ENVIRONMENTAL ISSUES IN THE RENDERING INDUSTRY

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Summary

The rendering industry has a significant positive impact on environmental quality. The processing of low economic value organic matter from the livestock production, meat processing, food processing, and food service industries by the rendering industry reduces the amount of wastes deposited in landfills and discharged to municipal wastewater treatment facilities. The rendering of dead stock from livestock production reduces the risk of groundwater pollution and public health problems associated with improper disposal of livestock mortalities.

The rendering industry also has the potential for producing negative impacts on environmental quality. Even though most rendering facilities do not produce hazardous wastes, the handling and processing of organic raw materials produce significant amounts of undesirable biodegradable by-products that can have significant impacts on water and air quality. Modern rendering facilities have sophisticated treatment processes and control equipment for maintaining acceptable water and air emissions. Water and air emission control systems require significant capital and plant operating costs.

The rendering industry operates under several sets of environmental regulations. In addition to governmental control under federal, state, and local regulations, the rendering industry is also subject to pressures from environmental interest groups and individual citizens. It is becoming increasingly difficult to site new facilities and to ensure compliance with all environmental regulations as the number and complexity of rules and regulations as well as environmental legal issues continue to increase.

Many members of the rendering industry rely on industry and trade organizations such as the National Renderers Association (NRA) and the American Meat Institute (AMI) and their environmental committees for monitoring the development of environmental policy and regulations.

The developing environmental management system (EMS) concept is a step toward self-regulation and environmental quality improvement implemented on a plant scale. EMS programs are encouraged by environmental regulatory agencies including the U.S. Environmental Protection Agency (EPA).

Environmental regulation will become more stringent and compliance will become more complex and expensive as more water and air contaminants are regulated in the future. The regulation of greenhouse gases and ammonia air emissions and total nitrogen, phosphorus, and dissolved solids wastewater discharges will be challenges in the near future. Regulation of other contaminants unknown at this time will undoubtedly develop in response to environmental research and real or perceived environmental problems.

The rendering industry has voluntarily participated in EPA research and industry survey projects. This type of cooperative work, rather than the traditional confrontational relationship with regulators, is leading to the development of federal rules, regulations, and policies that are based on the application of reliable and economically feasible control technology to provide adequate environmental protection.

Wastewater Issues

Rendering plants generate significant volumes of wastewater. The wastewater contains contaminants that are relatively low in long-term environmental risk, but cannot be released directly to the rivers, streams, or lakes without proper treatment. Wastewater discharges are regulated by federal, state, and local laws and rules.

Environmental Concerns

There are four basic categories of environmental concerns regarding wastewater generated and discharged by rendering plants: protection of aquatic life, protection of human and animal health, protection of receiving stream aesthetics, and protection of water supply quality. Protection of aquatic life requires the most significant attention and expense in wastewater treatment.

Limiting the discharge of organic matter attains protection of aquatic life from low dissolved oxygen in streams downstream of wastewater discharges. Organic matter is used as a food source by bacteria in streams. As bacteria consume the organic matter, they consume oxygen. If the rate of oxygen consumption by the bacteria exceeds the rate that oxygen dissolves into the stream, the dissolved oxygen concentration will decrease and fish will die due to lack of dissolved oxygen. Fish kills due to inadequate dissolved oxygen downstream of inadequately treated municipal and industrial discharges were common prior to the large scale construction of biological wastewater treatment facilities in the United States in the 1970s and 1980s.

Carbonaceous biochemical oxygen demand (CBOD) and biochemical oxygen demand (BOD) are methods of measuring the organic matter concentration. CBOD and BOD are the amounts of oxygen consumed by microorganisms as they utilize the contaminants as a food source during a five-day laboratory test. The results are expressed in terms of milligrams per liter (mg/l), or parts per million, of oxygen consumed during the five-day test.

BOD has been used for several decades as the measure of organic concentration. CBOD is similar to BOD, but the reaction of organic nitrogen is blocked in the CBOD test. The amount of nitrogen reaction is assumed to be insignificant in the BOD test when testing low strength wastewater. The BOD and CBOD concentrations are similar in wastewaters that have low nitrogen concentrations. Reaction of nitrogenous compounds during the BOD test can be significant in wastewater with high organic nitrogen and ammonia concentrations such as rendering plant wastewater. Therefore, the use of CBOD rather than BOD is preferred for these wastewaters. The CBOD concentration is always less than the BOD concentration. Raw rendering plant wastewater has CBOD concentrations in the range of 4,000 to 10,000 mg/l. Typical CBOD limitations for discharge to streams are 10 to 25 mg/l.

Ammonia is produced from the biological degradation of proteins. Total Kjeldahl nitrogen (TKN) is the sum of organic nitrogen and ammonia. Ammonia is very toxic to aquatic life. Free ammonia (NH_3) and ammonium (NH_4^+) coexist in equilibrium in water. Ammonia is toxic whereas ammonium is not toxic. Ammonium is converted to free ammonia as the pH increases. Ammonia is also more toxic at higher stream temperatures. Therefore, pH and temperature are important considerations in evaluating ammonia toxicity to aquatic life. Ammonia toxicity increases with increasing pH and temperature. Raw rendering plant wastewater has TKN concentrations in the range of 500 to 1,000 mg/l. Typical ammonia limitations for water quality in streams are less than two mg/l expressed as nitrogen.

Aquatic life is sensitive to pH. The typical range of allowable pH for discharge to streams is six to nine.

Some dissolved salts such as chloride and sulfate can be toxic to aquatic life. Rendering plant wastewater can contain high concentrations of dissolved salts due to salt discharge from hide operations and salts contained in raw materials such as blood serum water. Total dissolved solids (TDS) are the concentration of solids that pass through a filter paper. It is a measure of the dissolved organic matter and salts. The concentrations of specific components of the TDS such as chloride, sulfate, and other constituents are of greater concern rather than the TDS concentration. Therefore, the use of TDS as an aquatic life protection parameter is not as technically sound as the use of specific contaminant concentrations such as chloride and sulfate. Although several states have had water quality standards for dissolved solids, chloride, sulfate, and other dissolved constituents for several years, in many cases they have not applied the standards for these parameters to discharge permit limitations until recently. The development of regulatory standards for constituents that make up dissolved solids will be important in the future as states develop revised water quality standards.

Wastewater from rendering facilities contains the liquid that drains from uncooked raw material, including potentially pathogenic microorganisms. Fecal coliform is used as an indicator of the potential for pathogenic organisms. The concentration of fecal coliform is expressed in terms of “most probable number” per 100 milliliters (MPN/100 ml). The typical limitation for fecal coliform discharge to streams and lakes is 200 to 400 MPN/100 ml.

Total suspended solids (TSS) are a measure of the amount of material that can be removed from the wastewater by passing a sample of wastewater through a filter paper. TSS is an important aesthetic water quality parameter. Typical suspended solids limitations for discharge to streams are 10 to 30 mg/l.

Phosphorus and nitrogen compounds are sources of nutrients for plant growth in lakes and streams. Rendering process wastewater can have relatively high concentrations of nitrogen compounds as a result of protein degradation.

Nutrients stimulate excessive growth of algae in lakes and streams and thereby impact the aquatic life and water aesthetics. Limitations on phosphorus discharge to the Great Lakes drainage basin have been in effect for several years. The 2004 EPA rules require that discharges from rendering facilities to streams and lakes contain no more than 134 mg/l of total nitrogen. Local limitations based on state water quality standards may be more stringent. Typical phosphorus discharge limitations in regions with phosphorus water quality standards are 1.0 mg/l of total phosphorus. Phosphorus and total nitrogen limits may become significantly more stringent as states adopt more stringent nutrient water quality standards.

Oil and grease is an aesthetic water quality parameter. Oil and grease is defined as any material that can be recovered with an organic solvent such as hexane. Oil and grease is more correctly defined as hexane extractable material (HEM) as all compounds recovered by the test method may not actually be true oil or grease. Excessive oil and grease discharge can result in floating solids accumulation in streams and lakes. Excessive oil and grease discharge to city sewers forms grease coatings in sewers and leads to sewer maintenance problems. Typical oil and grease limitations for discharge to city sewers are 100 to 200 mg/l.

Regulation of Wastewater Discharges

Limitations on wastewater discharge to streams and lakes are based on two considerations: minimum quality based on the use of treatment technology (technology-based limits), and quality required for protection of the stream or lake water quality (water quality-based limits). The EPA establishes the minimum water quality based on the application of treatment technology for specific industries, commonly referred to as categorical industry discharge limitations or effluent limitation guidelines (ELGs). The rendering industry is subject to the ELGs for the renderer subcategory of the Meat and Poultry Products Point Source Category as published in the *Code of Federal Regulations* (40 CFR Part 432, Subpart J). The EPA established ELGs for independent renderers in 1975 and periodically reviews them. The EPA revised the ELGs for the renderer subcategory in 2004, which includes standards for new and existing point source dischargers to streams and lakes. The standards for ammonia, BOD, oil and grease, and TSS are based on raw material volume and are expressed in terms of pounds of contaminant per 1,000 pounds of raw material. The fecal coliform standard is 400 MPN/100 ml, and the total nitrogen standard is 134 mg/l as per the rules promulgated in 2004.

Water quality-based discharge limits are based on the water quality standards for the receiving stream. State regulatory agencies develop standards for protection of aquatic life and other uses of streams and lakes. Limits for discharges to streams are calculated by allocating the stream capacity for receiving and assimilating wastewater constituents from all sources without violating the stream water quality standards.

Direct discharges to streams and lakes are authorized with National Pollutant Discharge Elimination System (NPDES) permits issued by state regulatory agencies under authorization of the EPA and the Clean Water Act.

EPA may also impose standards for categorical industry discharge to municipal treatment facilities referred to as pretreatment standards. EPA did not include pretreatment standards for the renderer point source subcategory in the 2004 rules.

Limitations on discharge to publicly owned treatment works (POTW), or municipal sanitary sewers, are based on state rules, local city ordinances, and the POTW treatment facility capacity. In general, the wastewater characteristics from rendering facilities are compatible with conventional POTW treatment processes, if the POTW has adequate treatment capacity.

Discharges to POTWs are commonly authorized by local municipal ordinances and agreements between industrial users and the POTWs. In some regions, state permits or state approval of treatment agreements are required.

Storm water discharges are authorized with NPDES permits issued by state agencies under authorization of the EPA.

Wastewater Sources

Contaminants in rendering plant wastewater represent lost product. For example, the oil and grease discharge is grease that could have been recovered as finished grease in the rendering operations. The protein loss to wastewater can be estimated by multiplying the TKN concentration by 6.25. Ammonia discharge is indicative of the amount of protein that has been degraded. The organic nitrogen (TKN minus ammonia nitrogen) discharge is indicative of actual protein loss to the wastewater system. Packing plants routinely use the wastewater oil and grease and TKN monitoring data to determine product loss and indicators of production plant performance.

Rendering facility wastewater generation rates and characteristics are quite variable and are functions of raw material types and condition, type of rendering processes, and general housekeeping practices. Wastewater problems are often the result of relatively low volume but very high concentration wastewater sources. A typical dead stock rendering plant with three to seven million pounds of raw material per week production capacity generates about 100,000 gallons of wastewater per day with 5,000 lb CBOD and 900 lb TKN per million pounds of raw material.

A typical rendering plant generates wastewater from the following sources:

- Raw material liquids
- Cooking condensate
- Restaurant grease processing
- Blood processing
- Plant wash down and sanitation
- Hide operations
- Air pollution control equipment
- Non-contact cooling water
- Storm water

Even though raw material liquids are only a small fraction of the total wastewater volume, these liquids can be a significant source of CBOD, organic nitrogen, and ammonia. For example, the CBOD concentration of whole blood is in the range of 150,000 to 200,000 mg/l. Liquids that drain from raw materials increase in volume and strength as the raw material quality degrades during long holding periods in hot weather.

In conventional rendering facilities, cooking vapors are cooled and vapor condensate is discharged with the wastewater. The cooking vapor condensate contains condensable organic compounds, ammonium, and aerosol grease and solids carryover from the cooking process. Some rendering processes experience foaming problems and the foaming results in periodic very high concentrations of grease and solids in the vapor condensate. The amount of cooking condensate is easily estimated from rendering process yields. Cooking condensate quality is a function of raw material type and quality. Cooking condensate from feather processing and from degraded raw material can have very high ammonia concentrations. Typical cooking condensate has 2,000 to 5,000 mg/l CBOD and 500 to 1,000 mg/l TKN.

Some rendering facilities use short term, high temperature treatment of cooking vapors to destroy odorous organic compounds and discharge the thermally treated vapors to the atmosphere rather than condense the water vapor. These plants do not generate cooking condensate liquid waste.

The free water removed from restaurant grease is very high strength due to free fatty acids and protein degradation products. Typical restaurant grease process wastewater has 50,000 to 100,000 mg/l CBOD, 100 to 800 mg/l phosphorus, and 1,000 to 3,000 mg/l TKN.

Steam coagulation and centrifugal separation of whole blood generates serum water that has very high CBOD and TKN concentrations. Typical blood serum water has 7,000 mg/l CBOD, 150 mg/l phosphorus, and 1,800 mg/l TKN.

Hide salt brine raceways generate wastewater that has very high TDS, sodium, and chloride concentrations. Typical chloride concentrations in salt brine hide operations are 100,000 to 150,000 mg/l.

Packed bed air scrubbers produce wastewater with relatively low organic strength but high TDS concentration due to the addition of chemicals such as bleach and caustic soda.

Primary Pretreatment

Conventional wastewater pretreatment prior to discharge to municipal sanitary sewers involves removal of oil and grease and suspended solids. The removal of suspended solids also removes the CBOD fraction that is associated with the suspended solids.

Conventional wastewater pretreatment includes the following unit operations:

- Screening
- Gravity separation
- Flow equalization

- Chemical pretreatment
- Dissolved air flotation

Rotary drum screens with opening sizes of about 0.030 inches are used for removal of large diameter solids.

Gravity separation is the removal of particles and free floatable grease by gravity. The solids and grease are removed in circular or rectangular tanks with scraper mechanisms for continuous grease and solids removal.

Flow equalization is used to provide a more consistent flow rate and wastewater characteristics for downstream pretreatment operations. Flow equalization tanks also act as grease traps for partial protection of downstream operations from slug grease discharges.

Chemical pretreatment is the addition of chemicals to enhance the removal of oil and grease and small solids. Solids and grease remain in suspension due to surface charge characteristics. Most solids in suspension have net negative surface charges. Reduction of the pH with acid addition reduces the negative surface charge. Addition of metal coagulants such as aluminum sulfate (alum) further reduces the net negative particle surface charges and forms metal precipitates that trap the small solids inside larger agglomerates of solids called floc. Organic polymers with high surface charges further assist with coagulation of solids and floc formation.

The destabilized solids from the chemical pretreatment step are typically removed with dissolved air flotation (DAF). Conventional DAF involves introduction of water that is saturated with air at high pressure along with the chemically pretreated wastewater into a circular or rectangular open-top tank. As the pressure is reduced, the air comes out of the solution, small bubbles form on the particles, and the particles float to the tank surface. The solids are scraped from the surface and removed. A portion of the treated wastewater is re-circulated to the dissolved air pressurization system.

Pretreatment with chemicals and DAF typically produces wastewater with less than 100 mg/l oil and grease and TSS. Solids and grease recovered from pretreatment operations are commonly rendered along with the raw material.

Conventional pretreatment does not remove soluble CBOD or soluble TKN. Soluble proteins can be removed with aggressive chemical pretreatment for denaturing proteins followed by DAF. Proteins can be denatured with acid addition to very low pH and/or addition of a strong oxidizing agent such as chlorine. Aggressive chemical pretreatment for soluble protein removal is usually not cost-effective as compared with biological secondary wastewater treatment.

Secondary Treatment

Secondary treatment refers to the removal of organic contaminants using biological treatment processes. Secondary treatment processes involve the same basic natural biodegradation of the organic matter that occurs in streams and lakes. The biodegradation occurs in tanks with very high concentrations of microorganisms so that the organic matter can be removed from the wastewater in a much shorter time period than in the natural aquatic environment.

Anaerobic secondary treatment is the biological removal of organic contaminants in the absence of oxygen. Most of the organic matter is converted by bacteria into methane and carbon dioxide gas referred to as biogas. Some of the organic matter is incorporated into biomass or sludge. Organic nitrogen is converted into ammonia. The biogas is about 70 percent methane, or natural gas with a heating value of about 700 BTU per cubic foot. The biogas can be recovered for use as a boiler fuel for heating the anaerobic process and for use in production plant boilers. Anaerobic processes produce about eight to ten cubic feet of natural gas equivalent per pound of CBOD removed.

Anaerobic lagoons and covered anaerobic reactor tanks are typically used in the rendering industry for anaerobic biological secondary treatment. The tanks are covered for control of air emissions and biogas recovery. Many newer anaerobic lagoons are covered with plastic membranes for biogas recovery. Anaerobic processes perform best at about 100ºF. Anaerobic lagoons are typically not heated. Anaerobic reactor tanks are usually heated to maintain the 100ºF optimum operating temperature. Anaerobic pretreatment removes about 80 to 90 percent of the CBOD. Most of the organic nitrogen is converted to ammonia. Therefore, there is no significant reduction in TKN with anaerobic secondary treatment.

Aerobic secondary treatment is the biological removal of organic contaminants in the presence of oxygen. Organic matter is converted by bacteria and other microorganisms into carbon dioxide, water, and biomass or sludge. The activated sludge process is commonly used for aerobic biological treatment. The activated sludge process includes aeration tanks in which oxygen is supplied to the microorganisms using compressed air and air diffusers. The microorganisms, referred to as activated sludge, are removed from the treated liquid by gravity in a separate clarifier tank and returned to the aeration basin.

Batch treatment processes, or sequencing batch reactors (SBR) are also used as secondary treatment processes. A separate clarifier tank is not used in the SBR process. The SBR process is operated as a batch process. Solids are separated in the aeration tank by turning off the aeration air, allowing the solids to settle, and decanting the liquid.

The activated sludge solids are retained in the aeration basin system for several days even though the liquid retention time may be less than two days. The long solids retention time provides for very rapid removal of organic contaminants. The activated sludge process generates about four to five times the mass of biological solids per pound of CBOD removed than anaerobic processes. The disposal of the activated sludge biosolids can be a significant operating cost. Waste activated sludge is typically land-applied as a plant nutrient and soil amendment.

Aerobic and facultative lagoons have been used for biological secondary treatment, but the use of lagoon treatment for direct discharge to streams is becoming less common as the discharge limitations become more stringent. Lagoon treatment produces discharge with significant TSS concentration due to algae growth in the lagoons. Lagoon treatment requires very long retention times to achieve ammonia removal in cold climates.

Disinfection

Disinfection refers to the removal of pathogenic organisms. Use of a strong oxidizing agent such as chlorine or ultraviolet light is commonly used for disinfection of rendering plant wastewater. Chlorine gas and sodium hypochlorite or bleach are common sources of chlorine. Chlorine contact basins are designed with adequate volume and flow control baffles to ensure that the liquid is retained for at least 15 minutes prior to discharge. Chlorine is toxic to aquatic life. Unreacted chlorine is removed prior to discharge with a reducing agent chemical such as sulfur dioxide or sodium metabisulfite.

Tertiary Treatment

Tertiary treatment refers to processes that remove contaminants beyond conventional CBOD and TSS removal in secondary treatment processes. This includes ammonia, total nitrogen, phosphorus, and enhanced TSS removal. Tertiary treatment is frequently required to meet nutrient and ammonia discharge limits. Suspended solids removal may be required for meeting stringent CBOD or BOD discharge limits because biodegradable, organic suspended solids contribute to CBOD.

Organic nitrogen is converted to ammonia in anaerobic and aerobic biological treatment processes. Ammonia can be biologically converted to nitrate in the activated sludge process under the proper operating conditions. This process is called nitrification. Nitrification is accomplished in the activated sludge secondary treatment process by providing proper operating conditions. In general, nitrification requires longer solids retention times than conventional activated sludge process operation because the nitrification bacteria have slower growth rates than other organisms. The nitrification process requires adequate aeration to provide oxygen for the biological conversion of ammonia (NH_3) to nitrate (NO_3^{2-}). Nitrification also produces acid so pH control and alkalinity addition is usually required.

Nitrification processes usually achieve ammonia nitrogen concentrations of less than two mg/l. Nitrate removal is required for meeting nutrient, or total nitrogen, discharge limits. Nitrate is removed by the biological conversion of nitrate to nitrogen gas in the absence of dissolved oxygen. This process is called denitrification. Bacteria in the presence of nitrate, no dissolved oxygen, and a food source utilize nitrate in a manner similar to oxygen and convert the nitrate to nitrogen gas. This is called anoxic biological treatment. Anoxic treatment is a separate stage of biological treatment. Ammonia is converted to nitrate in aeration basins as part of the secondary treatment process. The sludge removed in the clarifier following the aeration basin and the aeration basin effluent contain nitrate and bacteria, but very little organic carbon food source. Dentrification is accomplished by bringing the clarifier return sludge and re-circulated aeration basin effluent in contact with raw wastewater in a mixed, but non-aerated basin. The bacteria use the nitrate as they metabolize the organic matter in the raw wastewater.

Denitrification is accomplished in SBR batch processes by operating with extended periods of no aeration after raw wastewater is introduced at the start of each batch. The denitrification process provides some benefits to the operation of the nitrification process. The use of CBOD in the raw wastewater as a food source in the anoxic process reduces the CBOD load and aeration requirements in the activated sludge process. The denitrification process produces alkalinity and raises the pH. This reduces the alkalinity chemical addition required in the activated sludge process for neutralization of acid produced by nitrification. The effluent nitrate concentration achieved with denitrification processes is dependent on the relative concentrations of TKN and CBOD in the raw wastewater and the sludge recirculation rate. There must be adequate CBOD available as a food source in the anoxic process for nitrate removal.

Phosphorus is removed by chemical precipitation. Phosphate is precipitated with aluminum using aluminum sulfate (alum) and with iron using ferric chloride or ferric sulfate. The chemicals are commonly added ahead of the clarifiers in an activated sludge secondary treatment process. The precipitated phosphate solids become part of the activated sludge. Separate stage phosphorus precipitation following the activated sludge clarifiers can be used to produce a phosphorus rich sludge and reduce the solids loading on the activated sludge process.

Phosphorus can be removed biologically in the activated sludge process under the proper operating conditions. The bacteria can concentrate the phosphorus in the biomass. The use of long solids retention times required for nitrification and denitrification at rendering facilities usually do not provide the operating conditions conducive for biological phosphorus removal. Chemical phosphorus removal can consistently achieve one mg/l total phosphorus discharge quality.

Additional suspended solids removal is usually required if the suspended solids and CBOD discharge limits are less than about 15 mg/l. Enhanced suspended solids removal is commonly accomplished with filtration using granular media filters. The suspended solids are captured within the pores of deep bed filters. Deep bed filters are single media sand or dual media sand and anthracite coal. The solids are removed from the filters by backwashing with water and air. Shallow bed filters remove solids by capturing the solids on the upper surface of the very small diameter granular filter media. In moving bridge filter equipment, the filter is divided into narrow segments. The solids are cleaned from the media surface by water backwash using a traveling backwash mechanism that isolates and backwashes each filter segment. Tertiary filtration can consistently achieve five mg/l TSS discharge water quality.

Land Application

Wastewater from rendering operations can be applied to agricultural land for beneficial use of the water as an irrigation water supply. The nitrogen and phosphorus contained in the wastewater is used beneficially as a supplement or replacement for commercial fertilizers. The organic carbon in the wastewater stimulates the growth of beneficial soil bacteria.

Wastewater application rates are usually limited by the nitrogen or phosphorus uptake rate of the crop, or agronomic rate. Wastewater is usually pretreated for reduction of CBOD prior to storage and land application for minimization of odor emissions. Extensive pretreatment is not required because the ammonia, phosphorus, and organic matter in CBOD are beneficial for soil fertility. Therefore, land application can have a significant capital and operating cost advantage over secondary and tertiary treatment and discharge to a stream.

Wastewater is land-applied using conventional irrigation equipment such as center pivots and traveling guns. Highly concentrated wastes with potential for odor emission can be land-applied with direct injection to the root zone with knife or field cultivator injection.

Use of sodium and other dissolved salts are limitations to the use of land application disposal. Excessive sodium application can cause clay soils to expand and lose the porous soil structure. This leads to inability to percolate water through the soil profile and development of a hard soil crust and loss of fertility. Dissolved salt application is a particular concern in arid climates where the salts accumulate in the upper soil profile due to high evaporation and low precipitation rates.

Air Quality Issues

Odor emissions have historically been the most significant air emission issue in the rendering industry. Regulation of odor emissions has been challenging due to the difficulty in quantifying odor concentrations. Odor emissions are often regulated at the local governmental level and regulations are often based on nuisance concepts rather than on analytical concepts.

The use of citizen or expert odor panels in qualitative evaluation and characterization of odors is frequently used in the evaluation of odor emissions. The odor unit concept has been developed as a method of quantifying odor intensity. The odor unit is a measure of the dilution required to reduce the odor to a concentration that is not detected by a panel of odor experts.

Other air emissions from rendering facilities are regulated by the EPA under the Clean Air Act and by states. In general, ammonia, particulates, nitrogen and sulfur oxides from boiler operations, and hydrogen sulfide or reduced sulfur are the emissions of most concern at rendering facilities. Greenhouse gases from boiler operations may become significant issues in the future.

Air Emission Controls

Rendering facilities have extensive controls for odor and particulate emissions. Most facilities do not have significant emissions of other constituents that require operation of emission control equipment. Particulate emissions from production operations that generate dust are commonly controlled with bag houses. Bag houses are fabric filters that capture particles as the air is passed through the filters. The filters are cleaned by periodic air purging and/or vibration.

Rendering plants are designed for capture and treatment of potentially odorous air and vapors. The room air ventilation systems are designed for maintaining negative pressures in the rooms, thereby preventing air escape from the rooms. Production operations that generate high intensity odors are designed with vapor and air collection systems that isolate the odor sources from the lower intensity room air.

Odor control methods include the following processes:

- Chemical oxidation
- Combustion
- Thermal destruction
- Biological odor reduction

Chemical oxidation involves absorbing the odorous compounds into water and then oxidizing the odorous compounds with a strong oxidizing agent such as chlorine or chlorine dioxide. Odorous compounds can also be oxidized directly in the vapor phase with ozone. The air from room air ventilation systems is usually scrubbed in a chemical oxidation system using packed bed scrubbers with chlorine, bleach, or chlorine dioxide.

Cooking vapors have high odor intensity. Cooking vapors are often treated in a two-stage process. The vapors are cooled and particulate is partially removed in venturi scrubbers. The vapors are passed through a venturi pipe restriction at a high velocity. Water is sprayed upstream of venturi. The cooking vapors are cooled and portions of the particulate and aerosol grease entrained in the vapors are removed in the venturi. The vapors from the venturi can be further treated in a chemical packed bed scrubber.

Cooking vapors can also be condensed with an air-cooled condenser or a shell and tube condenser using non-contact cooling water. The non-condensable vapors can be treated chemically or incinerated in a boiler. The high intensity odors from rendering processes and non-condensable cooking vapors are often used blended with combustion air at the plant boilers. The odorous compounds are incinerated in the boilers.

Odorous compounds can be removed by thermal destruction. Thermal destruction involves heating the odorous vapors to very high temperatures that result in destruction of the odorous compounds. This technique is applied to treatment of cooking vapors and other very high intensity odors. The advantage of thermal destruction of cooking vapors is that it does not generate cooking vapor condensate. The water evaporated from the cooking process leaves via the air emissions rather than as a wastewater emission.

Odorous compounds are organic compounds that can be used as a food source by bacteria. Biofilters are used for biological removal of odor. A biofilter consists of a packed bed that serves as a support structure for bacterial growth. The odorous air is passed through the packed bed. The odorous compounds are absorbed into the moist bed and bacteria consume the compounds as a food source.

Other Environmental Issues

Compliance with all environmental regulatory requirements can be very challenging, particularly for small, independent renderers that do not maintain full-time environmental staff. The following is a partial list of environmental regulations and requirements for operation of rendering facilities:

- Wastewater NPDES permitting for process wastewater discharges to streams
- Local wastewater pretreatment and discharge permitting
- Storm water NDPES permitting and reporting
- Spill Prevention Control and Countermeasures plans and implementation
- Land application permitting and reporting
- Air emission permits and inventory reporting for Clean Air Act Title V regulations
- Toxic chemical release reporting
- Underground and above ground storage tank registration and reporting
- Hazardous chemical inventory reporting
- Emergency Planning and Community Right-to-Know regulations
- Solid and hazardous waste disposal requirements

It is becoming increasingly difficult to manage environmental compliance and track environmental issues as the federal and state regulations grow at seemingly exponential rates. Many renderers rely on industry and trade organizations such as the NRA and the AMI and their environmental committees for monitoring the development of environmental policies and regulations. These industry and trade organizations pool the resources of its members to maintain close watch on developing environmental issues and policies. These trade organizations retain legal and technical consultants for monitoring regulatory agency and legal developments, and for developing the trade organization policies on environmental issues. While the trade organizations have been quite effective in providing professional and scientific input into the development of federal rules and policies, it has been quite difficult to monitor the state and local regulatory developments.

Environmental Management Systems

The development of the EMS concept in recent years is a step toward self-regulation and environmental quality improvement implemented on a plant scale. The EMS approach to environmental management in meat packing, food processing, and rendering industries has been developed in a cooperative effort between federal and state regulatory staff and industry organizations including the AMI's Environmental Committee.

An EMS is a systematic, iterative approach to achieve individualized, facility specific environmental and other organizational goals through continuous improvement. It is based on the objective of identifying environmental or process weaknesses that can adversely impact the operations. The EMS approach ranks the weaknesses and develops a prioritized schedule for resolving the problems. Progress is evaluated annually and the plan is modified for continuous improvement. The results improve financial performance and reduce environmental noncompliance risks. The EMS system energizes the employees to become part of the improvement team.

The International Organization for Standardization (ISO) has developed a standard for EMS systems. The ISO standard 14001 defines EMS as "the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing, and maintaining the environmental policy."

An EMS accomplishes the following:

- Identifies environmental risks and impacts
- Prioritizes risks and impacts
- Applies management control to risks and impacts
- Builds a business case for continuous improvement

An EMS includes evaluation of regulatory compliance, pollution prevention, waste reduction, and utility management. Facilities that have implemented EMS programs have documented significant improvements in environmental compliance records and reductions in operating costs that have greatly exceeded the costs of EMS program development.

Regulatory agencies, including the EPA, are encouraging the development and implementation of EMS programs. EPA has indicated that it may reduce the frequency and scope of regulatory compliance inspections and relax enforcement action penalties for facilities with EMS programs.

A formal ISO 14001 EMS is a very structured approach that requires periodic outside audits by ISO certified auditors. Full implementation of the ISO 14001 EMS program is a big task and experience has demonstrated that the ISO 14001 EMS is not suited for all facilities. An EMS program can be developed in phases, or tiers, that address the facility's immediate needs and then expanded in the future. The AMI Environmental Committee has developed a four-tier EMS program and model EMS that leads to ISO 14001 certification.

Cooperative Development of Environmental Protection Standards

The rendering industry has voluntarily participated in EPA research and industry survey projects. Renderers have assisted regulators with technical input and review of proposed environmental regulations. This type of cooperative work, rather than the traditional confrontational relationship with regulators, is leading to the development of federal rules, regulations, and policies that are based on the application of reliable and economically feasible control technology to provide adequate environmental protection.

As environmental protection and regulation expand to address future environmental quality concerns, cooperation between regulators and the regulated community will become more important. This cooperative effort is required for development of environmental policies and regulations that are reasonably and economically achievable.