SECTION 3

ODOR CONTROL OVERVIEW

ODOR CONTROL OVERVIEW

INTRODUCTION TO ODOR ABATEMENT EQUIPMENT

Odors are a by-product of many product processes. Because odor control is usually an expense rather than a revenue item, it is often the last problem addressed by an odor producing operation and often only after pressure is brought to bear by the public or government agencies.

Ecosorb presents the user with an alternative to the more traditional approaches of odor control, which in some cases can actually pose danger to the worker and the environment while not always being totally effective. Ecosorb is a broad based product that is environmentally safe, user friendly, functionally very effective, and cost effective.

One needs to distinguish between odor control and emissions control; they do differ. With odor control we tend to deal with nuisance odors that are disturbing neighbors, employees, or both. These odors are gases and as such, should be measured with instrumentation. However, when treating malodorous gases with Ecosorb, it is highly likely the gases remain measurable. For a short time, one will not smell the malodor but can measure them with instrumentation. The nose is the best odor control instrument.

In emissions control, we may be looking at odor control as a byproduct. It usually involves removing emission gases from a process air stream before the air is released into the atmosphere. Emission control will always involve some form of monitoring and/or measuring instrumentation.

The measurement of gases during odor control can and does become an issue. One example involves a municipality specifying that a contractor doing sewer work cannot allow nuisance odors to leave a job site while in the same odor control specification they specify H_2S levels be below a certain parts per million level measured at the perimeter of the job site. It is one thing to say the job shall not become an odor nuisance to the neighbors; it is something else to specify a gas level.

The most popular abatement equipment available is[1]:

- Chemical Scrubbers
- Adsorption - Activated Carbon
- Ozone
- Biological Filters
- Thermal & Catalytic Converters
- Incinerators
- Odor Neutralization

All but the last system involves costly capital equipment, has costly recurring expenses, and is not 100% efficient in odor control. Although they are very effective against odors and emissions in specific spectrums, they are not broad spectrum in their ability to control malodors

[1] Copyrighted and reprinted with permission from OCI (Pty) Ltd., South Africa, 1999.

Chemical Scrubbers

Scrubbing systems work in tandem with acids, caustics, oxidizers and surfactants to aid in eliminating odors. The chemical scrubber system is considered a “controlled environment” in which odors are negated by introduction to a variety of highly reactive chemicals.

The mechanics of a scrubber can be monitored and carefully controlled. The discharge to the environment can be maintained at a necessary level, but careful design considerations must take into account the inherent exhaust gas. Many applications have a tendency to create a ”chlorination” effect, which produces chlorine gas from the chemical reaction. Some of the newer technology scrubbers use a nickel catalyst to eliminate chlorination and to speed up reaction time; but this places an additional cost on the unit.

It is often necessary to use construction materials such as stainless steel or special composite compounds to construct the scrubber vessel because of the reactive nature of the chemicals used in odor control applications. This adds to the overall capital cost.

Scrubbing systems are very popular since they are well-understood technology and there are standard “text book” designs. They are expensive to build and operate and must be designed for a specific application. Systems can range from a single vessel to a multi-vessel unit, with different chemicals in each vessel, and must be operated by trained production personnel.

Adsorption *(Adsorb is defined as “condense and hold onto the surface.”)*

Adsorption is a process by which organics are retained on the surface of granular solids. One suitable medium that achieves this is “activated carbon,” which is very porous and has a large surface to volume ration. Gas particles penetrate the pores of the adsorbent and are captured on the large surface area available for adsorption. Materials such as Activated Carbon, Zeolite and Silica Gel may be used as adsorbents.

It is important to understand that activated carbons are not all the same. Care must be taken to select the correct carbon grade for the proposed duty or application. Activated carbon is made from various materials and varies considerably in the “surface area to mass ratio” as well as in price. Below are several forms of activated carbon.

- Coconut shell – Micropored (1600 m^2/g) and used for small molecular weight species and low concentrations.
- Wood & Peat – Meso/macropored (1200 m^2/g) and suitable for large molecular weight species and high concentrations.
- Coal & Coke – Between wood and shell and is the lowest cost and most common.
- Activated carbon made from bone is used for specific applications.

Activated Carbon is the most common adsorbent for organics removal. Carbons are commonly used to remove sulfur bearing compounds, aldehydes, and ketones. They are one of the few processes recommended for removing toxic compounds such as pesticides, DME, and heavy metals such as lead and mercury. Charcoal is ineffective on compounds such as ammonia and urea. Activated charcoal is reversible in nature, which allows the odor to return if the activated charcoal is heated, even in ambient conditions.

Be aware of several important parameters when designing an adsorption system, especially where more than one organic is to be adsorbed. They are:

- The effect of “preferential adsorption,” which can dramatically change design parameters and lower overall unit efficiency.
- The generation of heat within the unit. These units are prone to internal fires.
- The actual contact or resident time is critical to the design.
- The spent media disposal costs must be considered, especially when dealing with saturated toxic compounds since these usually require total encapsulation, which is extremely expensive.

Activated carbons are suitable for impregnating with chemicals to control a specific odor. This process known as “chemisorption” is a combination of both a**d**sorption (capture and held at the surface by weak forces of inter-molecular attraction) and a**b**sorption (where the odor is chemically converted).

Ozone

Ozone is one of the most powerful oxidants known to man. Ozone is composed of three atoms of oxygen (O_3) bound together. Ozone is not stable and is very reactive with other elements since O_3 wants to become O_2. Ozone is described (Encyclopedia Britannica) as an irritating, pale blue gas that is explosive and toxic, even at low concentrations. It is used as a bleaching agent for organic compounds, as a strong germicide to sterilize drinking water, and to remove objectionable odors and flavors.

Ozone generators are available to the market but are not accepted by the majority of odor control equipment designers. They are effective for a narrow spectrum of odor control and do not cover the full spectrum of organic and inorganic odors.

Due to its toxicity, a well-designed ozone odor control system should consist of an ozone generator, an ozone meter, and an ozone destroyer, making the system very expensive. The unit design must produce a stable gas, and on larger systems this requires an oxygen supply, making medium to large systems very expensive to purchase and operate. Ozone is better suited to the treatment of process effluents, than to malodor treatment.

Biological Filters

It is well known that a range of microorganisms have the ability to oxidize odorous compounds and much work has been done over the past few years on this type of odor abatement equipment.

The biofilter consists of a large container packed with a suitable fill–usually consisting of bark, twigs, pine needles and such media that have been saturated with micro-organisms. The odorous air stream is passed through the fill and the pollutant is digested, yielding carbon dioxide, water and mineral salts.

The design needs to consider factors such as the removal of dust, grease and inorganic matter from the air stream prior to entering the unit. The supply airflow and temperature must be constant since surges can kill the bacteria, as can large concentrations of gases. The units are operated at 100% humidity to keep the fill saturated, allowing the bacteria to work.

A biofilter is a large unit, designed to treat the entire airflow. A small flow rate requires a unit the size of a large shipping container. Biofilters operate at about 95% efficiency and need to have the fill replaced every 3-6 months. Newer units can be modified to include a special fill material and a carefully selected bacteria strain to offer 98% efficiency. These units can last up to 3 years without changing the fill but are more expensive.

Biological Oxidation (Scrubber)

A typical bioscrubber is an advanced biofilter and consists of an adsorption column (vertical vessel) and one or more (usually several) bioreactor stages in which much of the biological oxidation takes place. The air to be treated must first be pretreated in a scrubber (or filter) to eliminate entrained dust and to bring it within the temperature range of 50-104°F (10-40°C), which is suitable for the microorganisms to start reacting.

The bioscrubber is designed to operate at a linear velocity of about 2.6 ft/sec (0.8 m/s), with a packing residence time of about 1.6 seconds, a liquor circulation rate of about 120-144 lbs/ft^2 (5-6 kg/m^2) and a liquor residence time in the reaction tank of about 50-60 minutes, This makes the plant quite large for relatively small flow rates.

The reaction tanks have to be aerated and supplied with the nutrient solution. The microbial mass primarily remains in the circulation liquor since the circulation rate is sufficiently fast to prevent build-up on the packing. However, build-up is still possible and need to be removed periodically. Some of the accumulating microbial mass also needs to be removed from the circulating liquor, usually by flotation.

Experience with biological scrubbers is somewhat mixed while long term, large-scale plants are somewhat limited. The unit requires careful selection of the bacterial strain, which is laboratory developed and enhanced for optimal performance. These units require more skilled attention than the average odor abatement unit, and have only been successful when operated within the design parameters by skilled and trained staff. This type of plant is very expensive to build and operate.

These units are suitable for aromatic type odors such as methylene chloride, ketones, alcohols, ethers and chlorinated aromatics, VOC and hydrocarbons. They are capable of reducing these odors down to parts per billion (ppb) levels if they are well designed and operated.

Thermal & Catalytic Converters

Designers of these units claim that this is the most important waste gas purification technology available. However, there are skeptics. The system takes odorous gases and burns them, supposedly destroying the process odors. In fact, they can introduce a host of toxins and noxious substances into the air.

A better process is to burn the odorous waste gas and then convert these dangerous gases into harmless substances by reacting them with specific catalysts. At certain temperatures, chlorine and hydrocarbon emissions form dioxins and furan. The waste gas is destroyed in a furnace-type process and the exhausted hot gases are dosed with a reaction solution that is usually ammonia-rich urea (that also cools the gas) and then fed into a separate vessel and reacted with catalysts to neutralize any toxins.

There has been a lot of development for different catalytic mediums, mainly for mediums such as “reduction” and “oxidation” catalysts. The gas is passed over (or through) these catalysts, converting residual gases into harmless compounds, usually carbon dioxide, nitrogen and water. One problem, even for well designed and operated systems is the problem of catalyst saturation and sterilization.

Incineration

National, regional and municipal departments as well as industries that create toxic waste are frequently confronted with the problem of waste disposal. This is because previously available low cost disposal practices, such as landfill sites and registered toxic dumps, are filling quickly so charges are rising and some disposal methods are no longer acceptable.

The process of destroying process and industrial waste by the incineration method can create toxins and more odors. The industrial waste gas to be destroyed is subjected to very high temperatures, usually around 1472°F (800°C). These gases are then subjected to conversion of the molecules with a resultant breakdown by the heat. This process changes the odor from a potent to a less potent form. In some cases, the injection of additional air is required but this can cause the lighter volatile gases to be released from the waste gas.

In addition to the danger of the heat involved, the method is very expensive, not always entirely effective, and generally introduces oxides and chlorinated odors into the atmosphere. The solution is to fit the incinerator with an afterburner, raising the temperature to about 2012°F (1100°C)—a very costly addition.

The incineration process is effective against organic odors, but less effective on hydrogen sulfide and ammonia odors.

Chemical Odor Neutralization

Chemical odor neutralization offers an economical alternative to other processes. Chemical odor control combines physical absorption with a sensory change to the olfactory receptor. The olfactory receptor is responsible for odor perception and recognition. Chemical neutralization changes the odor molecule's structure, effectively modifying it. And unlike chemical masking agents or perfumes that superimpose a pleasant fragrance on an unpleasant odor, odor neutralizers absorb and convert malodors resulting in no odor at all!

The performance of a chemical odor neutralizer is based on the type of odorous compounds, their concentrations, and the human threshold limit to detect the odors. OMI manufactures only two products: one for most odors, including acids, bases and neutral compounds, and one specifically for styrene malodors. Ecosorb eliminates a host of common malodors on contact including: H_2S, ammonia, sulfur dioxide, ethyl and methyl mercaptans, amines, styrene, and other less soluble odors.

Ecosorb is a propriety formulation of several essential oils and a small amount of food grade surfactant. It is completely biodegradable, and safe to people, animals, and plant life. It is USDA (United States Department of Agriculture) approved and was tested against all the requirements of the US EPA (United States Environmental Protection Agency) standards for skin, oral and respiratory toxicity tests. Ecosorb will not add VOCs to an emission source, nor will it react with other chemical compounds to create an air pollution problem.

Ecosorb is an odor neutralizer. It is most often diluted with potable water and applied via atomization as a very fine mist directly into the odorous gas stream. The essential oils in the droplets combine to form a thin, electro statically charged film around each droplet. The make-up of this film attracts molecules that form the offensive odor. Odorous molecules are attracted and attach to the droplets where they are captured and neutralized by the essential oil mixture.

Ecosorb application equipment is uncomplicated in construction and easy to operate, whether the application is out in the open, inside a building, in a duct system, discharging via a stack, or captured and cleaned inside a designed misting scrubber. The equipment is low maintenance and there is no storage, handling, or disposal of hazardous chemicals. Ecosorb offers a cost effective and safe solution to most odor problems.

METHODS

Ecosorb does not require complex, specially designed equipment to administer the product into an odorous environment because it is multifunctional, broad based and completely non-hazardous. But system engineering is important. Whether the requirement is for dripping, fogging, dosing, injecting, or scrubbing, easy-to-use application equipment is available from many manufacturers and can be provided by your Ecosorb distributor.

There are many effective methods to deliver Ecosorb into an atmosphere to control malodor. The most suitable method will be determined by several factors such as:

- The type of odor to be controlled
- The source of the odor emission
- The size of the area to be controlled
- The possible presence of an existing odor control hardware system
- Ambient or process gas conditions
- Location of the target that needs to be protected from the odors (usually people)
- The flexibility of engineering facilities

Ecosorb is most effectively applied when atomized into odorous process air or open air near the source of a malodor. Since Ecosorb is not a masking agent, the main challenge is applying it effectively so that it is capable of performing the odor neutralization. The challenge is not the neutralization act itself. Consider how the product works when atomized into odorous air. The malodor molecules and the droplets of Ecosorb must come into contact with one another or be near enough for the electrostatic attraction to take over. Ultimately, the malodor must adsorb onto the droplet skin and/or be absorbed by the solubility mechanism of the odor control process. If enough malodor molecules remain free within the air above the odor threshold of the gas, the odor will not be controlled.

You will notice we use the term “atomized” not “sprayed.” The efficiency of Ecosorb increases with the reduction in applied droplet size. For airborne application, it is best to target a droplet size of less than 25 microns with less than 10 microns most desirable. Therefore, to improve product efficiency and optimize consumption rates, one must pay attention to application atomization. Simple spray equipment will cause the product to be less effective and result in a higher consumption rate. (See “Atomization Nozzles” later in this section.)

The following example explains the importance of small droplet size in the performance of the odor control system. Consider the difference in surface area between 10-micron and 1000-micron droplets. The ratio of the diameters is 100. The surface generated changes as the square of that ratio, or for the same amount of liquid, 10-micron droplets will generate 10,000 times the amount of surface area as 1000-micron droplets. For a fixed volume of liquid, there are more droplets and surface area available to absorb the odor molecules.

Dr. Donald Wilkinson of Delaware State University (USA) developed a model that considers the primary variables of Ecosorb odor control technology. Solubility is the first mechanism in odor control. Because of the way Ecosorb works, the malodor gas must be solubilized into the atomized droplets of Ecosorb for a reaction to occur. The efficiency in removing malodors is proportional (α) to the solubility of the malodor. Or stated another way, we can improve removal efficiency by increasing solubility of the atomized droplet. Manipulating the following variables does this.

1. Increase the concentration of Ecosorb [CONC] (dosage rate)
2. Decrease the size of the atomized droplet [SIZE]
3. Increase the contact between malodor and droplet [TIME]
4. Increase velocity of droplets and therefore impact velocity [VEL]
5. Change polarity of the droplet [POL] (we usually have little control here)

These relationships can be summarized as follows:

$$\text{SOLUBILITY} \;\alpha\; \frac{[\text{CONC}]\,[\text{TIME}]\,[\text{VEL}]\,[\text{POL}]}{[\text{SIZE}]} \;\alpha\; \text{EFFICIENCY}$$

Ideally we want a high concentration of Ecosorb, a long contact time, and a small, high velocity droplet. Unfortunately, this is not always the case and one needs to optimize the variables that are controllable in order to make up for those that cannot be controlled.

The types of delivery apparatus can vary from a simple fogging machine carried around from site-to-site to complex metering, injection and recovery systems used in large scale air handling systems. Ecosorb can be applied numerous ways to numerous settings including oil refineries, wastewater treatment plants, processing plants, landfills, and industrial plants of all kinds. Because of Ecosorb's application flexibility, existing odor control hardware can occasionally be adapted to disperse the product to required areas. This adaptation further reduces capital costs by keeping existing equipment from becoming redundant.

Indoor, Ecosorb can be diluted and applied topically, in atomized phase or vapor phase to eliminate malodors in confined composting, water treatment, sludge treatment, solid waste handling, and industrial process areas. An Ecosorb program is an inexpensive solution that provides a more pleasant, productive work environment.

Outdoors, Ecosorb controls odors from aeration ponds, lagoons, sludge pits, landfills, remediation sites, and industrial sites. Ecosorb systems are highly effective in breaking down odors and eliminating foul fumes that may travel to surrounding areas. It is a very cost effective form of treatment.

Ecosorb often replaces air scrubbers and other more elaborate odor control equipment used to deodorize stack emissions. Where scrubbers are installed, Ecosorb can be used as a safe, effective odor control substitute for potentially hazardous sodium hypochlorite, caustic, or blended cleansing solutions. It can also be used as a secondary polishing agent. Little equipment alteration is necessary to quickly install an Ecosorb system in almost any plant.

Below describes a variety of application hardware and delivery apparatus that gives the design engineer a starting point to examine potential application systems.

Atomizing nozzle

The use of atomizing nozzles is the most common form of dispersing diluted product into an atmosphere. Several manufacturers have nozzles available to atomize Ecosorb to an adequate droplet size for reasonable product efficiency. Nozzle performance varies from one type to another. Once Ecosorb is atomized, it is dispersed into an air stream and given the opportunity to find and react with the malodor.

Nozzles can be used indoors fixed to walls, scaffolding, or framework. They can also be assembled within a scrubbing system, air handling system or emission stack using either a string of nozzles or a cluster system. Nozzles can be attached to building perimeters, building openings, load out transfer areas, or hung loosely around odor producing process areas. Nozzle systems are also used on perimeter fencing as a last resort to control odors that are escaping from many points within a site.

Simple nozzle systems, both high-pressure hydraulic and air-operated, can be adapted to suit most industrial applications where a fixed/continuous source of odor control is required. Often a larger number of nozzles or nozzles with a greater delivery rate can be installed to expand a system.

Portable atomizers

Hand pumped atomizers (used in agriculture and pest control) can be used to deliver Ecosorb to areas where constant odor control may not be required, for simple topical applications, and where power may not be available. Small electric handheld atomizers of varying capacity can be used to deodorize small and large localized areas. The use of hand pumped atomizers with portable fogging machines offers the consumer maximum portability and coverage with a minimum of outlay.

Hollow bladed fan

The hollow bladed fan is a unique product designed as a humidifier for the agricultural industry but with the capacity of dispersing a diluted or concentrated form of Ecosorb into open air. The fan system is available with an oscillator to ensure the even disbursement of Ecosorb.

The hollow bladed fan system is primarily used in enclosed areas of up to 3,000 square feet and can be installed in series with other fans to cover larger areas. These units have also been used in wet wells or sewage treatment stations. This practice has grown in popularity due to the simplicity and reliability of the fan system.

Vapor systems

True vapor phase odor control systems provide a simple, effective method for transforming Ecosorb into a vapor state that can be easily transmitted into malodorous situations. These systems vaporize up to 100% of the Ecosorb for maximum product utilization. In addition, they do not use large amounts of water. This is very important in instances where added moisture and humidity is unacceptable. Nozzle systems, and to a lesser extent fan systems, add visible moisture to the process air. A true vapor phase system will add the least amount of moisture while doing an excellent job of delivering Ecosorb. Vapor phase systems can be used both indoor and outdoor where the odor source is easily isolated.

Scrubbing systems

Ecosorb can replace a wide range of odor control chemicals used in scrubbing systems. Ecosorb offers an environmentally friendly substitute to dangerous chemicals currently used in the majority of scrubbers since it is non-toxic, biodegradable and safe to use.

Prior investigation of relevant odor control regulations and odor control requirements may save a company millions of dollars by not installing costly scrubbing systems in the plant. It is possible that a simple injection or fogging process utilizing Ecosorb will allow the company to meet or exceed local odor emission regulations while saving extensive costs.

In all cases, Ecosorb should be evaluated as an independent odor control method. A simple process that uses inexpensive current technology may control situations formerly requiring large capital outlay. Tables 3.1 and 3.2 contain examples of equipment currently used to solve various odor problems. These are guidelines only as each application drives the correct equipment selection. When selecting your equipment, we suggest that you refer to Tables 3.3, 3.4, and 3.5 to ensure material compatibility and equipment longevity.

Table 3.1: Typical applications and delivery equipment

	Portable Fogger	Compressed Air Atomization	Hydraulic High Pressure	Hollow Bladed Fan	Wide Swath Sprayer	Vapor Phase System
Air Handling Systems		X	X			X
Building Fire Clean Up	X	X	X	X		X
Chemical Processes		X	X			X
Chemical Spills	X	X		X	X	
Clarifiers		X	X			X
Composting		X	X		X	
Explosive Environments		X	X	X		
Composite Fabrication		X		X		X
Food Processing Areas				X		X
Head Works		X	X	X		X
Industrial Oily Waste Processing		X		X		X
Landfills			X		X	
Livestock Pens		X	X	X		X
Paint Booths		X	X	X		X
Paper and Pulp Mills		X	X	X		X
Ponds and Lagoons			X			
Pump Stations		X	X	X		X
Refineries		X	X			
Rendering Plants		X	X	X		X
Screens		X	X			
Scrubbers		X	X			X
Septage Handling		X	X			
Sludge Dewatering		X	X	X		X
Soil Remediation			X		X	
Solid Waste Transfer Station		X	X	X		X
Wet and Dry Wells		X	X			X

Table 3.2: Application apparatus

Application Apparatus	Situation
Hand Pump Atomizer	Odors emitting from small areas that do not require constant treatment.
Electric Portable Atomizer	Small areas requiring regulated use.
Agricultural Wide Swath Sprayer	Landfill operations and other large moving target applications such as soil remediation.
Hollow Bladed Fans	Atomization of enclosed areas and/or where adding moisture to the air is undesirable (such as foundries and composites fabrication facilities).
High-Pressure Atomizing Nozzle Systems	Wastewater, open air applications, stacks, and enclosed odor intense areas, where ambient moisture addition is not a problem.
Pneumatic Atomization Nozzle Systems	An industrial and wastewater application, where adequate compressed air is available and ambient moisture addition is not a problem.
Vapor Phase Atomization System	Indoor, outdoor, plus some duct and stack applications, where odor sources can be isolated and moisture addition is undesirable.

Table 3.3: Compatibility of tubing and pump heads with Ecosorb

Material	Compatibility
Neoprene Tubing	Unsatisfactory
C-Flex Tubing	Satisfactory
Silicone Tubing	No data available
Tygon Tubing	Unsatisfactory
Viton Tubing	Satisfactory
Polycarbonate Pump Head	Satisfactory
Polyphenylene Sulfide Pump Head	Satisfactory

Table 3.4: Chemical resistance of resins to Ecosorb

Resin	Resistance
Low Density Polyethylene	Little damage after 30 day exposure
High Density Polyethylene & Cross Linked High Density Polyethylene	Little damage after 30 day exposure
Polypropylene/Polyallomer	Some effects after 7 day exposure
Polymethylpentene	Some effects after 7 day exposure
Polymethylmethacrylate	Not recommended
Polyvinyl Chloride	Some effects after 7 day exposure
Acetyl (Polyoxymethylene)	Some effects after 7 day exposure
Nylon (Polyamide)	No damage after 30 day exposure
Polycarbonate	No damage
Polysulfone	Not recommended
Tetrafluoroethylene (Teflon)	No damage
Polypropylene	No damage
Ethylene Tetrafluoroethylene Tefzel	No damage
Ethylene Chlorotrifluoroethylene Copolymer Halar	No damage
Perfloroalkoyl Teflon	No damage
Polyurethane	Not recommended
Ployvinylidene Fluoride	No damage after 30 day exposure
Polystryrene	Not recommended

Essential oil mixes may cause softening, swelling and/or permeation losses with resins. The effects are normally reversible.

Table 3.5: Compatibility of Ecosorb with common construction materials

Material	Compatibility
Epoxy	Excellent
Acetal (Delrin)	Not recommended
Phenolic	Excellent
Nylon	Moderate effect
Stainless Steel 316 & 440	Excellent
Cast Bronze	Fair
Carbon/Ceramic	Excellent
Seals	
Viton	Excellent
Buna	Fair
Neoprene	Not recommended
Nitrile	Fair
Natural Rubber	Not recommended
Hypalon	Not recommended
Kel F	Not recommended
Tygon	Not recommended
Silicone	Not recommended
Ceramic	Excellent
Carbon/Graphite	Fair

APPLICATION INFORMATION

The quantity of Ecosorb required for odor control depends on the volume and intensity of the malodor source. The correct application and dilution rate will create an atmosphere where neither the malodor nor the Ecosorb scent is noticeable.

The graph below demonstrates that an increase in Ecosorb consumption directly relates to a reduction of malodor sensitivity. Once the equilibrium point of "neutral odor" is reached, an increase in the Ecosorb use results in an Ecosorb scent within the surrounding atmosphere.

Once the neutral point is reached, many clients lose the perception that an odor problem exists or that Ecosorb is working effectively. OMI suggests that you increase the Ecosorb level slightly beyond the equilibrium point so that a slight hint of the product is noticeable to the operators. This will become their guideline if the unit requires more or less Ecosorb in the environment.

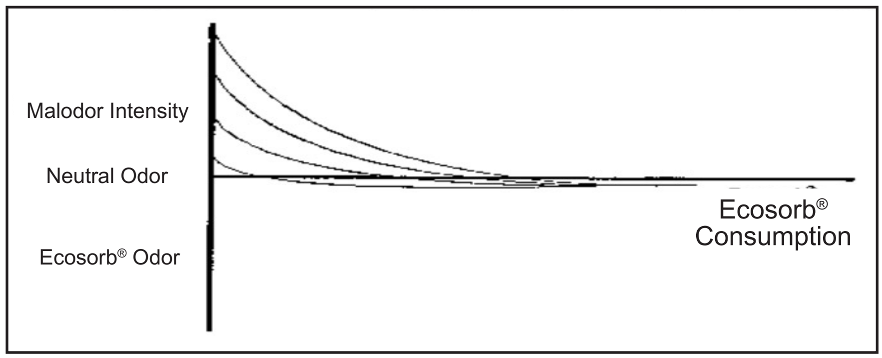

Figure 3.1: Ecosorb consumption for control of malodors.

The most effective addition and dilution rates for Ecosorb need to be determined on-site. The level of malodor present determines the Ecosorb level required. The determining factors are odor composition, efficiency of the delivery system, airflow rates, probability of contact between droplets and odor molecules, contact time and reaction time.

ATOMIZATION NOZZLES

Design engineers have two options when specifying nozzles. They can utilize the recommended nozzles in this manual or they can specify their own. If an engineer specifies their own nozzles, they need to pay attention to the nozzle droplet size. OMI recommends a droplet size of less than 25 microns with an optimum of less than 10 microns. Numerous nozzle manufacturers exist who will tell you their nozzles provide such a fine spray. However, their nozzle may not provide the best atomization capabilities. The fact is that all nozzles produce a spectrum of droplet sizes and OMI needs to specify the nozzle that provides the highest volume in the size range needed.

Spraying Systems Company provides "Spray Particle Definitions" below.

Drop of Particle Size: A measure of the droplet size such as diameter, weight, or volume. It can be expressed as the Median Volume Diameter (MVD), Mass Median Diameter (MMD), Sauter Mean Diameter (SMD) Median, or Mean Number Diameter (MND).

(MVD) Median Volume Diameter: A means of expressing particle size in terms of the volume of liquid sprayed. The median volume diameter particle size when measured in terms of volume (or mass) is a value where 50% of the total volume of liquid sprayed is made up of drops with diameters larger than the median value and 50% smaller than the median value.

(SMD) Sauter Mean Diameter: A means of expressing the fineness of a spray in terms of the surface area produced by the spray. The Sauter Mean Diameter expresses a uniform drop size diameter in terms of the actual total surface area as produced by the totality of drops in a given spray. The Sauter Mean Diameter is obtained by summing all the surface areas of all the drops produced by a given spray and all of the volumes of all of the drops. Then dividing the total volume by the total surface area and finding the diameter of a drop having the same volume to surface area ratio.

(MND) Median Number Diameter: A means of expressing particle size in terms of the number of particles in the spray. This means that 50% of the particles by count or number are smaller than the Median and 50% of the particles are larger than the given diameter.

(MND) Mean Number Diameter: Or average particle size. A means of expressing particles size in terms of the actual number of particles counted and measured and obtaining a simple arithmetical average by dividing the actual number of particles into the number of size classes and obtaining a mean or average size.

Of all the particle size expressions listed, the most useful terminology for the general description of spray appears to be the Median Volume Diameter. This deals with volume of liquid sprayed and weighs the given diameter in the direction of where the significant portion of the liquid sprayed will be found.

WATER QUALITY

One must pay close attention to supply water quality in all atomization systems, especially when specifying nozzle type systems. Atomization nozzle design usually includes small diameter orifices (0.008” typical) and narrow passages (0.020” common). Untreated potable water will always cause nozzle blockage. Water with Total Dissolved Solids (TDS) counts exceeding roughly 200 ppm or with high calcium should be treated in order to prevent excessive nozzle blockage. If water quality is questionable, it is worthwhile to obtain a water analysis report from a specialist and make treatment or filtering recommendations based on factual information. Should you find it necessary to treat the water, we recommend softening the water or reverse osmosis (RO) filtration. Deionized water is not recommended because it is aggressiveness can affect pumps and other components.