SECTION 1

ECOSORB ODOR NEUTRALIZER PRODUCT SELECTION

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INTRODUCTION

Growing environmental concerns are creating questions regarding the quality of our soil, the water we drink, and the air we breathe. Of particular concern to many industries is the prevalence of odor emissions surrounding wastewater facilities, manufacturing plants, landfills, and other sites where malodorous gases collect. Odors are basically gaseous chemicals detected by the human olfactory organs and while the like or dislike of a particular smell is purely subjective, certain odors are generally agreed to be offensive or harmful to all.

As a result, many devices have emerged to satisfy the demand for better control of offensive odor emissions. Unfortunately, many solutions fall short in one of two categories, either they act as mere masking agents and do not address reactions with the malodorous gasses, or as they eliminate odors they may introduce hazardous compounds into the very areas they "clean."

Ecosorb is an odor neutralizer, not a masking agent. It is applied most often via atomization as described in the "Methods of Application" section of this manual. The product is a proprietary formulation of several essential oils and a food grade surfactant. It is biodegradable and totally safe to people, animals, and plant life. Please see the various third party lab test reports included in Section 5.

Originally there was only one Ecosorb, which consisted of the industrial strength version known as Ecosorb 606 and its lesser strength derivatives known as Ecosorb 505 and 404. These products contained the same active ingredients with varying intensities. Ecosorb 606 and its derivatives are broad spectrum, applicable in multiple industries, and contain only the natural fragrance of the active ingredients.

Recently, Odor Management, Inc. responded to market requests by developing Ecosorb 606AB (Apple Blossom) and Ecosorb 606M (Magnolia). These "scented" versions of Ecosorb provide the user with an odor neutralizer that also deposits a substitute odor into the process air. Instead of neutralizing the malodor thereby yielding no odor, these new products neutralize the malodor and leave a subtle floral scent behind. Little attention is given in this manual to Ecosorb 606AB and 606M. The methods of delivery and neutralization mechanisms are the same as Ecosorb 606.

A new Ecosorb product was introduced in 1999. This product was developed specifically for application into the styrene market and is known as Ecosorb 206. Testing shows this product to be an effective styrene odor neutralizer and to be more effective on organics similar to styrene than Ecosorb 606. Attention will be given to Ecosorb 206 herein. When this manual refers to mechanisms and application systems that pertain to both 606 and 206, we will refer to the product simply as Ecosorb. When relating to topics specific to one product or the other, we will identify the appropriate product.

ESSENTIAL OILS

An essential oil is the predominately volatile material isolated by some physical process from an odorous single-species botanical. Over 3,000 oils are identified from the vast number of plant species and several hundred are commercialized. Of these, some are extremely rare and produced in only kilogram quantities, e.g., violet oil, concretes (flower extracts), and angelica root oil.

Essential oils are derived from various plant parts, such as leaves, fruit, bark, root, grass, wood, heartwood, gum, balsam, berries, seed, flowers, twigs, and buds. These plant parts are processed to yield their quintessence or essential oils, which are mostly devoid of cellulose, glycerides, starches, sugars, tannins, salts, and minerals, which also occur in these botanicals.

Essential oils are used as such for flavors and fragrances. But products derived from, or based on essential oils have large volume usage for specific applications. Essential oils are concentrated, rectified, extracted, or chemically treated to further isolate vital components, purify, adjust properties, or increase the concentration of significant flavor or fragrance components. The versatility of essential oils for odor control has made them an acceptable and effective technique.[1] The correct blending and selection of the oils are a science unto itself.

Fluctuations in the cost and availability of natural oils and the high cost of some oils have induced users to seek substitutes. Nonetheless, there is a trend away from synthetic oils because complete duplications are in most cases not technically, aesthetically, or economically possible.[2]

Science once believed essential oils were only good as masking agents and had no potential to actually neutralize odor. However, testing indicates that certain essential oils have the ability to cancel out particular malodors. For example, oil of wintergreen will neutralize rank tobacco odors and juniper oil cancels the odor of rancid butter and milk fats.

Not only is the type of oil (juniper versus wintergreen) important but also where that oil is produced since similar oils do not necessarily have the same chemical content. Melaleuca Alternifolia (tea tree oil), for example, is found on three continents. However, the therapeutic effect needed for the production of pharmaceuticals is only found in the oils produced in the Lismore area of New South Wales, Australia. It has becoming evident that this is true of many essential oils used in odor control.

The full mechanics of how essential oils work is quite complex. However, they basically operate through the use of weak electrostatic bonding, gas phase solubility, and acid base reactions. The oils are mixed with water and sprayed into the air. The mix in these droplets separate and the oils form a thin film over the water droplet itself and inside the droplet. The exterior "skin" formed by the oils creates an electrostatic charge over its outer surface. This charge attracts the odor molecules onto and into the droplet. Although the water droplet is quite minute, it is still large enough to capture the malodor molecules, and affect the neutralization process.

[1] "Odor and VOC Control Handbook", Harold J. Rafson, 1998, McGraw Hill, p. 8.20

[2] "Concise Encyclopedia of Chemical Technology", Kirk-Othmer, 1985, John Wiley & Sons, Inc.

ECOSORB THE PRODUCT

Ecosorb is carried into an atmosphere where it attracts or is attracted to whatever is in the atmosphere - whether it is a pleasant odor, malodor, or particulate. Some studies claim that essential oils work by either:

1. Van der Waals forces,
2. Zwaardemaker pairing,
3. Reaction / neutralization, or
4. a combination of any two.

Ecosorb tests indicate that all three phenomena take place in various areas. The oils collect and bond onto the gas molecule (Van der Waals forces). In each case, the odor is eliminated (possible occasional presence of Zwaardemaker pairs). And, the subject gases are drastically reduced in content because of a chemical reaction (reaction/neutralization).

Additionally, Ecosorb has the unique ability to bond onto particles that do not have dipoles such as chlorine gas and carbon dioxide. This is achieved by creating a momentary unevenness in the electron cloud around a particle. Once this unevenness is created, bonding takes place.

The essential oils in Ecosorb operate as a cluster and bond onto gases in the atmosphere. The cluster continues to operate until it saturates and falls to ground or is otherwise removed. The residual effect of the oils on the contaminant indicate that Ecosorb is 100% efficient and will remain airborne until such time as it is fully utilized. As Ecosorb bonds with the particles, a process is initiated that reduces the volatility of the particle to its lowest possible form.

Extensive laboratory testing shows that reactions between Ecosorb 606 and malodor compounds occur. Ecosorb 606, being a blend of essential oils, develops into an "acid buffer." This buffer can react with both weak acids and bases. The reaction varies with the gas. In the case of basic gases such as amines, lab tests identified an acid base reaction. In the case of acidic gases, an acid-base reaction was observed and there is evidence of ion transfer with additions across double bonds within the product. In both cases, the result is a non-volatile organic salt. For a more in-depth look at these reactions, please refer to the technical paper provided in Section 5 entitled, "Control of Malodors Using Ecosorb." For independent laboratory evidence of reactions causing gas reduction, refer to the Southern Petroleum Laboratory test reports in Section 5.

Using the blend of essential oils in Ecosorb is an advantage because we can control the full spectrum of odors and not leave any peripheral odors or odorous by-products. Although essential oils are capable of working on most gases, there are instances where they may not be economically feasible for use as an odor control. These situations include atmospheres where the gases contain heavy aromatics, strong acids, and strong alkalis. The weight and solubility of heavy aromatics sometimes make it difficult to control their odor in high contamination levels. Atmospheres containing large doses of strong acids and alkali also appear to reduce the effectiveness of the oils by destabilizing the bonding between the oil particles.

Because of the various specific gravities and flash points of the oils, the oils will begin to separate at high temperatures. This marginally reduces their effectiveness. However, we have situations where Ecosorb is being successfully injected into exhaust flues where the gas emissions are measured at 425°F (204°C).

There are many factors, which will affect the amount of Ecosorb required to control a situation. To measure the potential effectiveness of Ecosorb on a particle you have to look at:

1. Parts per million (ppm)
2. Air Flow
3. Solubility
4. Molecular Weight
5. Molecular Density
6. Make up (organic/inorganic)

SOLUBILITY

Reaction is not the only mechanism through which Ecosorb controls odors. In fact, it is not the first mechanism. Before Ecosorb can react with gasses, the malodor gases must be dissolved into the atomized droplet containing Ecosorb. The first mechanism in odor control using Ecosorb is solubility. Industrial malodor gasses vary in terms of solubility in water. This variation ranges from "very slightly soluble" such as styrene to "very soluble" such as ammonia. Generally speaking, Ecosorb increases the solubility of most malodor gases.

Once the gas is dissolved (absorbed) into the atomized droplets, "Henry's Law" takes affect and a percentage of the gas wants to leave the droplet and form a state of equilibrium. We refer to the ability of the liquid to hold the gas as the "distribution constant." It was proven in the laboratory that Ecosorb enhances the ability of an aqueous solution to hold liquid, thereby favorably affecting the distribution constant. Therefore, Ecosorb increases the solubility of the gas into the aqueous solution and increases the ability of the liquid to contain the gas.

Laboratory testing relative to the solubility of a few common industrial gasses was performed under the direction of OMI. Section 5, Reference Materials, contains reports that address the solubility effects of the product. The report, "Control of Malodors Using Ecosorb," addresses acidic and basic gasses in Ecosorb 606. The subject of styrene solubility and its distribution constant can be found in the report entitled "The Use of Ecosorb 206 in Controlling Styrene Odors." Finally, a study specific to the solubility of benzene is reported in "Effect of Ecosorb 206 on the Solubility of Benzene."

ECOSORB 206, STYRENE, AND OTHER NEUTRAL HYDROCARBONS

Ecosorb 206 was developed specifically with the solubility of styrene in mind. Styrene odors associated with the composites industry and regulatory pressure within that industry influenced Odor Management, Inc. to develop a product targeted specifically for control of styrene odors.

Ecosorb 206 differs slightly from Ecosorb 606 in oils that make up the blend. It is slightly more volatile and acidic than 606. The toxicity, health, and safety characteristics are equivalent to 606; it is safe. The product has a noticeably different natural fragrance while still remaining similar in fragrance. Application methods of the two products are identical.

Ecosorb 206 was designed to enhance the solubility of styrene in an aqueous solution. It was not designed to react with styrene. Since reactions are only a piece of the odor control puzzle, we believed that if we could absorb and adsorb more styrene into an atomized aqueous solution of the new Ecosorb product, then we could affect odor control by removing the atomized droplets from the air. This concept proved true; however, we also discovered that a reaction with styrene does exist. Further investigation determined that the oxidation reaction takes place between styrene and water, but that styrene does not readily dissolve in water. By measurably increasing the amount of styrene that dissolves into water containing Ecosorb 206, we can capture and hold significant amounts of styrene and react it causing identifiable byproducts. For more details, please refer to "The Use of Ecosorb 206 in Controlling Styrene Odors" located in Section 5.

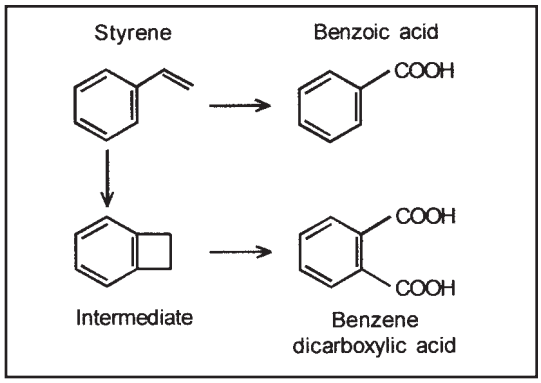

Figure 1.1: Degradation of Styrene in Ecosorb 206 solution

Even though Ecosorb 206 was designed for styrene applications, we also found it is more effective on compounds with which 606 has the most trouble, such as the BETX series. Generally speaking, when dealing with neutral hydrocarbon compounds, Ecosorb 206 is the product of choice.

Because of its acidity, Ecosorb 206 is not recommended for applications involving acidic gasses.

MATERIAL SAFETY DATA SHEET (MSDS)

An independent laboratory examined Ecosorb to provide the information for our MSDS. The criterion to which Ecosorb was tested is the OSHA Federal Hazard Communications Standard, 29 CFR 1910-1200, which does not allow OMI to make any disclaimers on the product testing.

Having the product tested to these standards, OMI can state "There are no harmful ingredients in Ecosorb" (MSDS Section II – Hazardous ingredients / Identity information). OMI can also point to the fact that Ecosorb does not contain any hazardous Volatile Organic Compounds (VOCs). The "Percent Volatile" section of MSDS Section III – Physical / Chemical Characteristics" shows the percent volatile measures approximately 1.4%, but our corroborative testing by Pace Laboratories and Chemical Waste Management to EPA Guidelines 8260 and 624 show that none of the volatiles tested for are in Ecosorb.

MSDSs are supplied by the majority of manufacturers on the products they offer to the market. Unfortunately, there is no requirement by the manufacturers to specify exact information and disclaimers such as the following were taken from a competitive source.

> *"The information on this MSDS was obtained from current and reputable sources. However, the data is provided without any warranty, expressed or implied, regarding its correctness or accuracy. It is the user's responsibility to assume liability for loss, injury, damage, or expense resulting from improper use of this product."*

This removes the onus from the manufacturer to be exact in the presentation of information. The reader will not find this disclaimer on the Ecosorb MSDS.

HUMAN TOXICITY

Industry is more aware of personal and environmental dangers from the use of chemicals. OMI had studies completed to assure our clients that Ecosorb is safe to use personally and for the environment. These reports can be found in Section 5, Reference Materials.

Tox Monitor Laboratories in Chicago tested Ecosorb 606 to the following EPA Guidelines:

EPA Guideline 81-1	Acute Oral Toxicity
EPA Guideline 81-2	Acute Dermal Toxicity
EPA Guideline 81-3	Acute Inhalation Toxicity
EPA Guideline 81-4	Acute Eye Irritation
EPA Guideline 81-5	Primary Dermal Irritation
EPA Guideline 81-6	Sensitization

Tox Monitor Laboratories also tested Ecosorb 206 for toxicity. The test protocol was nearly identical to the previous tests but the regulating agency (EPA Office of Prevention, Pesticides, and Toxic Substances (OPPTS)) and protocol designators changed as follows:

OPPTS 885.3050 Guideline	Acute Oral Toxicity Study
OPPTS 885.3100 Guideline	Acute Dermal Toxicity Study
OPPTS 870.1300 Guideline	Acute Inhalation Toxicity Study
OPPTS 870.2400 Guideline	Acute Eye Irritant/Corrosion Study
OPPTS 870.2500 Guideline	Acute Dermal Irritation/Corrosion Study
OPPTS 870.2600 Guideline	Dermal Sensitization Study

In all cases, Ecosorb received the safest possible classification.

FISH TOXICITY

T.R. Wilbury Laboratories conducted fish toxicity testing on Ecosorb in April 1993. These tests were performed to establish any potential problems from the spillage or use of Ecosorb in an exposed water stream.

The tests performed included:

EPA Method 72-2	Daphnia Magna
EPA Method 72-1	Fathead Minnow
EPA Method 72-1	Rainbow Trout
EPA Method 797-1300	Daphnia Magna
EPA Method 797-1400	Fathead Minnow
EPA Method 797-1400	Rainbow Trout

These tests proved that Ecosorb was completely non-toxic to marine life. The letter associated with this report can be found in Section 5, Reference Materials.

VOC ANALYSIS

EPA and state regulatory bodies are becoming more and more stringent relative to Volatile Organic Compounds (VOC) emissions. Ecosorb was tested to EPA Method 8260 and EPA Method 624. In both tests, there were no harmful VOCs detected.

However, Ecosorb contains natural active ingredients that are organic and volatile. Ecosorb 206 and 606 were tested according to United States Environmental Protection Agency (US EPA) Method 24, in part "Determination of Volatile Matter Content." It was determined that undiluted Ecosorb 606 contains about 1.42% volatile matter content and Ecosorb 206 contains about 1.5% volatile matter content. In application, these products are usually diluted thereby reducing these percent contents.

GAS TESTING

OMI has tested a range of gases that are found to be common nuisance odors in industry. These gases include:

- Hydrogen sulfide
- Sulfur dioxide
- Ammonia
- Ethyl mercaptan
- Methyl mercaptan

Ecosorb exhibited a dramatic effect on each gas. Most notably sulfur dioxide, ethyl mercaptan and methyl mercaptan were reduced by over 97% on contact.

The results of current testing are shown in Table 1.1. Since there were no established testing procedures for our requirements, OMI developed our own methods.

The method of testing is best described as:

- The subject gas is introduced, using a pure gas permeation tube, into a constant air stream flowing into and out of a reaction chamber. Once a constant gas rate is maintained in and out of the reaction chamber, a brief spray of Ecosorb is introduced.
- Exit samples are taken immediately upon the introduction of Ecosorb and periodically thereafter. Samples are analyzed using gas chromatography, except in the case of ammonia where a colorimetric sensor is used.
- The reader will note a gradual increase in hydrogen sulfide, sulfur dioxide, and ammonia after the introduction of Ecosorb. This is caused by a residual effect of the brief product introduction on the constant incoming gas.

Table 1.1: Ecosorb contact testing with identified gases

	ppm/vol. Perm Tube	ppm/vol. Reactor Out	Contact	4 minutes	18 minutes
Hydrogen sulfide	36	36	20.04	36	
Sulfur dioxide	26	26	<0.01	4.4	
Ammonia	97	97	68	8	38
Ethyl mercaptan	3.92	3.92	< 0.1		<0.1
Methyl mercaptan	3.2	3.2	< 0.01		<0.1
Testing completed by independent laboratories. Full test methods and results are provided in Section 5.					

PRODUCT SPECIFICATIONS

The odor-neutralizing product shall meet or exceed the following requirements:

1. Shall be a food grade, water based formulation designed to neutralize malodors associated with wastewater treatment, composing, landfills and lechate, industrial processes, refinery and petrochemical processing, and other related or similar odors.

2. All constituents shall be non-hazardous according to Federal Hazard Communication Standard (29 CFR 1910-1200).

3. Shall function as an atmospheric odor neutralizer and contain no disinfectants or other ingredients designed for contact anti-bacterial activity.

4. Shall have non-descript odor and shall not be a masking agent and shall not depend on a heavy scent to cover up.

5. Shall be documented to reduce malodorous compounds such as hydrogen sulfide and ammonia by 95% and sulfur dioxide, ethyl mercaptan, and methyl mercaptan by 97% on contact.

6. Will have been demonstrated on site at the subject facility and approved by the appropriate management.

7. Shall contain no volatile organic compounds as determined by EPA Methods 8260 and 624.

8. Shall be non-toxic according to the following test procedures.

Acute Eye Irritation	EPA Guideline 81-4
Primary Dermal Irritation	EPA Guideline 81-5
Acute Oral Toxicity	EPA Guideline 81-1
Acute Inhalation Toxicity	EPA Guideline 81-3
Acute Dermal Toxicity	EPA Guideline 81-2
Sensitization	EPA Guideline 81-6
Daphnia Magna	EPA Guideline 72-2
Fathead Minnow	EPA Guideline 72-1
Rainbow Trout	EPA Guideline 72-1
Daphnia Magna	EPA Guideline 797-1300
Fathead Minnow	EPA Guideline 797-1400
Rainbow Trout	EPA Guideline 797-1400

9. Shall have no flash point.

10. Shall have compound authorization by the USDA.

11. Shall have a:
    - Boiling point of 212°F (100°C)
    - Vapor pressure of 0.7 psia @ 100°F
    - Specific gravity of 0.96
    - pH of 6.5 to 6.8

12. Shall not contain any nitrogenous substances.

13. Shall contain no more than 0.50% non-toxic, food-grade emulsifiers and/or surfactants.