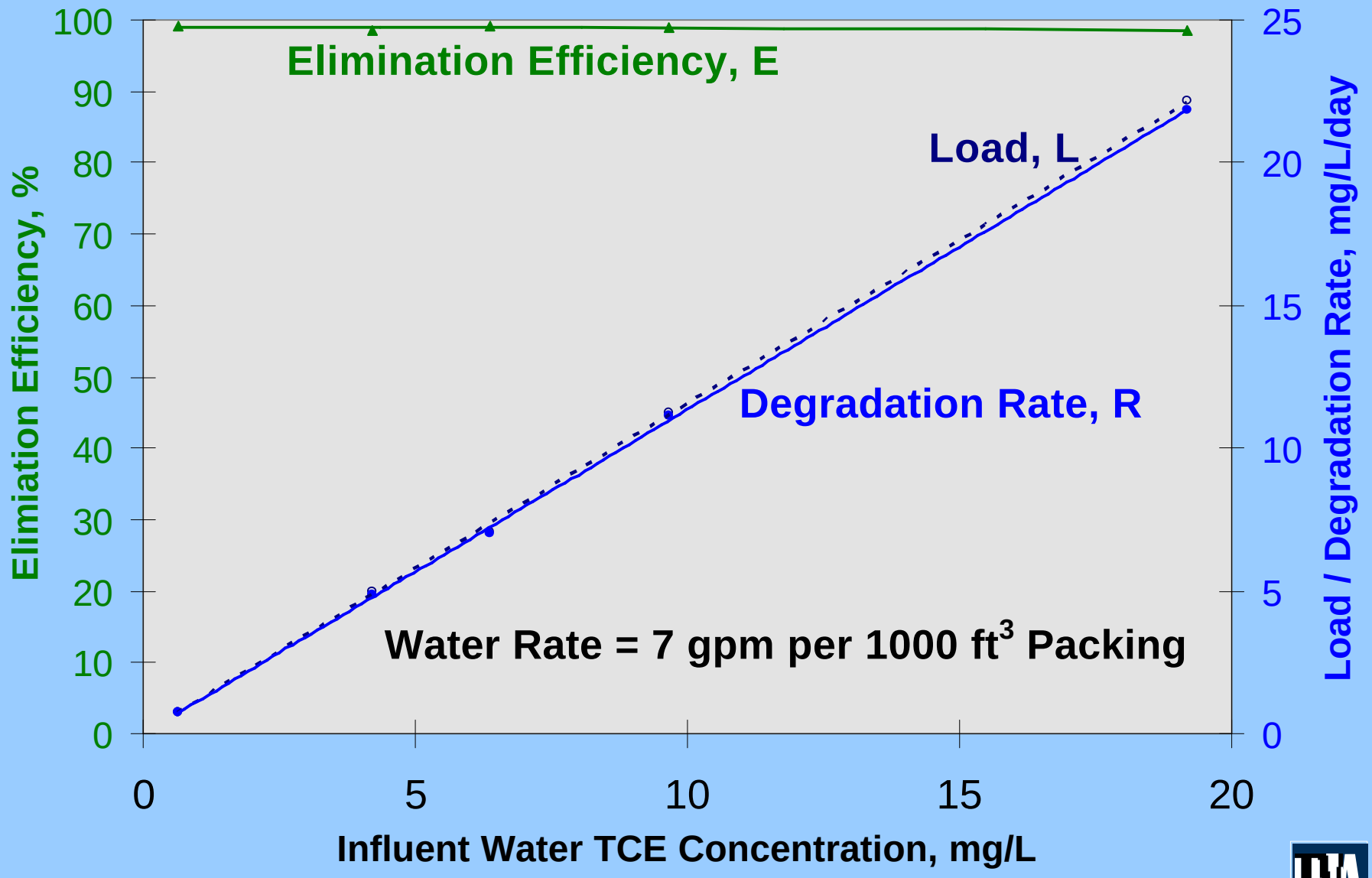
Rapid Decrease in Size/Costs Required



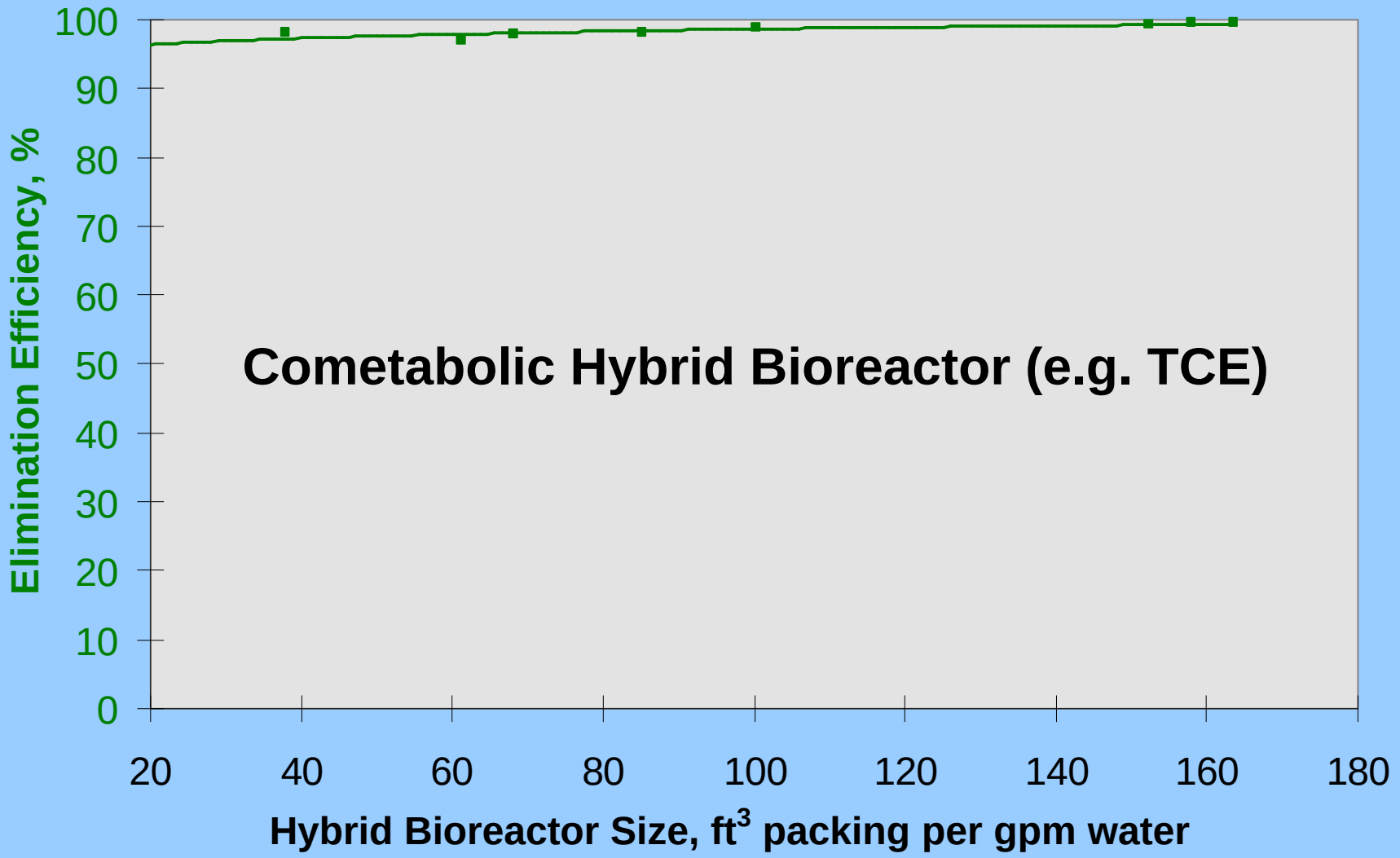
Improvement Over ANAD Biofilter



Increasing Water Concentration



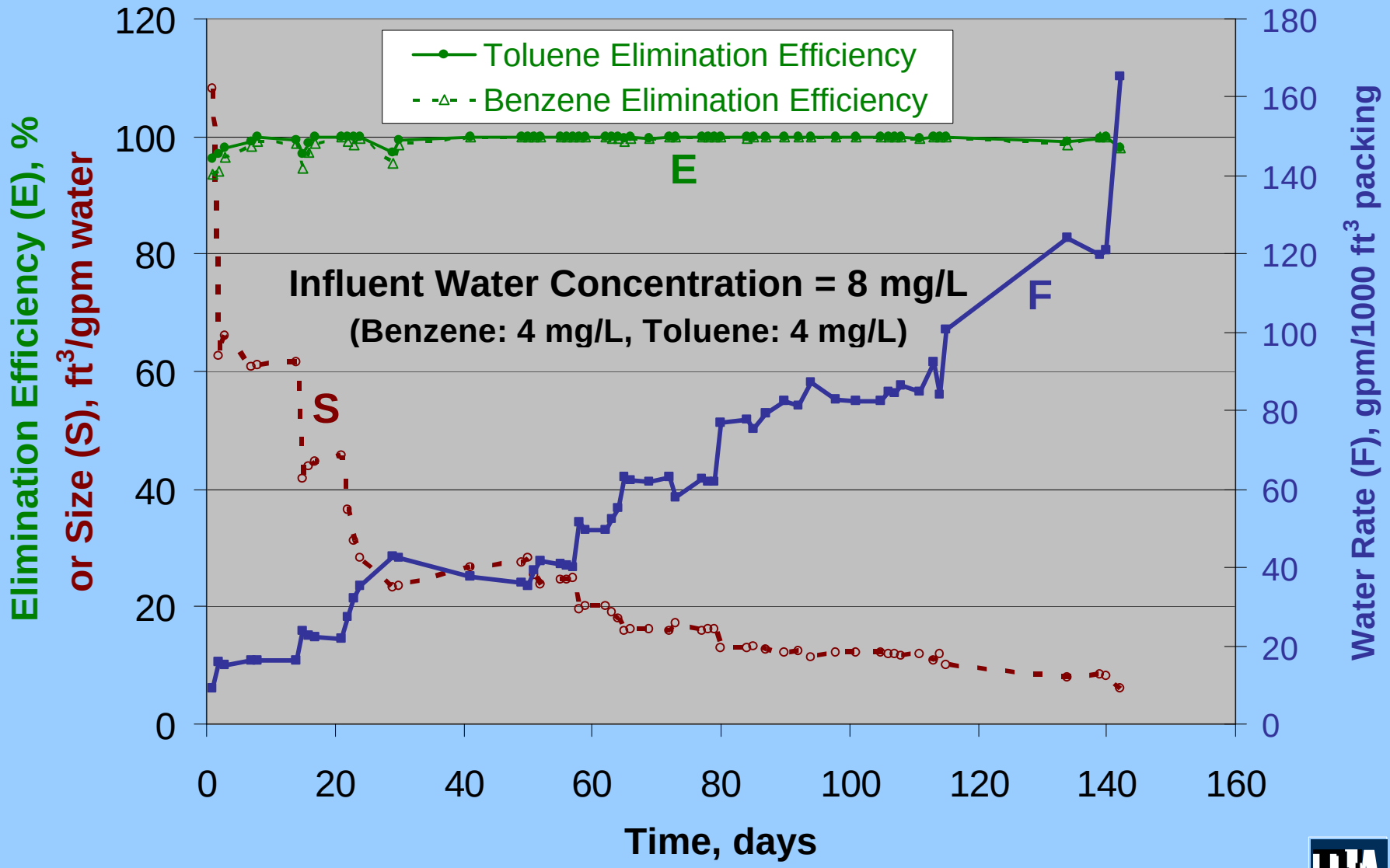
Decreasing Size and Costs



Direct-Metabolic Bioreactors

- ☑Pollutants directly consumed (food)
- ☑BTEX, VOCs, fuel components
- ☑Some chlorinated compounds
- ☑Ammonia, hydrogen sulfide, odors
- ☑High efficiency, low cost

Rapid Performance Improvement



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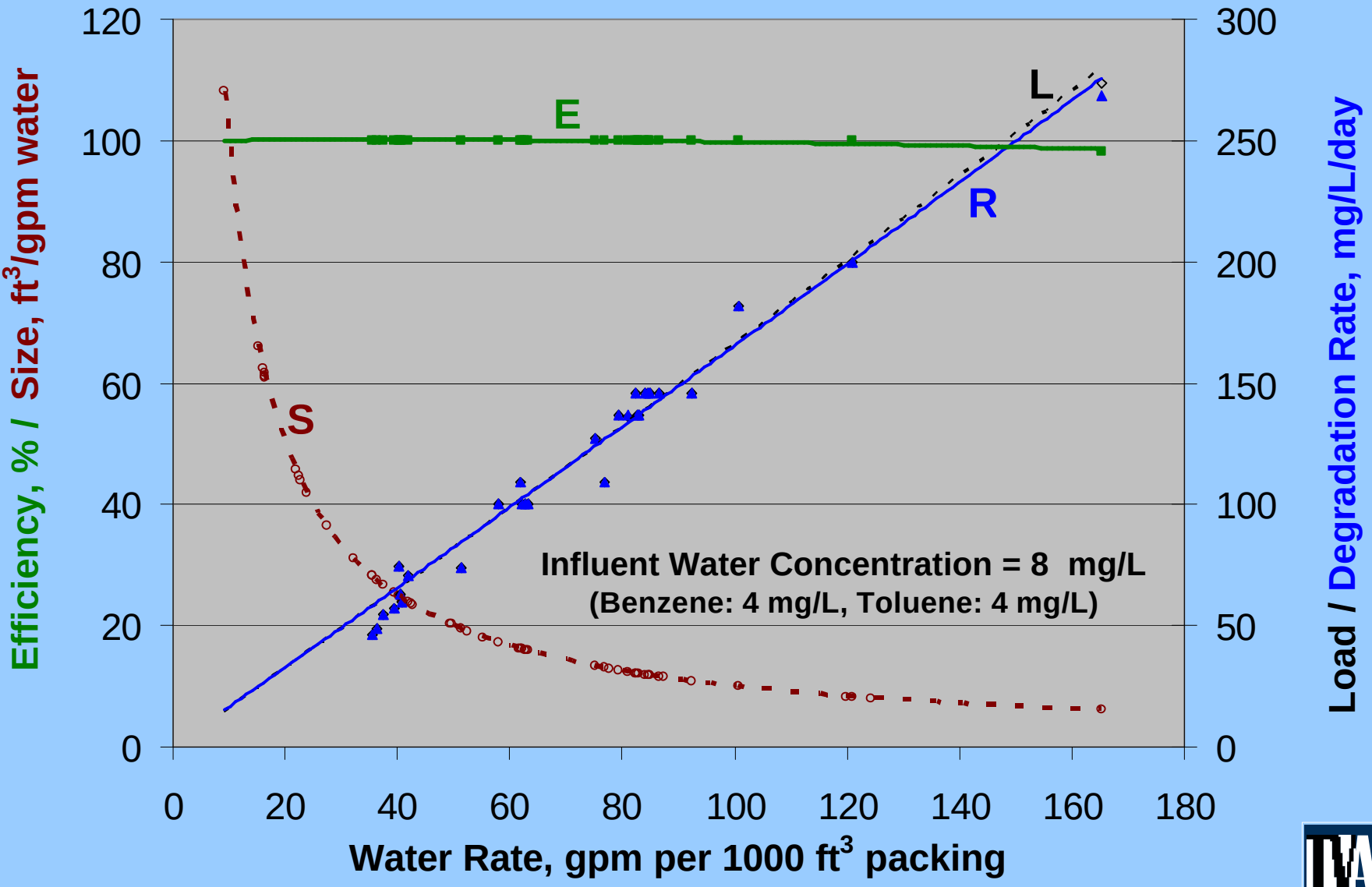
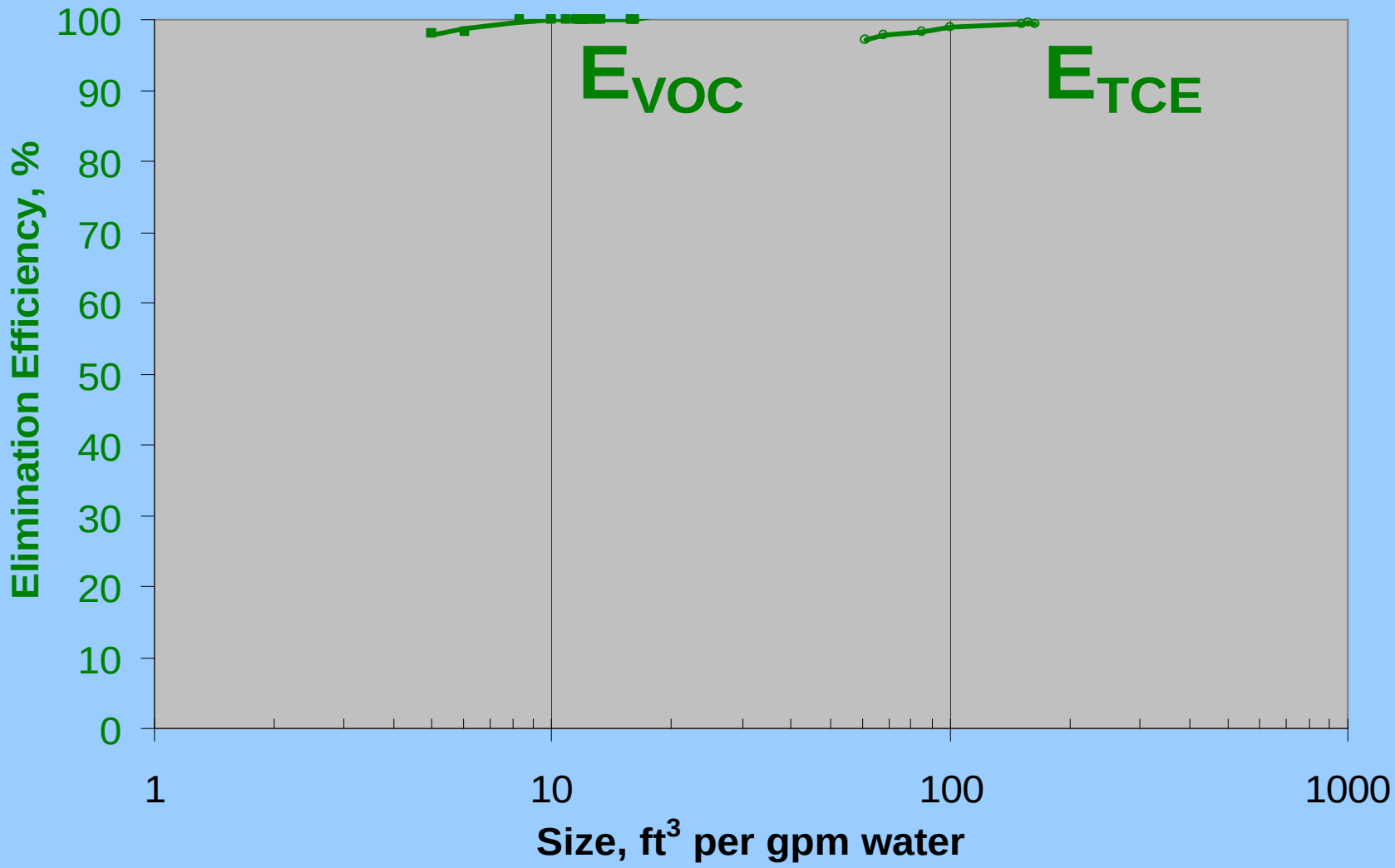


Comparing Size and Costs



Advantages

- **Dramatic cost savings**
- **Single-step water/air cleanup**
- **Remove *and* destroy toxics**
- **No contaminated off-gases**
- **No secondary waste streams**
- **Variety of contaminants**
- **Auto operation, minimal labor**

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