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ANIMAL WASTE UTILIZATION WORKSHOP

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I. Executive Summary

The workshop goal was to develop a roadmap for potential FETC R&D activities that support the livestock breeding sector of the U.S. economy while resolving water and air pollution issues. A collateral objective of the workshop was to provide a participatory forum where stakeholders could address and build consensus on research topics and technology priorities for the deployment of new animal biomass disposal techniques. The desired workshop output is a roadmap of promising technology approaches, R&D needs, and timing to support future government-industry R&D partnerships for utilization of animal biomass as opportunity fuels in combustion and gasification and to develop and demonstrate efficient and economical next-generation animal biomass management technologies.

The workshop consisted of oral presentations and breakout group sessions to share information and stimulated discussions on various topical areas. A wide variety of papers covering many technology areas, such as, Environmental and Health Drivers for Improved Animal Waste Management, Animal Waste Management Opportunities, Needs, Issues and Answers, and New Management Technologies were presented at the Workshop. The overview presentations provided background information and stimulated discussions at the breakout sessions.

Three breakout sessions were held on the following topics.

- New Concept for Animal Waste Management and Engineering R&D Needs
- Success Indicators, Environmental and Regulatory Issues, and Public Policy
- Economic Issues and Financing

Three sessions addressed barrier issues and built consensus on research needs and technology priorities for advanced animal biomass utilization processes, prevention of nutrient waste discharge to water supplies, and compliance with legislation.

Two realities will drive the change in the management of animal waste activities. First, producers will face increasing waste management regulations. Second, the deregulation of electric utility industry and its effect on the cost of electricity. One or the other will push this market. Future options would include on-site integrated digester/distributed generation to consume the waste and generate competitively priced electricity with lower NOx emissions. Public support is essential to the success of animal waste management. The consensus was to get away from the term "animal waste" to a more acceptable standard term. The workshop consensus was that the term **"Animal Biomass"** was the best option to focus on the problem.

II. Background and Motivation

The management of animal biomass has become one of the most important issues to the animal breeding industry sector in the U.S. Regulations provide guidelines for livestock and poultry operations to manage their waste. Traditional disposal methods use animal waste as a fertilizer. These methods require proper land application at agronomic rates and soil management to ensure beneficial use and watershed protection. The Poultry Electric Energy Power Act bill was introduced in April 1999. This bill would revise the IRS Code to allow a tax credit for producing electricity from poultry waste. In addition, the Animal Feeding Operations (AFO) joint strategy between EPA and USDA was released in March 1999. It is crucial that the Cooperative State Research, Education, and Extension Service (CSREES), through the Land Grant System of Institutions, be at the forefront of conducting research and disseminating the knowledge to the producers and agencies involved. The Land Grant System of Institutions is located in each state and territory.

The continued growth toward larger animal feeding operations has raised questions about the air and water quality throughout the U.S. and its potential negative health impact on our citizenry.
The size of the operation and the amount of waste produced keep increasing while the land available for application keeps decreasing. Certain pathogens related to animal waste, as well as nitrates and algae, have been found in certain foods and in our drinking water. Recent outbreaks of *Cryptosporidiosis* and *E. Coli* have alerted the public to the possible dangers of contamination from animal waste. The recent "mad cow disease" scare in the U.K. has caused a public awareness of possible infection routes within the human food chain.

Policies seeking to regulate the use and disposal of animal biomass must have a clear connection to the technological solutions available to the farming community. Failure to ensure economic solutions to problems and the inability to provide opportunities to offset additional disposal costs can lead to severe disruption of farming communities and all those who depend on them. A careful balance of regulatory incentives and penalties, coupled with improved technologies and education, is needed. The regional dimensions of the operation, the business, environmental, and social aspects, make this an area for involvement of federal, state and local authorities. In addition, all of the stakeholders - the whole agribusiness industry from fertilizer, feed and equipment manufacturer, farmer and integrator, wholesalers and retailers, transporters, the environmental community, and bankers - need to be involved in finding beneficial solutions that can enhance both the animal waste management business and the environment. Maximizing the benefits from the use of animal biomass will require policies and regulations, combined with technologies that provide a win-win situation for all players. The animal biomass is a resource as a fertilizer, for soil amendment, and as a source of chemicals and energy. The beneficial balance of such products will vary widely from case to case. Therefore, a wide range of solutions to animal biomass use must be developed.

Combustion of animal biomass is one way to use livestock and poultry manure while reducing water and air quality problems and lessening the transmission of certain disease organisms. Using animal biomass as a fuel can eliminate its use in products that might be hazardous to human health, and can also reduce the need for conventional fuels. Cofiring with animal biomass would help reduce greenhouse gas and SO_2 emissions and reburning with animal biomass would lower NOx.

III. Oral Presentations:

The abstracts and a full-length paper in this section have been reproduced primarily on an “as received” basis with only minor editing.

(1) Economic and Technical Feasibility of Energy Production from Poultry Litter and Nutrient Filter Biomass on the Lower Delmarva Peninsula

Authors: Edward E. Gray, P.E. and Kevin S. Comer, Antares Group Incorporated

The Northeast Regional Biomass Program has sponsored a broad-based investigation of the potential for biomass production and energy conversion systems to provide economic solutions to the environmental problems associated with the land application of poultry litter. Antares was commissioned to assess the energy technologies and applications that had the best potential, technically and economically, to use poultry litter and nutrient filter biomass fuels.

Opportunities for bioenergy exist on the Delmarva Peninsula in the industrial, public, and private heat and power generation markets. Coal is the source of 54 percent of energy consumed by electric utilities in Delaware. In total, there is about 920 MW of large-scale coal or oil-fired power generation capacity on the lower Delmarva Peninsula. The entire annual lower Delmarva poultry litter generation (over 550,000 tons per year) is enough to fuel more than 40 MW of power generation capacity. This is about 4 percent of the utility power generation capacity on the Delmarva. Cofiring operations have been designed to allow as much as 15 percent of a power plant’s heat to come from biomass. Although to date no cofiring operations have been commercialized using poultry litter, the relative amounts of poultry litter production and power generation capacity indicate that cofiring is an option for consideration on the peninsula.

Opportunities for poultry-litter combustion in Delmarva’s industrial sector, including the poultry processing industry, were also explored and show significant potential. Three of Delaware’s top 25 employers are poultry processors. Some of these facilities have heat and power requirements well-suited for cogeneration. The annual heat requirement for the lower peninsula’s poultry industry is estimated at about 700 billion Btu per year, a figure equivalent to the heat contained in about 70,000 tons of litter (per year). The industry’s annual electricity requirements exceed 200 million kWh per year-- two-thirds of the total electricity generation potential for all poultry litter on the peninsula.

Antares and its Consultants, Foster Wheeler and T. R Miles Technical Consulting, evaluated the suitability of technologies for three classes of potential consumers on the Delmarva Peninsula: bulk power producers, poultry and other industrial process facilities, and institutional facilities. The biomass resources of interest to this effort are the waste poultry litter generated by the poultry industry and harvested nutrient filter materials. Results from the study will be presented.

(2) Presentation Title: Animal Waste Management Research and Issues

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The management of animal manures has become one of the most important, if not the most important issue, to animal agriculture in the U.S. Many of the state legislatures have introduced or passed legislation in the 1996-98 period on how the livestock and poultry operations manage their manure. At the present time, some states have placed moratoriums on the construction of any new animal production facilities. The Environmental Protection Agency (EPA) is in the process of writing effluent guidelines for animal wastes. The Animal Feeding Operations (AFO) joint strategy between EPA and USDA was released in March 1999. Therefore, the Cooperative State Research, Education, and Extension Service (CSREES), through its state partners, must be at the forefront of conducting research and disseminating the knowledge to producers and agencies involved with this topic.

The continued trend of larger animal feeding operations has raised many concerns about air and water quality throughout the U.S. This concentration of animal production facilities has been most prevalent with poultry and more recently with swine. For example, in the hog industry's top 10 production states, the inventory controlled by the operations in the largest category (500 or more hogs) increased from about 40 percent of the inventory of these states in 1978 to about 77 percent in 1994. In the broiler sector, the largest category (100,000 or more birds sold) increased from 70 percent of national sales in 1974 to about 97 percent in 1992. For dairies and beef feeding operations, the management of manure is one of their most difficult problems, just as it is for poultry and swine. Complicating the situation is the sociological issue of large farms vs. the traditional "family" farm and the effect on the community.

The presentation will summarize the current research that is cooperatively supported through federal funds cooperatively with other federal or state funds. This will include over 500 projects classified by animal species (dairy, beef, poultry, and swine) and category (animal mortalities, animal by-products, water quality, air quality, animal nutrition, land application, treatment/storage/collection, pathogens, social, and economics. These categories are generally the major issues being addressed on animal waste management.

(3) The Development of a Modular System to Burn Farm Animal Waste to Generate Heat and Power

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This paper will describe the author's experience in designing, building, developing, and testing about 40 bubbling fluid-bed boilers that have burned different fuels. Some reference will be made to the building of about 14 CFB boilers that also were used for a number of different fuels.

The main thrust of this paper is the description of the latest design of the packaged Internally Circulating Fluid Bed watertube boilers. A recent example is the installation of such a boiler at the Resthaven Nursing Home near Pottsville, PA. This design is suitable for supplying heat and power in the range of 50-200 KW with fully automated control for unattended operation.

The problems of burning poultry litter in fluid beds are discussed with particular reference to operational problems that can be caused by low temperature eutectics in the fuel and also by high concentrations of nitrogen and ammonia. The control of these elements is described and the results are discussed.

(4) Design and Operating Challenges In the Combustion of Human and Animal Waste

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INTRODUCTION

At the present time, there is a dearth of information regarding the thermodynamic characterization and combustion of animal waste. In an effort to supplement this information deficiency, lessons learned from the combustion of human waste appear to represent a reasonable alternative. The purpose of this paper is not to provide the reader with detailed technical information regarding waste combustion, and to provide an overview of the problems. Although this description of some of the potential animal waste combustion problems may seem to represent a pessimistic view of the process by the authors, it is not. Indeed, each of the authors has worked for more than 30 years in the field of combustion and has seen a multitude of waste disposal problems successfully solved with this process. They have also seen failures and recognize that the continued future of waste combustion depends on minimizing these failures.

In this paper, the authors are attempting to provide the reader with sufficient insight to recognize potential pitfalls in his/her search for a solution. With recognition of the problem comes the opportunity for a solution. Reader desiring more specific engineering details on combustion systems are encouraged to consult the reference list.

DEFINITIONS OF HUMAN AND ANIMAL WASTE

Human waste generally falls into two categories, municipal solid waste (MSW) and sewage sludge. MSW is collected from both residential and industrial sources. Although it is extremely heterogeneous, it generally can be represented by the following average composition:

Moisture	25%
Ash	25%
Combustible	50%

The higher heating value (HHV) of the combustible fraction is approximately 10,000 Btu/Lbm. The HHV for the above mixture of MSW would be 5,000 Btu/Lbm.

In a wastewater treatment plant, the solids are separated from the effluent in what is termed the dewatering step to form sewerage sludge. To reduce the moisture content, the sewerage sludge is usually dewatered by centrifuges or belt filters. When the dewatered sewerage solids are applied to the land, for either beneficial use or simple disposal, they are called biosolids. This has assisted in the effort to gain public acceptance of this disposal option. However, when we discuss sewerage solids in context with combustion, we will continue to use the term sludge because of its inference to a high moisture content.

Sludge from a wastewater treatment plant can be a combination of both primary and secondary solids. The sludge is made up of many cellular organisms containing bound water. Secondary sludges contain a greater percentage of bound water, thus making dewatering a more difficult operation. As a result of differing wastewater treatment methods and dewatering methods, the moisture content of dewatered sludges can vary from 60% to 85%. In the jargon of wastewater treatment plant operation, the solids are broken down into two fractions, volatiles and ash. Again, because of the wide differences in municipal collection systems and treatment plant practices, the fraction of volatiles will vary. However, 50% - 70% is a reasonable range. The HHV of the dry volatile solids will, like MSW, be approximately 10,000 Btu/Lbm. This is no surprise because in both cases they are a similar mixture of cellulose and oil.

Expressed in the same format as the MSW analysis above, a somewhat typical sludge composition would be:

Moisture	70%
Ash (Inerts)	12%
Combustible (volatiles)	18%

The HHV for the above mixture would be 1,800 Btu/Lbm. A good method of thermodynamically comparing high moisture wastes is the ratio of Btu's to pounds of water. For the MSW whose composition is given above, this ratio is 20,000. For the sludge, it is 2,571. In this example, the MSW is a significantly better fuel.

At this time, there does not appear to be a simple characterization of animal waste. For this paper, it is assumed to comprise of manure, urine, straw, and other forms of litter along with some agricultural (crop) waste.

HISTORICAL BACKGROUND

The first full-scale municipal sewage sludge incinerator was placed into operation in Dearborn, Michigan in February 1935. It is a multiple hearth furnace. The first fluid-bed sludge incinerator was installed at Lynnwood, Washington in 1962. A fluid-bed sludge incinerator has recently been retrofitted with overfire air nozzles to increase capacity by more than 50%. Although the total number of sludge furnaces built and operated in the U.S. is uncertain, a reasonable estimate is 400 multiple hearths and 200 fluid beds. The experiences gained from this history should be used by those evaluating combustion as a disposal option for animal waste. The application of combustion as a means of animal waste disposal appears to have been somewhat sporadic, probably due to its high cost relative to land disposal.

COMBUSTION, GASIFICATION, AND PYROLYSIS

No matter what the thermodynamic process, the ultimate goal is to react the carbon and hydrogen in the waste with oxygen to form carbon dioxide and water. Any ash (inerts) in the waste will generally be oxidized in the process. A flame with a sharply defined blue cone represents combustion with just the right amount of air. This is called stoichiometric air. If the air is reduced, a long, yellow flame is present. This scenario at less than stoichiometric air is called sub-stoichiometric combustion and is perhaps more commonly known as “running rich.” If the air is increased past what is theoretically required, some long, pale blue flame results. This is commonly referred to as “running lean.” Simple combustion in a furnace or incinerator is generally combustion at approximately 25% to 75% more air than is theoretically needed. A 50% extra air operation could be called either 50% excess air or 150% stoichiometric air.

Gasification and pyrolysis are variations on the combustion theme. Gasification is conducted with less than the required air, also known as sub-stoichiometric. Pyrolysis is a destructive distillation process resulting from heat applied in the absence of oxygen. A simple example of gasification is smoking a cigarette, cigar, or pipe. When something is cooking in a covered frying pan and gives off large quantities of smoke because it has gotten too hot, that is pyrolysis. The primary reason for the employment of either gasification or pyrolysis is to produce a combustible gas (smoke in the foregoing examples) that can be combusted, or otherwise utilized, in a remote location directly connected to or some distance downstream from the gasification or pyrolysis chamber.

With the current concerns about the "Greenhouse Effect," broad ranging research efforts are now directed at processes that sequester the carbon and utilize the hydrogen to generate electrical power. Anaerobic digestion, gasification, pyrolysis, with downstream reforming to hydrogen and carbon monoxide for distributed power generation using fuel cells, represent some of the processes currently under investigation.

COMBUSTION OF ANIMAL WASTE

Economic Challenges

The major historical stumbling block to the combustion of animal waste and the conversion of the liberated energy to electrical power is quite simply economics. The cost of time tested, well built, and reliable combustion equipment is high and the economies of scale work against the small furnace. The thickness and other general construction details of a refractory wall to contain 1,600EF is, for all practical purposes, the same regardless of the quantity of waste being combusted.

Material Handling Challenges

Just as you cannot operate an automobile by pouring a cup of gasoline into the engine every mile or so, you cannot feed an incinerator in large batches. A uniform and continuous feed, although admittedly difficult to achieve with a heterogeneous material such as animal waste, is a necessity to a successful operation. MSW furnaces, with their highly heterogeneous feed, are able to feed in a continuous batch mode consisting of small charges of waste. The time between charges is not strictly on a time mode. The experienced furnace operator takes into account the combustion conditions within the furnace resulting from the previous charges. Furnaces, such as a fluidized bed, are known for their "thermal inertia" due to the large mass of heated sand. However, no known furnaces have a corresponding "oxygen inertia." A sudden overload of fuel will quickly deplete available oxygen, resulting in a rapid departure from the intended operating mode.

Clinkers and Slag

One potential problem, often overlooked in agricultural and animal waste combustion, is the formation of clinkers and slag, which can result in excessive downtime and extremely high maintenance costs. The chemistry of slags is extremely complex. Although the American Society for Testing Materials (ASTM) and others have developed tests to determine ash fusion temperatures, the heterogeneous nature of the waste coupled with the ever-changing thermodynamic conditions within a firebox have made accurate predictions from laboratory tests difficult. Because of the numerous problems that resulted from alkali deposits in full scale biofuel-to-energy facilities, DOE/NREL, along with other government agencies, universities, and private industry, initiated a study to characterize the chemistry and firing characteristics of some of these biofuels. Summary results were distributed to participating member organizations in 1995. As a result of this work, improved ash softening test procedures can now better predict what actually will happen in a furnace.

There is a great risk in attempting to generalize on slag, clinker, and alkali deposit formation. One of the important findings of the alkali deposit study was to clearly demonstrate the need for detailed and specific information. As you go from trunk to leaf in some trees, there is a significant increase in alkali deposits resulting from combustion. Experience has also shown the merits of what might appear an ultraconservative approach. At least one fluidized-bed manufacturer that operates a pilot-scale furnace for test purposes, does so for a minimum of five days, 24 hours a day (120 hours total), when testing a new, potentially slag-forming waste material. This approach allows trace elements to reach long-term equilibrium concentrations where they might cause a problem.

Energy and Economics

It takes approximately 1,000 Btu to evaporate a pound of water at 212EF. Starting with water initially at 60EF and ending up as water vapor at 1,600EF requires a total of 1,837 Btu. If the purpose of the combustion process is to generate steam and the fuel has a high moisture content, a lot of the potential steam ends up on the wrong side of the boiler tubes. When combusting a high moisture waste, auxiliary fuel usage can be minimized through the use of a flue gas to combustion air heat exchanger. A rough estimate of minimum solids content for autogenous (no auxiliary fuel required) combustion is 30%. At the present time, energy is cheap. Therefore, unless there is a significant disposal tip fee or other economic incentive, waste-to-energy facilities are generally not currently economically viable compared to land disposal operations.

Environmental Challenges

The biggest environmental challenge is not the engineering technology to control emissions, but rather a statement of clear and concise standards to be met. Wet scrubbers and baghouses represent the front line of demonstrated technology capable of meeting extremely stringent standards.

Scamps, scallywags, and scoundrels

The high cost of time-proven, well-built, and reliable combustion systems presents a definite economic shock to animal waste generators who previously enjoyed low-cost land disposal. Unfortunately, this has caused many otherwise sound and cautious companies to ignore good business practices and invest in unproven equipment. The old adage, “If it sounds too good to be true -- it probably is” most definitely applies to many of the pyrolysis and gasification systems. In the proper situation, pyrolysis and gasification offer many unique advantages. However, the capital and operating costs are rarely lower than conventional combustion systems.

The First and Second Laws of Thermodynamics are the basis for all combustion and energy conversion systems. They are paraphrased below.

First Law of Thermodynamics -- You can't beat the game.
Second Law of Thermodynamics -- You can't even break even.

When presented with the opportunity to purchase a new combustion-based system for a fraction of the cost of a conventional one, the prospective buyer should perhaps remember these laws.

WHAT KIND OF FURNACE?

One of the most common questions is what kind of furnace is best? The answer is there is no "best" furnace. Most of today's furnace designs are good. Several parameters should be examined. The first is the material handling characteristic of the furnace relative to the intended waste to be combusted. If the thermodynamic properties and material handling characteristics of the animal waste is reasonably homogeneous and slagging, clinkers, or alkali deposits do not appear to present a major concern, a wide range of furnace types becomes viable options. For the more difficult material handling wastes, rotary kilns and fluidized-bed furnaces may be the proper choice. When alkali salts, or other slag and clinker-forming constituents are present in the proper combination to combine and form deposits, even the choice of a fluid bed may not be a guarantee of trouble-free operation. The choice of combustion process, combustion, gasification, or pyrolysis will also impact the optimum style of a furnace.

A detailed description of alternate furnace styles, along with the advantages and disadvantages of each, is beyond the scope of this paper. Prior to making any commitment in a thermal disposal system, the reader is encouraged to make sure that material handling, firebox construction, combustion process, and emission control have been thoroughly considered.

NITROGEN OXIDE (NOx) EMISSIONS

Wastewater treatment plant sludge and animal manures contain high quantities of fuel bound nitrogen. Even with a relatively low-temperature combustion process, the emission of nitrous oxides may be high. While ammonia or urea injection is sometimes a viable alternative in large, utility scale systems, installation and operating costs may be prohibitive in smaller sizes.

One method of achieving low NOx operation is with staged combustion. From 1986 to 1996, the City of Los Angeles Hyperion Wastewater Treatment Plant operated three, fluid-bed gasifiers, each rated for 50,000 pounds of steam per hour. Starting with 8% fuel bound nitrogen in the combustible fraction of the sludge, this combustion process utilized four stages of combustion and was able to achieve NOx emissions of less than 30 ppm corrected to 5% oxygen with simultaneous emissions of CO less than 10 ppm.

SUMMARY AND CONCLUSIONS

This paper has presented a broad overview of the many potential challenges in the combustion of animal waste. The authors believe it can provide a road map to help prevent problems of the past from repeating themselves in the future.

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(5) Cofiring of Biomass with Coal: How about Animal Waste? Another Opportunity Fuel

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Evan E. Hughes, EPRI

For the past few years, DOE and EPRI have been involved in a cofiring program that has resulted in several full-scale demonstration cofiring tests of coal and biomass. The variety of animal wastes will probably be as diverse as the types of biomass that can be cofired, however, many of the same issues addressed in cofiring coal and biomass will need to be addressed in cofiring coal and animal wastes. Issues such as fuel handling, preparation, and delivery to the boiler; boiler performance and degradation; and waste issues have been investigated in a variety of pulverized coal plants for biomass cofiring. Many of these same issues will need to be investigated for cofiring or direct firing of animal wastes. Results of the DOE/EPRI program have shown that cofiring coal and biomass is a viable option and in many cases can result in reduced NO_x, SO_2, CO_2 neutral emissions and in some cases reduced fuel cost with only a minor decrease in boiler efficiency (generally around 1%) and no effect on boiler stability. Knowledge gained from biomass cofiring tests could have some usefulness in advancing the cofiring or direct firing of animal wastes. Results from the biomass cofiring tests will be presented along with some information gathered on the potential for cofiring animal wastes.

(6) Cofiring of a Small Scale Boiler Burner With Coal and Feedlot Waste Blends

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Power plants spend nearly 50 billion dollars a year on fuel cost and coal accounts for over 55% of the fuel used in the utility industries. The fuel cost could be reduced by supplementing coal fuels with alternative renewable fuels such as the by-products of industries located in the vicinity of the power plants. One of the by-products of feedlots is manure, a bio-solid fuel which is cheaper than coal, on a tonnage and heat value basis. Coal-manure blend cofiring technology is proposed as a beneficial use of manure for power plants located near feedlots. Such a technology will also lead to reduction in fossil generated CO_2 emission. Experiments were performed in a small scale boiler burner facility with coal only and then for 80:20 blends on a wet-weight (as-received) basis. Data were taken during the warm-up, gasification, and combustion. Three types of feedlot manure were examined for blending: raw feedlot manure (RM), partially composted feedlot manure (PC), and finished composted (FC) feedlot manure. A summary of the findings is as follows: **1**) Manure contained up to 80% volatile matter (VM) on a dry ash-free (DAF) basis, which was twice the VM of conventional coal. **2)** Combustion efficiency was slightly higher with the coal-manure blend (or simply called a blend) than with coal. **3)** NOx emission increased from 420-ppm at 80% burned fraction (BF) to 550-ppm at 95% BF for coal while corresponding numbers for blend were 620 ppm to 550 ppm. **4)** SO_2 increased from 30 ppm to 180 ppm for coal while for the blend SO_2 was almost zero-ppm up to 90% BF, but increased to 10-ppm at 95% BF. Currently more small-scale and pilot-plant experiments are in progress.

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(7) Anaerobic Digestion Technology

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Anaerobic digestion is an engineered methanogenic anaerobic decomposition of organic matter and involves a mixed consortium of different species of anaerobic microorganisms that transform organic matter into biogas. The process is successfully used for the treatment of municipal sludge, animal manure, industrial sludge, and industrial and municipal waste waters. Applications of anaerobic digestion for waste treatment produce significant benefits beyond simple waste removal. These benefits include both energy production and energy conservation. In addition to waste removal, other environmental benefits result from anaerobic digestion, including odor abatement, pathogen control, minimization of sludge production, conservation of nutrients, and reduction of greenhouse gas emissions. Anaerobic digestion is both a waste treatment technology, which enhances environmental quality, and a sustainable energy production technology.

IV. Breakout Sessions

Three breakout sessions were held and the workshop participants were assigned to one of the sessions. The breakout sessions provided a participatory forum for the attendees to discuss the topic and reach some consensus on barrier issues and answers. One representative from each session presented an overview.

IV-1. Breakout Session #1

Title: New Concepts for Animal Waste Management and Engineering R&D Needs

The following items were discussed:

<u>Standard Terms</u>:

Standard terms and terminology are needed in the animal waste management industry. In the human waste business, the waste used to be called sewage sludge (a negative connotation), and it is not politically correct. A number of years ago, in a major renaming effort, it was called biosolids in order to get better public acceptance. Something similar is needed in the animal waste industry to develop a uniform term, and the one suggestion agreed to by the group was **Animal Biomass.** The terminology used in this industry must be standardized and defined.

<u>Definition of Waste</u>:

The participants deliberated on the definition of waste. Waste is something that has no use or value to its owner. Animal biomass does not have the connotation of waste.

<u>Quantity of Animal Biomass</u>:

An estimate of the available amount of animal waste is needed and it is believed that, in terms of population equivalents, animal waste is 25 times that of human waste. The quantity of animl biomass in the U.S. from cttle, hogs, and poultry is approximtely 300 million tons per year.

Satisfy End-User Needs:

The attendees further agreed that it is imperative to focus on end user needs, i.e., the ability to give the farmers what they need and in a size they can use. Firing and handling equipment used by the farmers must be of high quality functional without the need for lot of maintenance or repeated maintenance.

Drivers for Changes:

Economic vs. regulatory, if one doesn't change it, the other one will.
Federal funding for agricultural programs, funded in proportion to the municipal system funding. Cross-discipline education of problems and opportunities.
Novel concepts and thinking outside the box.

Outreach Activities:

Use the Land Grant College and Extension System as an outreach tool.
Coordinate related federal programs across federal agencies (EPA, USDA, DOE, etc.)
Educate farmers and the public on how to address stigmas, myths, and facts.
Publicize demonstration sites and site-specific studies.
Pair energy users with biogas production systems.
Review energy crises research and foreign animal biomass systems -- don't reinvent the wheel.
Stakeholders need a data base providing upto date information on the advancement of the animal biomass management state-of-the-art, preferably on the Internet.

Technology R&D:

- Efficient and profitable use of animal biomass.
- Value-added products:
  - biogas/energy
  - fertilizer
  - soil amendment
  - building materials, particle boards, bricks, etc.
  - Other uses
- Characteristics of Animal Biomass
  - beyond BOD, COD, and Ash
  - chemistry
  - microbiology
  - volatile solids
- Better Material handling Systems

- ! Determine Digester/Energy Value of Non-Manure Biomass
- ! Improved and simplified biogas separation technology
- ! Better manure fibre/water separation technology
- ! High Rate Digesters
- ! Two-Stage Digestion - Improved Acid Phase
- ! Firing Issues - Like alkaline Firing
- ! Study if advances in coal feeders work with animal biomass
    - slurry feed or paste feed
- ! Synergistic Systems
    - Digest then gasify
    - Fuel cell CO_2 to hot house
- ! Improved biosolids pre-treatment for improving digester efficiency
- ! Odor and Pathogen management
    - Genetic Engineering
        - methanogens and other microbes to improve gas quantity and quality
- ! Re-think animal feeding priorities to match desired animal biomass
- ! Genetic selection of animals for more desirable biomass.

The session ended with a final message. It's not waste, unless it doesn't get used. Animal biomass is a resource.

IV-2. Breakout Session #2

Title: Success Indicators, and Environmental and Regulatory Issues, and Public Policy

This section is written in two subsections. Subsection IV-2-i, titled, High Priority Issues, lists and discusses the issues prioritized by the participants, but not necessarily in order of importance. Also, Success Indicators, Environmental and Regulatory Issues, and Public Policy are separately presented under individual headings. In subsection IV-2-ii, the entire list of as-identified issues generated during the brainstorming period is listed.

IV-2-i. High Priority Issues:

A. Success Indicators:

This breakout group identified three main categories of success indicators:

- ! Environment
- ! Regulation and
- ! Policy.

Each of these success indicator categories was further classified into five sub-categories. These are

(1) Product Related, (2) Operation, (3) Societal/Public Relations, (4) Economic, and (5) Legal.

All in all 43 different issues related to these sub-categories were identified. However, only the most important issues for each of the five sub-categories are listed below.

Product Related Area:

The two most important issues were the shared goal of providing energy and food as well as developing a useful by-product.

Operation:

The most important issue cited was to maximize the amount of animal biomass used for energy conversion.

Societal/Public Relations:

Success would occur when farmers, processors, and concentrated animal feeding operations are recognized as good neighbors or accepted by the public other than just the livestock producers.

Economics:

The two most important issues are minimizing the cost to the farmers for disposal of the waste and providing a benefit to the farmer.

Legal:

The main objective would be to provide clear and consistent standards for farmers to follow and allow self-regulation where possible.

B. Environmental and Regulatory Issues

There were 40 issues identified in the Environmental and Regulatory area. The issues considered most important are as follows:

- Enforcement and implementation of regulations
- Cost of the regulations and who pays for them,
- Compliance assistance - it's not only about the regulations but the regulatory agents that enforce...will they also be of assistance to the people that are expected to comply with the regulations... in other words, this would include education to a larger extent
- The regulations that facilitated handling and transportation of the material.

! To a lesser extent, the following issues were also listed under the Environmental and Regulatory area: the cost benefit aspects, consistent regulations, food quality, and safety protection and risk assessment.

C. Public Policy

Under Public Policy, 12 issues were identified. The top issues are the following:

! fair reporting on issues,
! public policy based on good science,
! financial and technical assistance and
! who pays for environmental regulation? It is the most obvious question that comes to mind when a farmer would be confronted with additional regulations.

IV-2-ii. The full list of issues identified during brainstorming is presented in this section.

Success Indicators

- When communities want feedlots and consider them to be assets
- When communities are not aware that they have concentrated animal feeding operations (CAFOs)
- Operation would achieve goals without negative impacts
- Easily operated and maintained
- Not an eyesore
- Does not pollute
- Volumetric reduction of waste
- Maximize the amount of animal waste put through energy processing for energy generation
- Financial
- A place where people want to work
- Good neighbor
- Reducing health hazard
- Optimize cost of energy conversion using animal waste
- Improvement of public perception
- Minimize cost to the feedlot operators for disposal of waste
- Come up with a useful by-product
- Positive press
- Establish federal/state/university/industry consortium
- Convert situation from problem to opportunity
- Conversion of waste to product
- Benefit to farmers
- Positive synergism between accrued technology and public need
- Domestic job creation, job opportunities

- To be seen as addressing pressing societal needs (i.e. global warming)
- Solve distribution problem of animal waste and/or its products
- Broad acceptance by operators of the best industry practices for CAFOs
- Identify and justify funding for R&D including technology development
- Use of automated controls to reduce human involvement
- Establish a strong commercial position through R&D
- Shared goal of providing energy and food
- Positive attitude from consumer groups and regulators
- Technology consistent for sustainable animal feeding operations
- Supported by environmental groups
- Generate return on investment
- Good forum to pass info between interested groups (tech transfer)
- Cost competitive with alternatives
- Establish and identify stakeholders for program support
- Self-regulation
- Encourage small business entrepreneurs
- No legal problems
- Produce a good, nutritious, and safe product (something the consumer wants)
- Maintain a cheap food supply
- Clear and consistent standards

Environmental and Regulatory Issues

- Tie in with global carbon budget
- Enforcement and implementation of regulations
- Financial and criminal liabilities for fraudulent operators and accidents
- Cost of regulation - who pays?
- Compliance assistance
- Animal product quality
- Save the fish from pfisteria
- Carbon dioxide/methane release
- Avoidance of heavy metal contamination
- Animal health and comfort (waste management and public concerns)
- Animal disposal
- Increasingly stringent environmental regulations
- Global collaboration to identify consistent health effect issues
- Managing the carbon budget
- Pesticide use
- Composting and anaerobic digestion
- Incentives for infrastructure development
- Chlorinated hydrocarbon emissions from feed (chlorinated feed)

- Public confidence in regulatory agencies
- Cattle manure dust control
- Regulations that facilitate handling and transport of material
- Cost/benefit aspects
- Establish distinction between perceived and actual issues
- Reward good management of environment
- Consistent regulations
- Consideration of externalities
- Distinguish between hazardous and non-hazardous waste
- Eliminate unnecessary regulations
- Use database to assist with promulgation of regulations
- Facilitate inter-state transport and handling
- Worker protection
- Control hauling of ash for collection
- Involve stakeholders in developing regulations
- Transparency/openness/clearness
- Food quality and safety protection
- Establish public confidence
- Establish baseline emissions for emission from coal-fired power plant (to assess co-firing)
- Odor
- Location of CAFOs away from cities and developed areas
- Risk assessment

PUBLIC POLICY

- Fair reporting on issues
- Timely reporting
- Grid access/price tax subsidy
- Consistent definition of "animal unit"
- Public policy based on good science
- Challenges of making public policy with limited science
- Formation of a council that overseas and arbitrates issues between different parties (non-governmental)
- Financial and technical assistance
- Honest brokers
- Who pays for environmental regulations?
- How does animal waste get defined - as a public good or a nuisance?
- Who decides?

IV-C. Breakout Session #3

Title: Economic Issues and Financing

The attendees in this session were unanimous on a major issue. And the issue is the following:

A need does exist to process animal and farm wastes.

In order to achieve this major objective, the panel felt that the evolving animal biomass management technologies must (1) comply with regulations and the regulatory process, and (2) maintain affordability by staying within the livestock breeding industry sector, i.e., farmers, producers, and processors.

Outreach activities to educate the public, the politicians, and the policy makers about the existing regulations, farm practices, and the long-term benefits of cleaning up were believed necessary. Public support is essential to the success. Without public education and support, a negative perception on burning or disposing of waste would prevail. Farmers and processors must be educated and in terms of the environmental alternatives they need a good set of examples, cost information, and valid numbers.

Support on subsidies, tax credits and demonstration units are needed. Animal biomass management is a waste disposal issue and the drivers are first regulatory and second economic. These drivers are (1) reducing waste, (2) water conservation and use, (3) deregulation of the power industry, and (4) deregulation of the natural gas industry.

<u>Categories of the Farm Industry Structure</u>:

These are poultry, swine, beef, and dairy and they operate in slightly different ways. The poultry process has a lot of farmers and several big processors and integrators. The dairy farms have a lot of independent producers and some of them sell directly to distributors and merchants, and there is a very big difference in how to handle the waste. The swine industry is close to the poultry industry but is of larger scale with more processors and farms but not very many independents. Beef comes in between the dairy and swine industry categories. One of the big issues is to lose the support of the farmer because the tax credits or any other incentives given to the middle man means that the middle man takes all the profit from disposing of the waste. Right now the middle man does not want the waste. It's an economic issue that is of concern to the farmers and must be resolved before farmers would be interested in new disposal techniques.

Partnerships currently exist with the EPA and the Department of Agriculture. It was felt that FETC should take the lead in bringing together and coordinating the efforts between farmers, foresters, and miners for land use issues. State departments of agriculture and Extension associates and all other stakeholders will have to be brought into the equation.

<u>Financing</u>:

The big question is where is the risk and venture capital. For advanced animal biomass management operations, the farmers will deal with local bankers. The bankers would be very cautious, conservative, and would scrutinize the farmers very carefully. New management or disposal approaches that are cost effective or, in the worst case, cost neutral are necessary. The farmers are making 10 to 35 cents per pound wholesale and do not want to be burdened with any more costs. As a minimum, the waste disposal approaches will have to be cost neutral or generate a profit, if possible, with someone else paying for all of these additional costs. Multiple approaches with defined cost estimates are needed.

The farmers should be given the option to choose the management and disposal approaches. As an example, in the case of electricity generation there is a difference between the cost offset to the farmer and where they sell the electricity. The farmers may be paying 8 cents for electricity production and getting back 1 or 2 cents when selling to offsite grids. If the farm electricity can be made self sufficient, then it may be attractive to farmers. Once again, the economic benefits for deploying advanced animal biomass management techniques should go the farmer and not to the integrator.

Session Summary:

! The Do's and the Don'ts

• Do process animal and farm wastes.
• Do comply with regulations and regulatory processes.
• Do maintain affordability by staying within the livestock breeding industry sector.
• Do not pass all the economic benefits to the integrator. Save some for the farmer.

! Education:

• The Public, the Politician, and the Policy Makers
    - State and Federal regulations
    - Farm practices
    - Long-term Benefits

! Farmers and Processors
    • Environmental Alternatives and Cost Information

! Public Support:
    ! Essential to Success. There must be support on:
        • Subsidies
        • Tax Credits
        • Demonstration Units
        • Focus on farmer interests, not processors

- Regulations:
  - Animal biomass is a waste disposal issue
  - The drivers are first regulatory, and then economic. The drivers are
    - Reduction of waste
    - Water Conservation and Use
    - Deregulation of the Power Industry
    - Deregulation of the Natural Gas Industry

- Industry Structure:
  - Beef
  - Dairy: farmer-integrator-processor-grocery. Also, independent producers.
  - Poultry: farmer-integrator-processor-grocery
  - Swine

- Partnerships:
  - EPA
  - USDA

- Leadership:
  - FETC should take the lead in bringing together and coordinating the efforts of farmers, foresters, and miners for land use issues.

- Financing:
  - Where is the Risk or Venture Capital
  - Farmers typically deal with local bankers and these bankers are cautious and conservative
  - Costs need to be defined
  - Solutions must be cost-effective or cost-neutral
  - Multiple approaches with defined cost estimates are needed
  - In the case of electricity production, there is a difference between cost offset and merely selling electricity.
  - Care should be taken to avoid giving all the economic benefit to the integrator and not the farmer.

V. Looking Forward:

DOE-FETC wanted to create a potential stakeholder base in this new area of technology to consult with and establish technology R&D partnerships. The workshop provided input to FETC's program planning process by providing insights to the issues, needs, and problems that would help to identify and assess R&D needs to overcome the technology, market, economic, and environmental barriers to deploying advanced animal biomass management technologies. FETC looks forward to working with industry and other federal and state agencies to create cost-shared RD&D partnerships to develop, demonstrate, and deploy futuristic animal biomass management and disposal technologies for stimulating the livestock breeding sector of the U.S. economy and compliance with increasingly stringent health, water, and air quality improvement regulations in the future.

Attachment I.
Workshop Attendees

Kalyan Annamalai, Texas A&M University
Bill Austin, Therm Chem
Mark Badger, Penn State University
Bert R. Bock, Tennessee Valley Authority
Donald L. Bonk, FETC
Larry Bool, Praxair
Arun C. Bose, FETC
Terry Brown, Western Research Institute
John W. Bam, K&M Engineering & Consulting
Pat Cannon, E.G.&G TSWV Inc.
Carla Castagnero, AgRecycle Inc.
Dan Cillo, FETC
Kevin S. Comer, Antares Group Inc.
Doug Deak, FETC
David A. Ellis, WV House of Delegates
J.P. Fontenot, Virginia Polytechnic Institute
Dale F. Galloway, RDE Incorporated
Thomas Giaier, Detroit Stoker Company
Peter Gogolek, Canmet Energy Tech. Center
Philip Goldberg, FETC
Edward E. Gray, Antares Group Incorporated
John S. Halow, FETC
Stan Harding, Reaction Engr. International
Randall J. Harris, FETC
Richard Hegg, US Department of Agriculture
Melvin B. Henley, Murray State University
Jeff Herholdt, WV Development Office
David A. Hoecke, Enercon Systems Inc.
Lisa Hollingsworth, FETC
William C. Holmberg, FARMS
Adam Karpati, Centers for Disease & Prevention
Patricia Katzen, VA Off. of Natl. Resources
Ann Kim, FETC
Edgar B. Klunder, FETC
F. Michael Lewis, F Michael Lewis Inc.
Ira Linville, Kentucky Dept. of Agriculture
Sam P. Lockard, WV Farm Bureau
Jim Longanbach, FETC
Ripudaman Malhotra, SRI International
Carl Maronde, FETC
M. P. Mother, FETC
Robyn McGuckin, United BioEnergy Comm.
Joseph S. Mei, FETC
Bruce Miller, Penn State University
Chuck Myers, CDM Federal Programs
Harvey M. Ness, FETC
Claude Nuckols, Poultry Consulting
John Ontko, FETC
Pinakin S. Patel, Energy Research Corporation
J. Robert Paterek, Institute of Gas Tech.
Sean Plasynski, FETC
Rick Pratt, FETC
Dale E. Richards, T J Gundlach Machine Co.
Mike Robb, King Coal Furnace Corporation
Herb Roberts, Darling International Inc.
John M. Rockey, FETC
James Roth, Darling International Inc.
John R. Rotunda, FETC
Rich Russell, West Virginia University
Ralph Schaffer, Waste Policy Institute
Kenneth J. Schwartz, K J Schwartz Engr. Inc
Daniel Scruton, VT. Dept of Agriculture
Jonathan Servaites, Maryland Energy Admin
Jer-yu Shang, U.S. Department of Energy
Eric Simpkins, Energy Research Corporation
Dan Skedzielewski, Conectiv
Al Stiller, West Virginia University
David Stopek, Illinois Power/Illinova
Robert M. Stwalley, Stwalley & Stwalley Engr.
Chris Taylor, Parsons
Bob Travers, U.S. Department of Energy
John Tryon, State Univ. of NY at Cobleskill
Rick Turnbell, Illinova Resource Recovery Inc.
Suellen Van Ooteghem, FETC
Jim Vaughan, Murray State University
Michael Virr, Spinheat Limited

David J. White, Natl. Fuel Cell Research Center
Bill Witts, Illinova Resource Recovery Inc.
Ann C. Wilkie, University of Florida
Kim Yavorsky, FETC

Attachment II.
Workshop Agenda

<u>June 8</u>

Welcome and Workshop Purpose by Donald L. Bonk, U.S. DOE FETC

Overview Presentations:

Experimental Uses for Animal Waste
Al Stiller, West Virginia University, Department of Chemical Engineering

Environmental Drivers for Improved Animal Waste Management
Paul Lauterbach, Burns and Roe Services Corporation

Animal Waste Management Research and Issues
Adam Karpati, National Center for Environmental Health
Richard Hegg, United States Department of Agriculture

Management and Disposal Technologies

- *Gasification*, Robert Stwalley, Stwalley & Stwalley
- *Fluidized-Bed Combustion*, Mike Virr, Spinheat Limited

Economic and Technical Feasibility of Energy Production
Edward E. Gray and Kevin S. Comer, Antares Group, Inc.

- *Fuel Cell Systems*, Eric Simpkins, U.S. Fuel Cell Council
- *Small Turbine Systems*, Dave White, National Fuel Cell Research Center

Digester Technology, Ann C. Wilkie, University of Florida

Discussion — Fibrowatt Animal Waste Combustion
Donald L. Bonk, U.S. DOE Federal Energy Technology Center

Facilitated Breakout Sessions

- *New Concepts for Animal Waste Management and Engineering R&D Needs*
- *Success Indicators, Environmental and Regulatory Issues, and Public Policy*
- *Economic Issues and Financing*

June 9

Overview Presentations:

Cofiring of Biomass with Coal
Sean I. Plasynski, U.S. DOE Federal Energy Technology Center

Operating Challenges in the Combustion of Animal and Human Waste
F. Michael Lewis

Breakout Sessions Reconvene

Presentations of Breakout Topic Reports