Odor Control Technology Overview

Presenter: Ken Galardi, PE
Senior Engineer – Odor Control
CH2M HILL, Corvallis, OR
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

1. Using Odor Control Goal(s) at Property Line and Meeting/Exceeding Air Quality Requirements, Establish Design Targets

2. Determine Ventilation/Containment Requirements

3. Determine Control Requirements (Dispersion Modeling)

4. Find the Right Solution for Air Quality and Odor Prevention

5. Show Results through Modeling and Monitoring
Odor Containment

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

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

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

#### Advantages
- Effective removal for high $\text{H}_2\text{S}$ 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
  - $\text{H}_2\text{S}$ - 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 $\text{H}_2\text{S}$ loadings ($\leq 20$ ppm $\text{H}_2\text{S}$)
  - 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 $\text{H}_2\text{S}$ 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
General types of biofilters:
- Open vessel systems
- Closed-vessel systems
- Packaged Systems
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)
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 H₂S
- Package units available for smaller airflow
- 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 H₂S 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
- GES
- BioAir
- Others: Azzuro, ECS
- Evoqua
**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* \( \text{H}_2\text{S} \) loads
- Elevated stack dispersion
- Multiple vendors available
- No chemical handling/use
- Multi-stage beds can target organic compounds

**Disadvantages**
- Strong \( \text{H}_2\text{S} \) 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 $\text{H}_2\text{S}$
     - Ion tubes generate electromagnetic field which ionizes $\text{O}_2$

   - **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
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
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

![Graph showing benefit to cost ratio for different odor control technology alternatives.](Image)
Questions?

Ken Galardi, P.E.
Ken.galardi@ch2m.com