



Mushroom Composting Odor Control Using Ozone

Presenter – Allan Finney

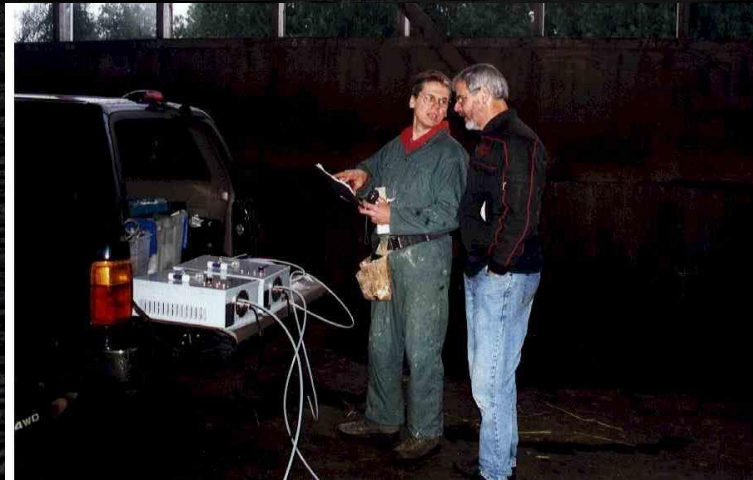
Greenwood Mushroom Farms, Ont.



- One of the largest mushroom producers in Canada
- In operation since the 1960s
- Windmill Farms is the sales, distribution and marketing arm of Greenwood
- Produces Organic, Pre-packaged, Specialty and Bulk Mushrooms
- Lawsuits filed beginning in 1995 for nuisance odors

Compost Trial - UBC

- Environ had been conducting hog barn trials
- We were contacted by the BC Ministry of Agriculture
- Invited to conduct a trial at a BC composting facility
- Researcher in BC was Dr. Monty Bruce, UBC
- Trial Results (olfactometry) Odor Panel



UBC Olfactometry Results

- On-site measurements amines reduced 21% to 59%
- Raw samples required dilution rates of 1701-3043
(typical of odorous samples)
- Treated samples required dilution rates of 209-264
(typical of non-odorous samples)
- Faint ozone smell reported in non-odorous samples

Greenwood History

- Farm operated in the 1960's and expanded in 1994
- Generated complaints since opening of the expansion (Ashburn, Ont. (Whitby))
- Toronto was growing around the farm – urban sprawl
- Condo developments, acreages developed
- Initial group of complainants filed a lawsuit in 1995
- Eventually went to the Supreme Court of Canada
- You don't have an odor problem until you have a legal problem

Greenwood Lawsuit - 1995

- In 1995 a group of residents took Greenwood to court
- Claimed damages for mental distress, health problems, interference with the enjoyment of their properties and a decrease in property values.
- Damages awarded but no injunction against operations
- Greenwood appealed the results
- Ontario Court of Appeal upheld decision (not unanimous)
- Opened the way for Supreme Court Appeal

Greenwood Lawsuit – to 2003

- Greenwood appeal based on Farm Practices Protection Act and the Farming and Food Production Protection Act (amended in 1998)
- In 2000 another group of residents applied to the NFPPB (Normal Farm Practices Protection Board)
- Subsequently 150 plaintiffs filed a \$10 Million lawsuit
- In 2003 a ruling from NFPPB allowed time for Envron's system to be installed

Greenwood Lawsuits – Final Result

- Ruling by Ontario Superior Court - action dismissed without costs.
- This was a result of a motion made requesting dismissal by the plaintiffs
- Neighboring property owners agreed that the introduction of ozone in Phase 1 composting had alleviated their concerns.
- One of the highest profile odor cases in Ontario

Parties Involved

- Ontario Government - Legislature
- Ontario Government (Normal Farm Practices Legislation)
- Canadian Mushroom Growers Association
- Ontario Agricultural Commodity Council
- Agricultural Adaptation Council
- AirChem Consulting and Research Inc. (final report)
- Environ Environmental Ltd. – odor control system

Greenwood Composting Site 2003

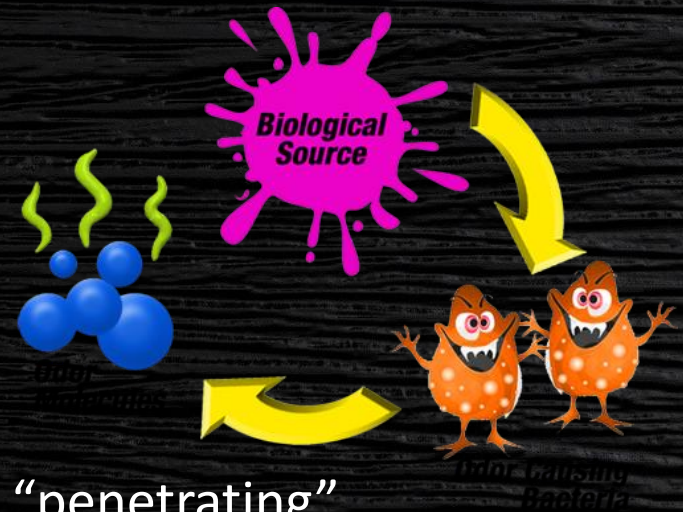


Greenwood Ozone System



Odorous Compounds - Composting

- Reduced organic sulfur compounds (mercaptans, sulfides)
- Hydrogen Sulfide (H₂S)
- Amines and ammonia
- Volatile Fatty Acids
- Alcohols
- Ketones
- Combinations of compounds – truly “penetrating”
- Pathogens/Bacteria travel with the odors
- Legionnaires disease linked to poorly maintained scrubber

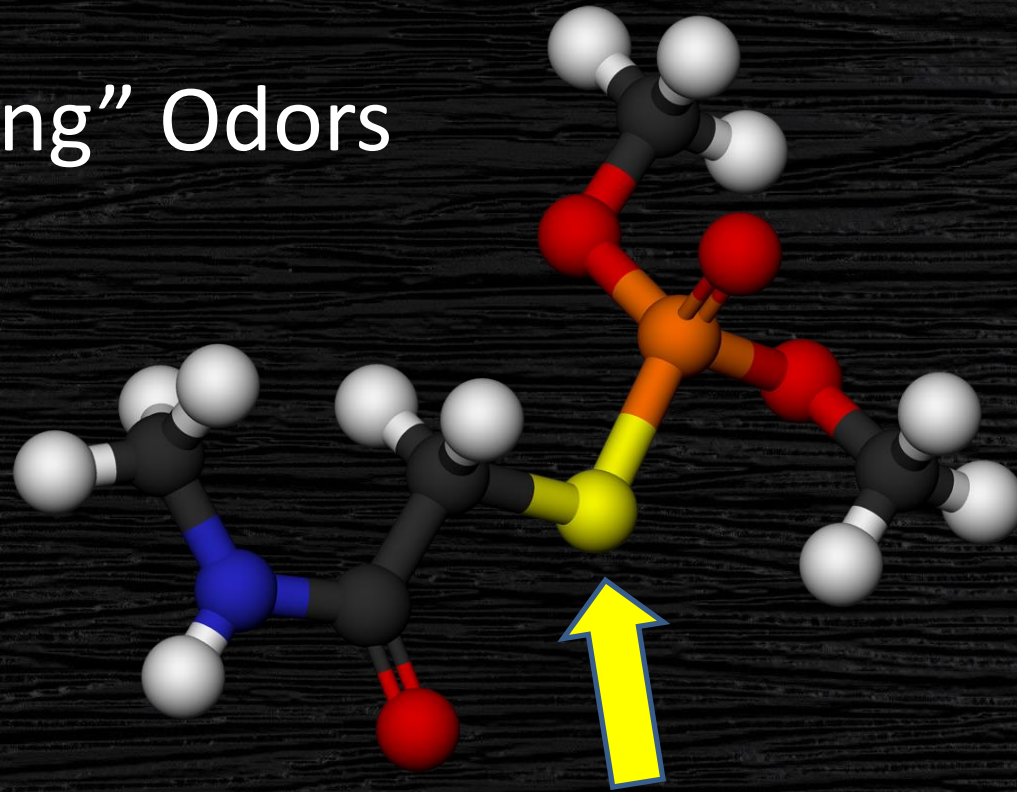


Ozone Reaction Kinetics

- Ozone is a strong oxidizer
- Reduces compounds to base components
- Penetrating odors are “long-chain” molecules (combined)
- Weak energetic links in long chains (highly reactive)
- Penetrating odors are the first to be oxidized (instant ozone demand)
- Odors are highly subjective

Reactions – Combined Compounds

“Penetrating” Odors



Weak energetic links
(highly reactive)

End Product Breakdowns - Ozone

Compound	Product
Methane	Carbon Dioxide and H ₂ O
Aromatic Compounds	CO ₂ , Water, O ₂
Sulphur Compounds (H ₂ S)	CO ₂ , H ₂ O, S Trioxides, O ₂
Formic Acid	CO ₂ , H ₂ O
Smoke	CO ₂ , H ₂ O
Trichloroethylene	CO ₂ , H ₂ O, HCL
Aliphatic Compounds	CO ₂ , H ₂ O, O ₂
Formic Acid	CO ₂ , H ₂ O
Ammonia	Nitrogen, H ₂ O

Intermediary Reactions

- Consulting chemist using chemistry simulation software
- We were looking for breakdown of odorous compounds
- Trying to find out how Ozone breaks down odors
- 1,500 intermediary reactions
- Eventually he just turned off the simulation



Enclosed Ozone Systems Mimic Nature

- A lightning strike – 100 million to billions of volts
- Corresponding number of watts – 100 million to billions
- A huge amount of ozone is produced naturally
- Typically in a very saturated environment (rainfall)
- Ozone combining with rain also produces Hydrogen Peroxide
- Considered an AOP (Advanced Oxidative Process)

Lessons Learned at Greenwood

- Greg Duns at AirChem had some recommendations (study author)
- Two values that we can manipulate in an Ozone system
 - Amount of ozone
 - Oxidation reaction times
- The longer the reaction times, the more thorough breakdown (higher efficiency in odor control)
- The more ozone that is used provides more complete oxidation

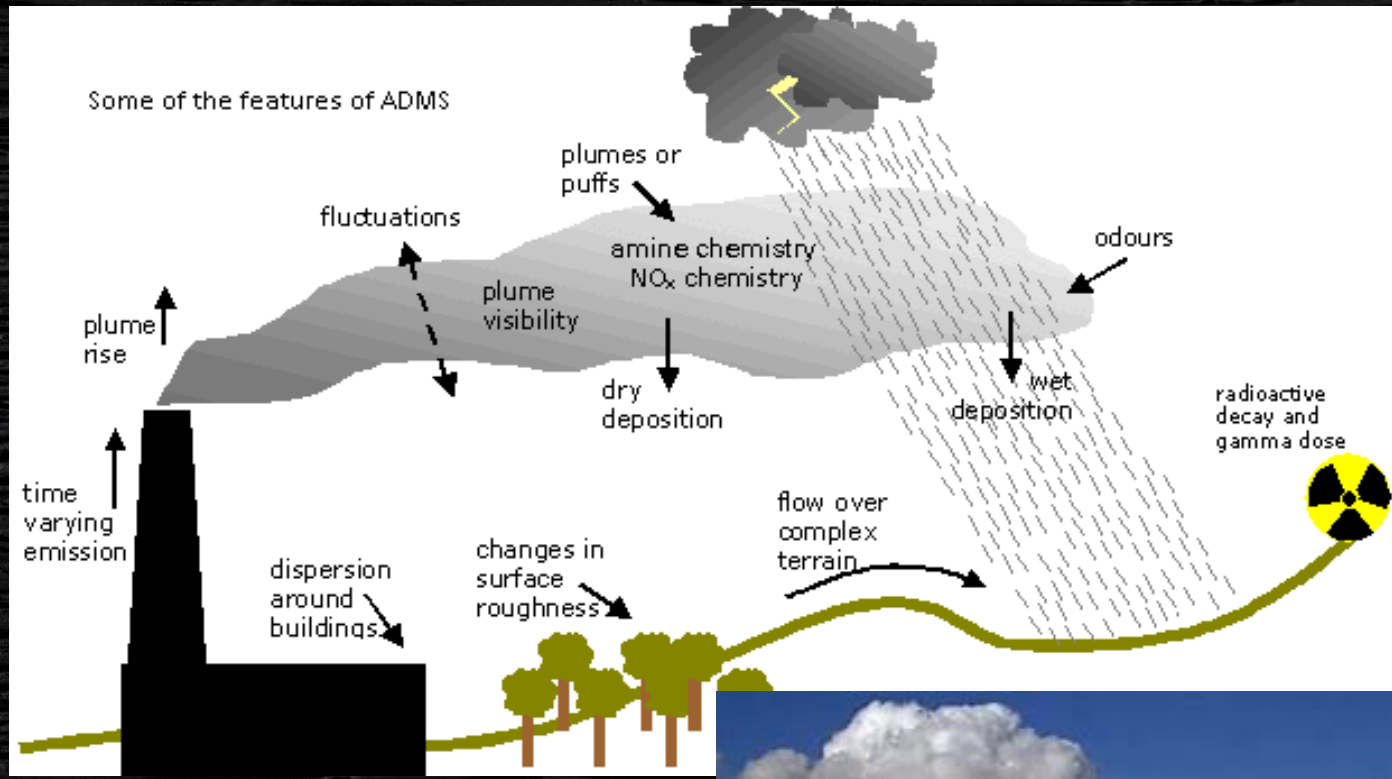
Conclusions - Greenwood

- Ozone effective at controlling composting odors
- Planning an odor control strategy is Best Management Practice
- In real costs adding an odor control system from day one is prudent – proactive vs. reactive approach
- Brent Taylor (owner, Greenwood) said he spent 10 times the amount on lawyers than the system cost
- Know some good lawyers

Ozone vs Competing Technologies

- Ozone odor control systems based on strong Oxidizer
- Ozone is the fastest acting Oxidizer that is commercially available (highly reactive)
- Highly regarded sanitizer, disinfectant
- Biofilters are based on microbes that feed on compounds
- Requires maintaining correct environment (hot days)
- Scrubbers are based on acids and hypochlorite (chlorine)
- Regenerative Thermal Oxidizers use heat as an oxidant
- Can generate a burnt smell

EN13725 vs Odor Measurement/Ozone



Best Management Practices - Ozone

- System design – ozone demand test (large scale)
- Contacting/Retention system design
- Ozone Generators (low maintenance)
- Ozone system redundancy (critical applications)
- Ozone Generator clean room (electronics)
- System safety – ambient ozone monitor (controls system integration)

Ozone vs. “Entrenched” Technologies

- City planners, designers rely on Engineers
- Engineers design what they’ve been taught
- Chemical Scrubbers, Biofilters entrenched technology
- Municipal, civic buyers are very conservative
- Commercial operations – market not as conservative
- Migration of ozone technology – large to small (large water treatment systems required large generators)

Modern Ozone Generating System

- Scalable – rack mounted generators
- Systems can be maintained by relatively unskilled labor
- Oxygen concentrators are self-contained
- Provides “off the shelf” solutions

