Odor Control Technology Overview

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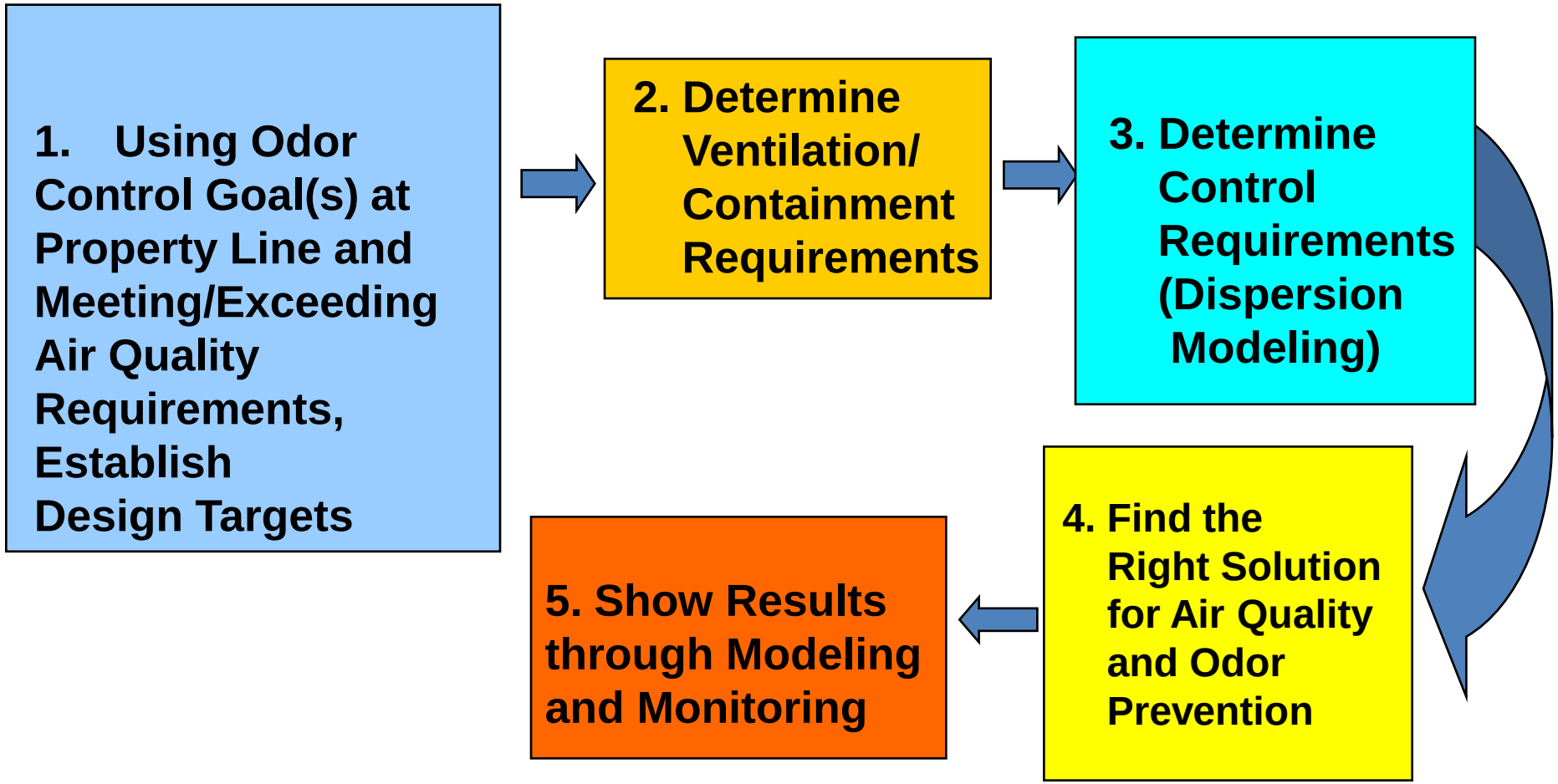
Presentation Outline

- General Approach to Odor Control
  - Odor Containment
  - Ventilation
  - Odor Collection
- Vapor Phase Treatment Technologies
  - Packed Tower Chemical Scrubbers
  - Carbon Adsorption
  - Biofilters
  - Biotowers
  - Activated Sludge Diffusion
  - Thermal Treatment
  - Other technologies
  - Multi-Stage Treatment
  - Dispersion
- Technology Selection
- Q and A

How We Select Odor and Air Emissions Prevention Systems

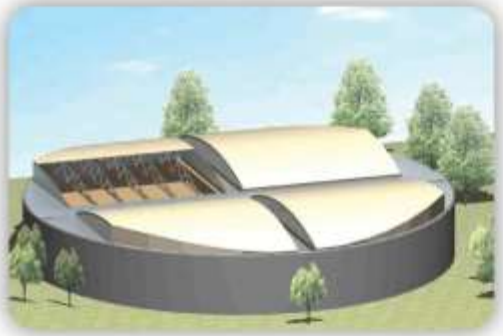


Odor Containment

- Covers
  - Structural Considerations
  - Material Considerations
  - Features
    - Walkable?
    - Accessibility?
    - Hatches?
  - Leakage Rates
    - Acceptance Criteria: Infiltration ≤ 0.5 cfm @ - 0.2” WC

Aluminum Closed Box Beam Cover

Low Profile Aluminum Geodesic Dome



Retractable Fabric Cover

Aluminum Open Web Truss Cover

Aluminum Domed Walk-In Cover

Flat Fiberglass Reinforced Plastic Cover

Odor Containment

- Enclosures/Hoods/Curtains
  - Accessibility
  - Capture Efficiency
- Launder Covers
  - Lower Cost
  - Better Accessibility
  - Lower Air Flow
  - Quiescent Zone Still Exposed

Ventilation

- Criteria:
  - Safety and Operator Comfort
    - Minimum 12 ACH @ Occupied Areas
    - Truck Loadout Areas: 12 – 20 ACH
  - NFPA 820 “Standard for Fire Protection in Wastewater Treatment and Collection Facilities”
  - Minimum -0.1-inches WC
  - 50 fpm Face Velocity across Open Hatches
  - Scavenging to Reduce Corrosion
- Fans:
  - FRP, SST

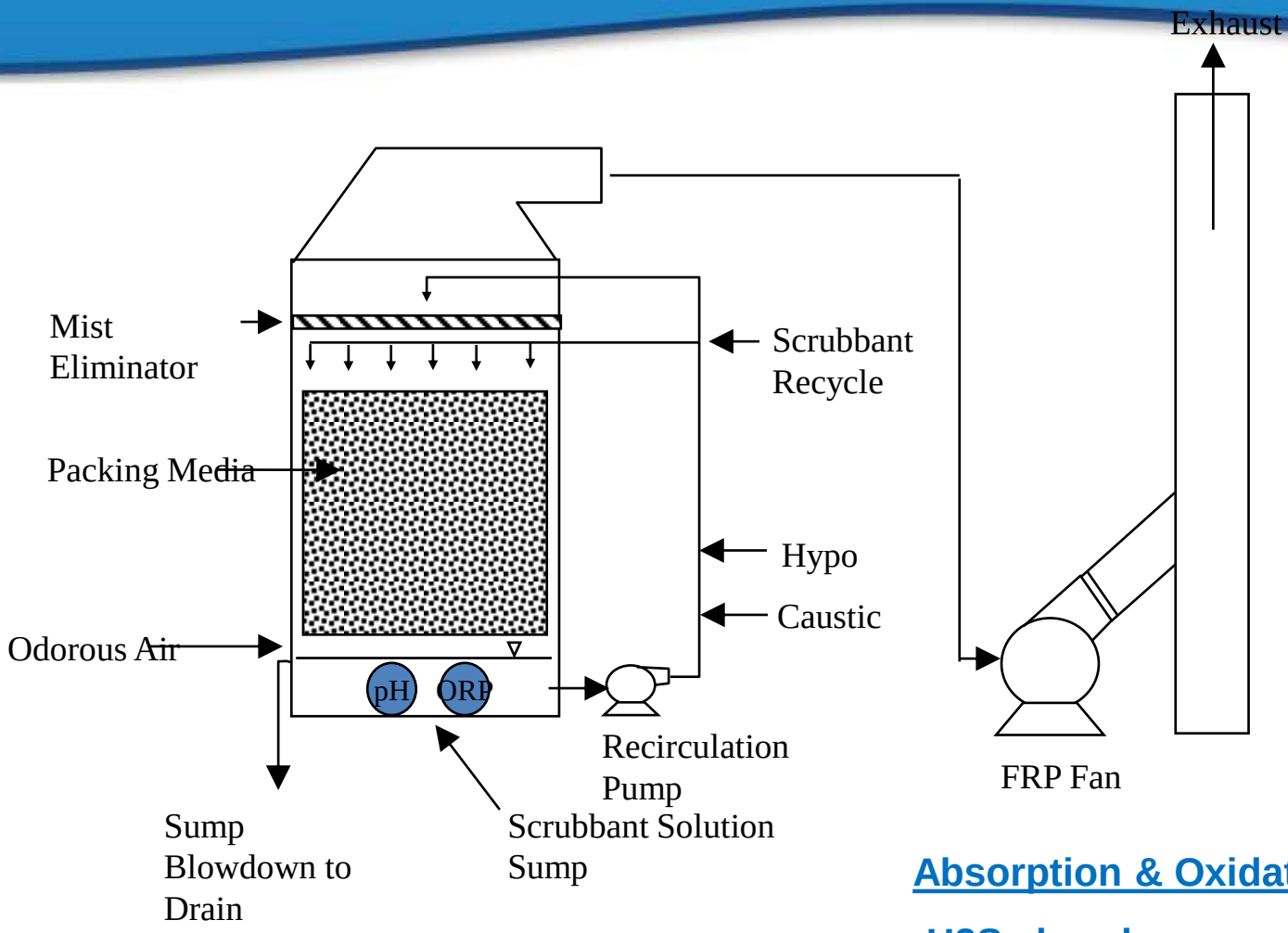
Odor Collection

- Collect @ Source
  - Balance System
- Duct Material Types:
  - FRP
  - Type 316 SST
  - Type 304 SST Lined
  - Aluminum
  - HDPE

Vapor Phase Treatment Technologies

- Chemical Wet Scrubbers
- Activated Carbon
- Biotechnologies
  - –Biofilters
  - –Biotowers
- Thermal Treatment
- Activated Sludge Diffusion
- Multi-Stage Treatment
- Others?
  - – Masking Agents/Counteractants
  - – Ionization

Packed Tower Scrubbers



Mist Scrubbers: Older technology, slow adjustment to inlet peak loadings

Absorption & Oxidation

-H2S absorbs more readily @ high pH
-NH3 absorbs more readily @ lower pH
-Oxidation improves mass transfer

Packed Tower Scrubbers

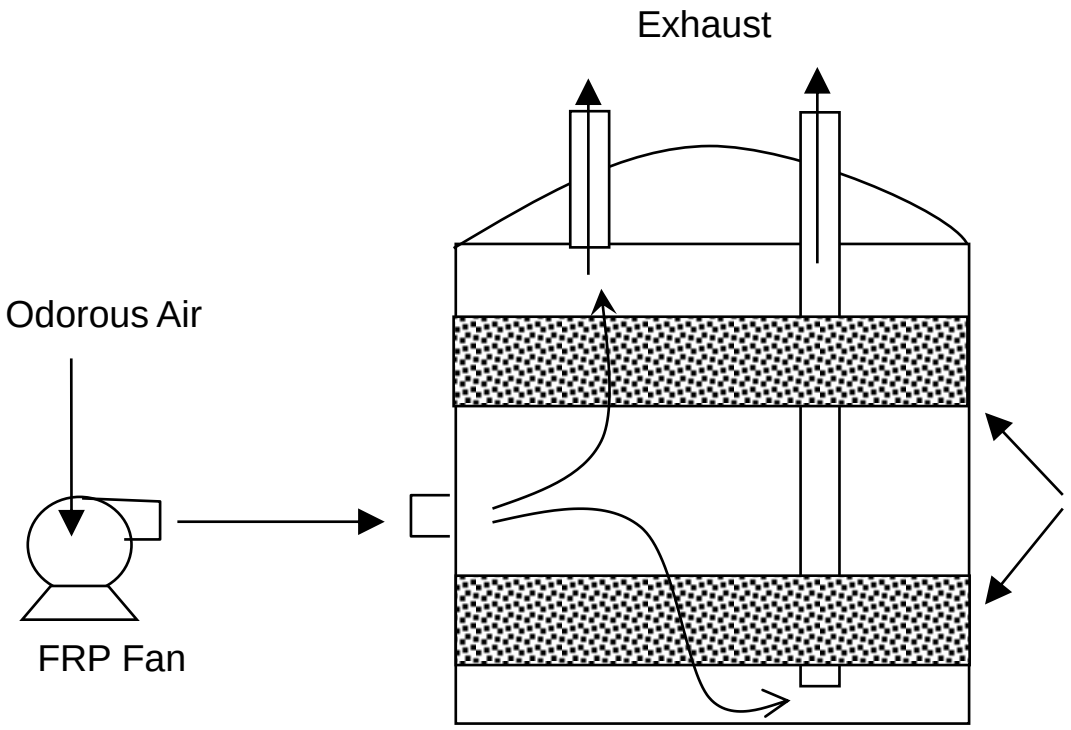
- **Advantages**
  - Effective removal for high H_2S concentrations
  - Can be effective on ammonia (acid chemistry)
  - Lower space requirements than biofilters or biotowers (but needs space for chemical storage)
  - Effective on varying odor load concentrations
  - Effective treatment on day one
- **Disadvantages**
  - Requires observation and periodic cleanings
  - Can be impacted by freezing conditions
  - Chemical handling (safety) and related costs
  - Limited effectiveness on organic based odors
  - Potential residual chlorine smell
  - Higher first costs due to chemical storage
  - Mechanically complex system

Packed Tower Scrubbers

- Suppliers & Photos
  - Evoqua Water Technologies
  - Daniel Company
  - ECS

Carbon Adsorption

- Physical adsorption of odor compounds
  - Physical Adsorption: Intermolecular forces of attraction between molecules (London dispersion forces)
- Activation of carbon creates large surface area (high temperatures)
- Systems must be designed for media replacement
- Limitations regarding targeted odor constituents
  - H_2S - good
  - Ammonia – bad
- Carbon types



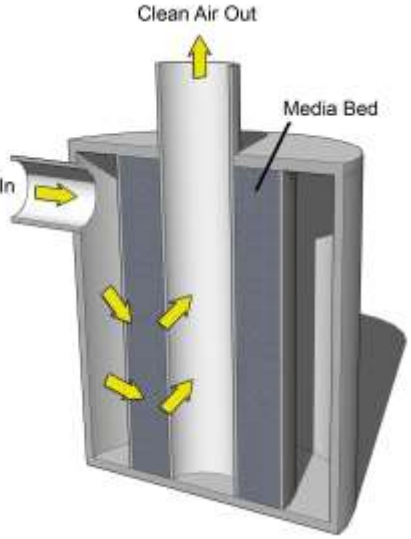
Typical Dual-Bed Carbon System Schematic

Carbon Adsorption

Carbon System Options

- Sweet Streets
- Skid Mounted
- Single Bed
- Dual Bed
- Radial Flow
- Quad-Bed

- Suppliers
  - Evoqua WT
  - ECS
  - PureAir
  - Daniel Company
  - Spundstrand



Carbon Adsorption

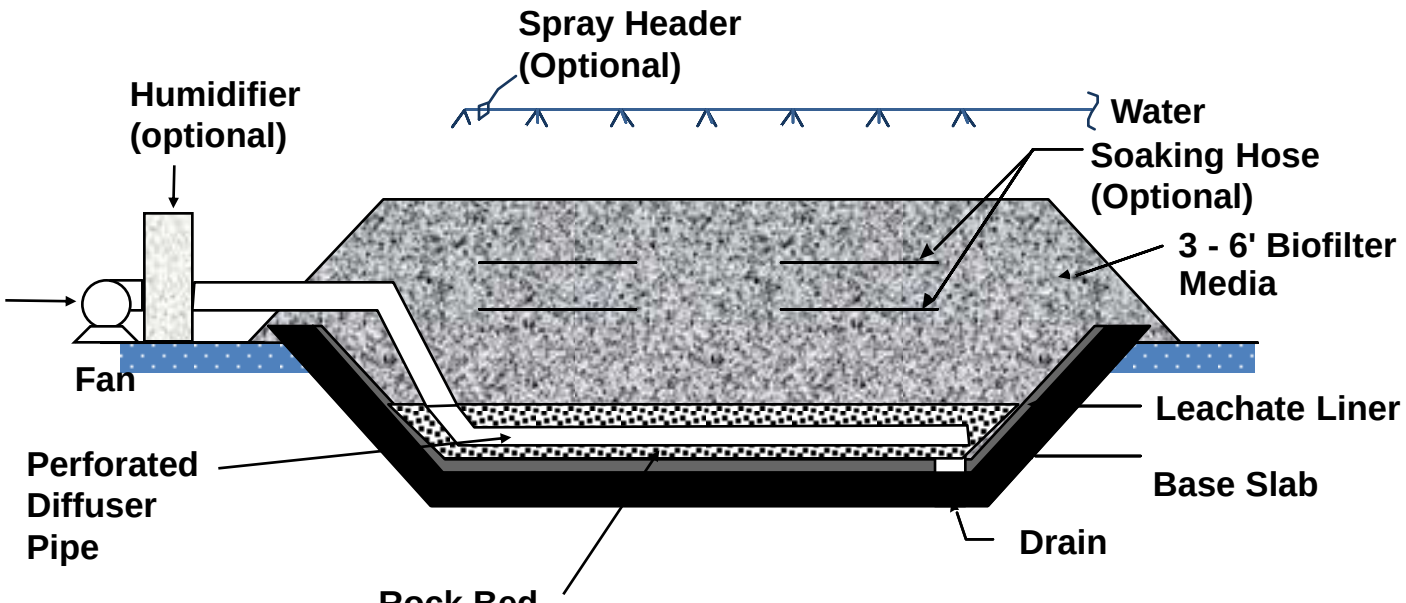
- **Advantages**
  - Simple to operate, small (compared to biofilters), low cost
  - High rate effective for medium H_2S loadings (≤ 20 ppm H_2S)
  - Virgin activated can remove a wide range of organic compounds
  - Virgin activated good for polishing
  - Effective treatment on day one

- **Disadvantages**
  - Quickly used in high H_2S environments
  - Replacement can be expensive and labor intensive
  - Can be moisture sensitive
  - Can cake due to grease
  - Safety issues with media change-out
  - Pressure drop through media high
  - Media disposal issues
  - High water usage for water washable carbon

Biofilters

General types of biofilters:

- Open vessel systems
- Closed-vessel systems
- Packaged Systems



TYPICAL OPEN VESSEL SYSTEM

Biofilters

Media Types:

- Organic (natural)
  - –soils (topsoil or permeable sandy loams)
  - –bark and wood chips (bulking agents)
  - –compost (yard waste, sludge)
  - –sea shells
  - –peat
  - –rice hulls
- Synthetic
  - –perlite
  - –plastics
  - –ceramics
  - –expanded clay
  - –pumice or lava rock
  - –Manufactured (engineered long life)

BARK/WOODCHIPS MEDIA

COATED MEDIA

LAVA ROCK MEDIA

Biofilters

- Suppliers and Photos:
  - –Bohn (soil)
  - –Biorem (Coated)
  - –Enduro (Clay)
  - –Bord Na Mona (monafil, seashell)
  - –Global Environmental Solutions (Lava)

Biofilters

Advantages

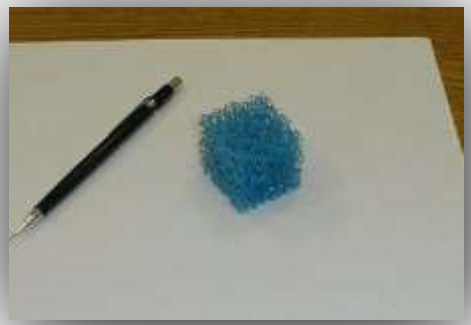
- Relatively Simple O&M
- No chemicals
- Relatively effective for compounds other than H_2S
- Package units available for smaller airflows
- Multiple vendors available
- Long life media systems are available

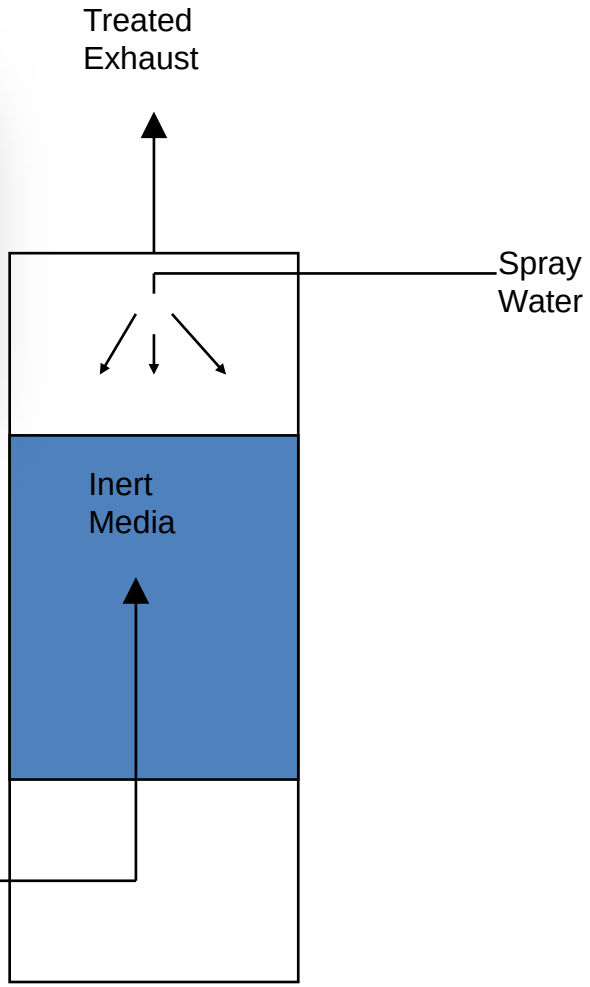
Disadvantages

- Space intensive
- Tend to have a residual *low-level* musty smell
  - media dependent
- Media Replacements
  - Long life 10-20 year media available but limited vendors
- Upper limit on H_2S concentrations they can handle
  - Sustained levels over 50 ppm problematic
- Must remain moist
- Requires acclimation and need to stay online once acclimated

Biotowers

- Similar look to packed tower chemical scrubbers
- Media Types
  - lava rock
  - inert (“plastic”) media
  - inert foam media
  - expanded clay
- Top spray
  - constant or intermittent
- Requires acclimation and seeding
- Often use plant water as nutrient source
  - but may require nutrient addition
- Typical 10 to 30 seconds EBRT





Biotower Vendors & Photos

Biorem

Enduro

Daniel Company

BioAir

GES

Evoqua

Others: Azzuro, ECS

Biotowers

Advantages

- Fully inert long life media (guaranteed 10 years)
- Shorter empty bed contact times than Biofilters
  - 10 to 20 seconds typical
  - Smaller footprint than biofilters
- Can handle *very high* H_2S loads
- Elevated stack dispersion
- Multiple vendors available
- No chemical handling/use
- Multi-stage beds can target organic compounds

Disadvantages

- Strong H_2S track record, but can be less effective on organic-based odor compounds
- More complex than biofilters
- Pressure drop higher than organic biofilters
- Leachate is acidic
- Can use large amounts of water
- Nutrient feed
- **Acclimation required and must stay online**

Activated Sludge Diffusion

- **Description**
  - Collect odorous air, direct to suction side of process/aeration blowers
  - Diffuse into activated sludge basins via fine-bubble or coarse bubble diffusers
  - Odors removed via absorption and biological oxidation
- **Advantages**
  - Effective odor control for a wide range of compounds
  - Simple operation
  - Low first cost if diffused aeration already exists
  - No additional land use
- **Disadvantages**
  - Lower removal efficiencies w/coarse bubble (95%)
  - Blower corrosion (sulfuric acid)
  - Fine bubble diffusers can become plugged
  - Matching air flows can require complex controls

Thermal Treatment

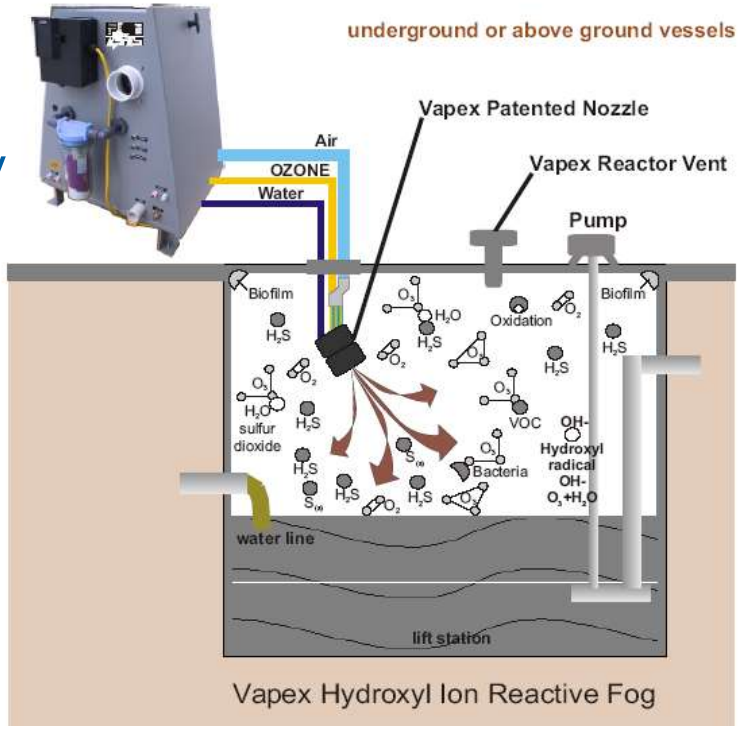
- **Description**
  - Destroys odors by converting them to fully oxidized compounds
    - Through combustion
  - Byproducts non-odorous or less odorous
- **Technology Examples**
  - Incinerators, Flares
  - Recuperative Thermal Oxidizers/Regenerative Thermal Oxidizers (RTO's)
  - Combustion air source for digester gas engines or boilers
- **Advantages**
  - Effective odor control for a wide range of compounds
  - Effective VOC control
- **Disadvantages**
  - Potential for SOx or NOx emissions
  - Equipment complexity
  - Costs !!!!!

Other Technologies

- **Ionization**

Hydroxyl Ion Fog

- Description
  - Simulates troposphere droplet chemistry to oxidize H_2S
  - Ion tubes generate electromagnetic field which ionizes O2
- Advantages
  - Simple, no chemical deliveries
- Disadvantages
  - Impacts of ozone on materials
  - Personnel exposure?
  - Effectiveness is not proven and would need to be field pilot tested



Vapex Hydroxyl Ion Reactive Fog

Other Technologies

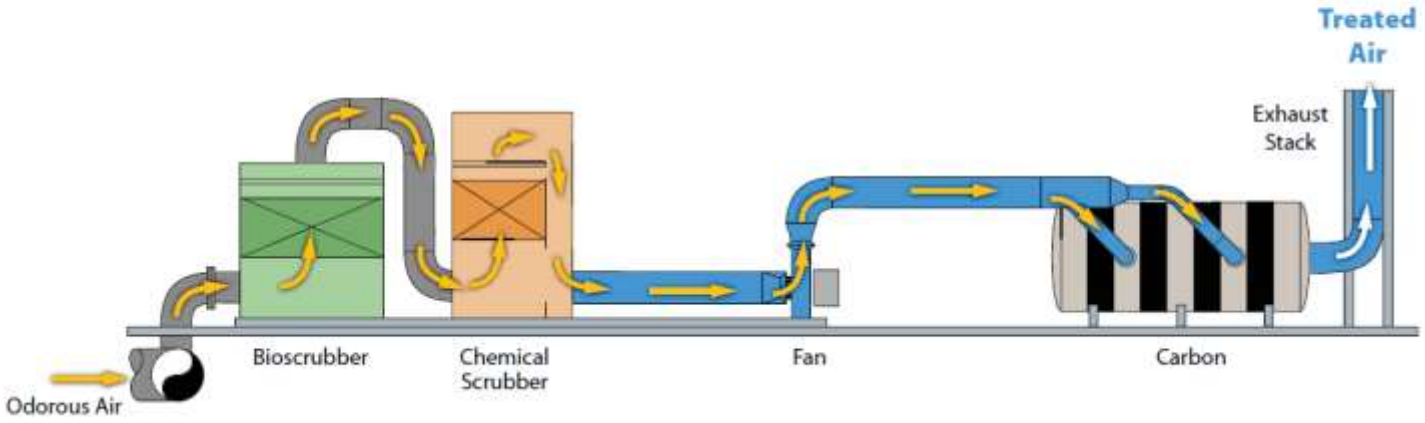
Counteractants

- Two categories
  - masking agents (perfumes)
  - reactants
- Chemistries are not well defined
- Can be direct surface application
- More often spray atomized around or above the odor source
- Interference reactions
  - Removes “perception of odor”

Multi-Stage Treatment

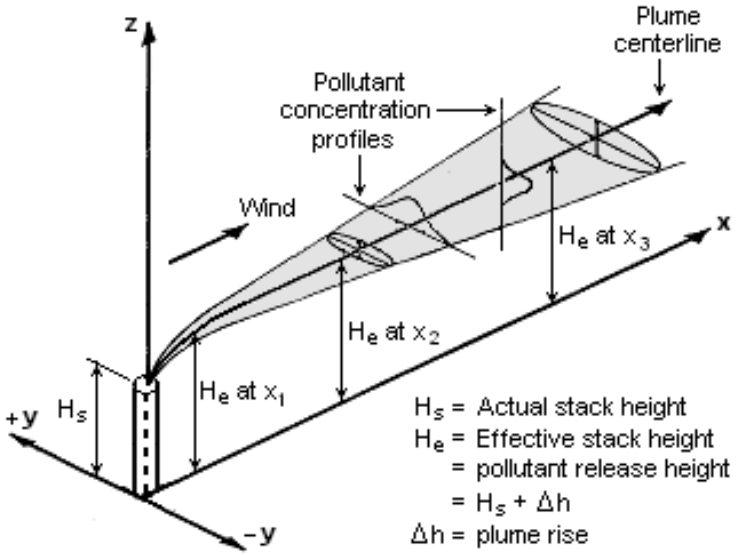
- **2-stage**
  - Multi-Stage Chemical Scrubbers
  - Chemical Scrubber + Carbon
  - Chemical Scrubber + Biofilter
  - Biotower + Chemical Scrubber
  - Biotower + Biofilter
  - Biotower + Carbon
- **3-stage**
  - Biotower + Chemical Scrubber + Carbon
  - Biotower + Biofilter + Carbon

Brightwater's Odor Prevention System



Dispersion

- **Dilution of odors as they disperse through air**
  - Weather
  - Buildings (downwash effects)
  - Topography
  - Stack exit velocity
  - Stack height
  - Temperature of air stream
- **Dispersion Modeling**
- **Point source vs. area source**



Visualization of a buoyant Gaussian air pollutant dispersion plume

Gas Phase Treatment Technologies Selection

Initial Screening

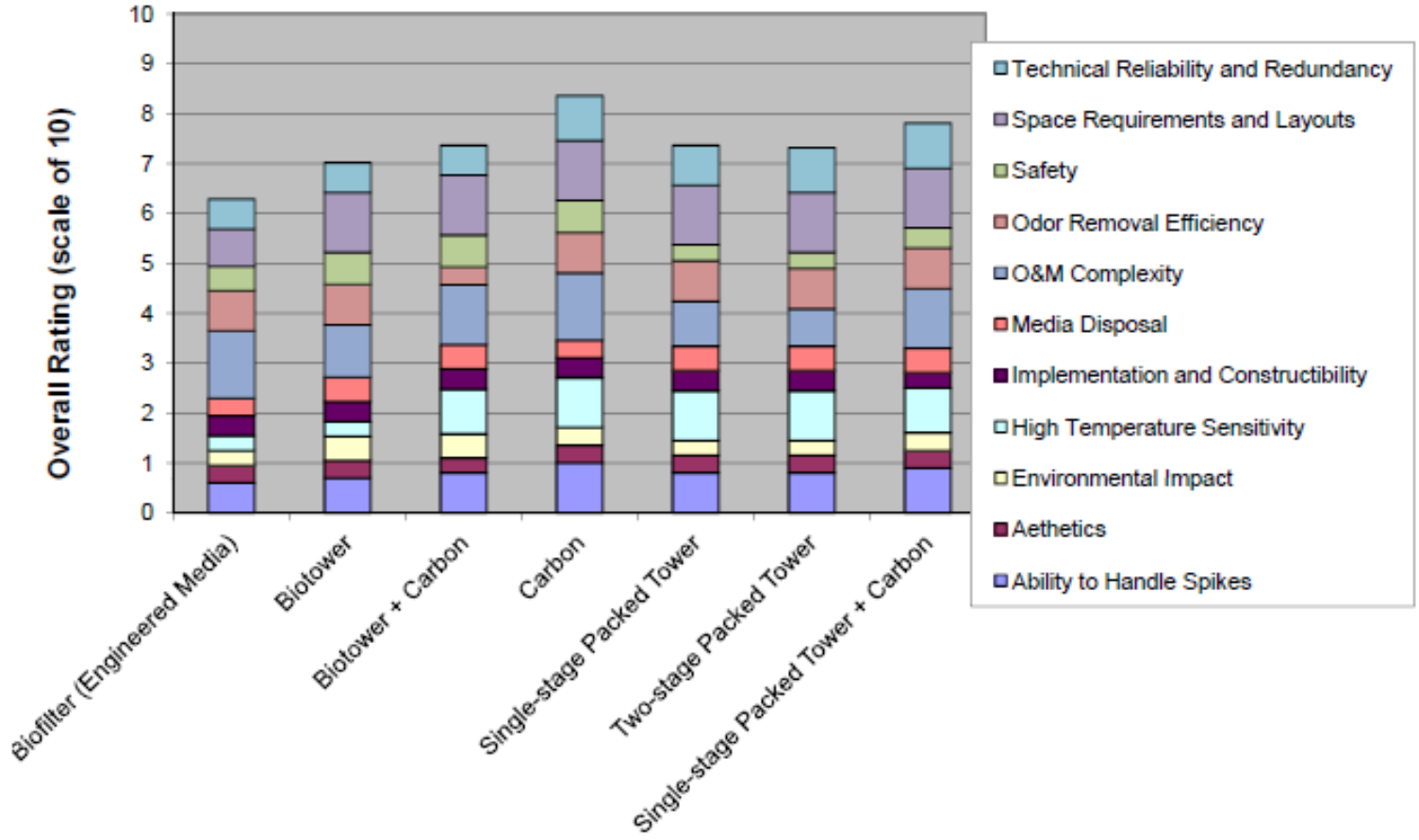
- ~~Thermal Treatment~~
- Wet Scrubbers
- Activated Carbon
- Biotechnologies
  - –Biofilters
  - –Biotowers
- Ozone and Ionization
- ~~Others?~~
  - – Combination systems





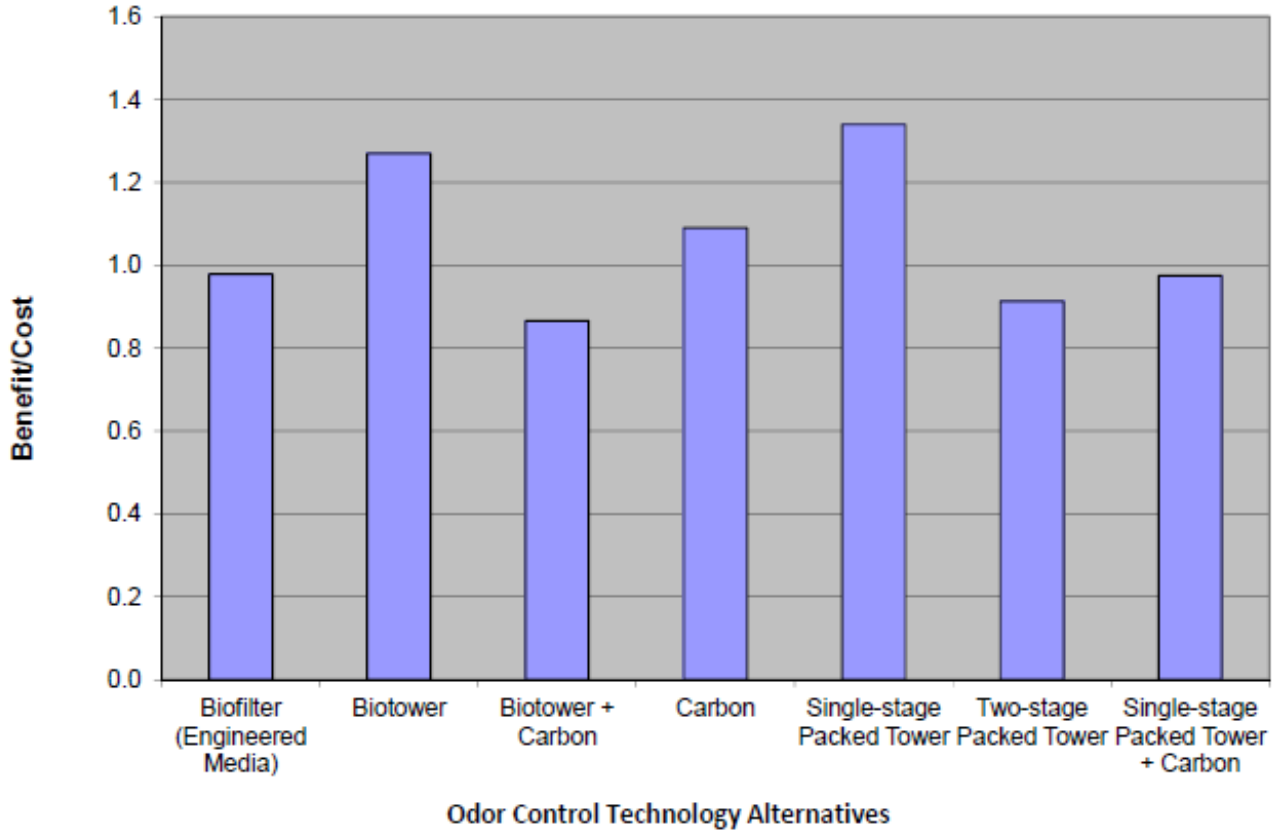

Gas Phase Treatment Technologies Selection

- Qualitative Analysis



Gas Phase Treatment Technologies Selection

- Qualitative and Cost Benefit Analysis



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Questions?