waste management research Report

News from State University of New York at Buffalo and Stony Brook, and Cornell University

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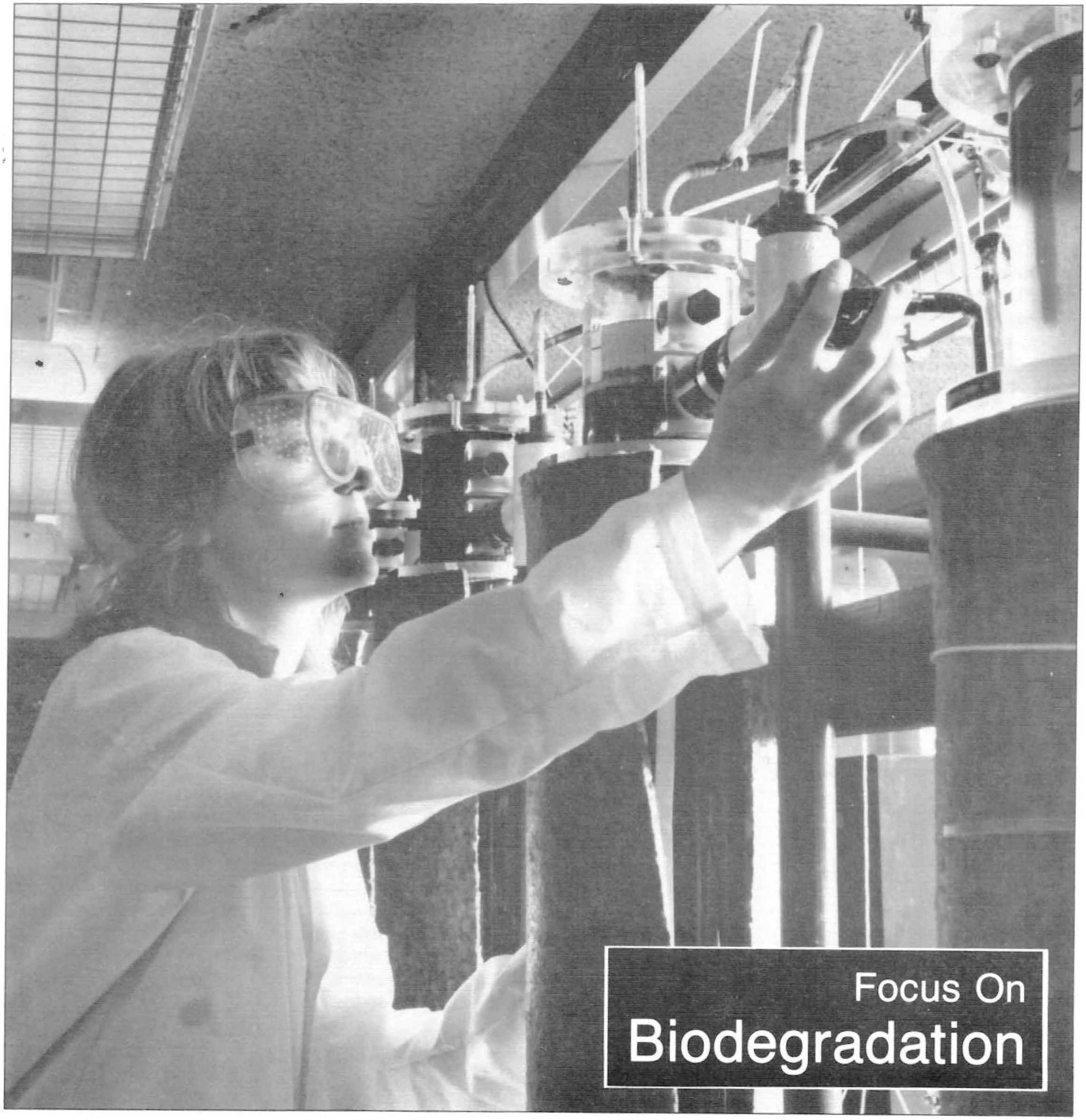

Focus On Biodegradation

Waste Management Research Report

Vol. 1, No. 3 Fall 1989

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About This Newsletter

Waste Management Research Report appears three times a year in order to share research from the publication's contributing institutions. Each issue focuses on one major area of waste management and highlights the contributing institution where researchers investigate the featured topic. The New York State Center for Hazardous Waste Management at State University of New York at Buffalo is responsible for this *Report*, with the focus on biodegradation. The Cornell Waste Management Institute will be responsible for the Winter, 1990 issue which will focus on retrofit regulations. December 1 is submissions deadline. Mail all material to Louise W. Laughton at the editorial office address.

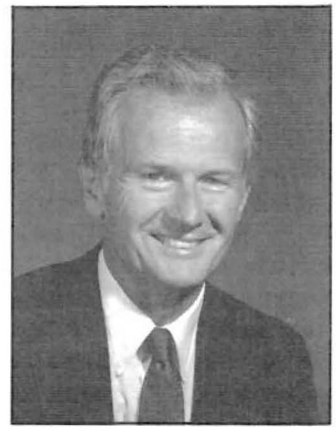
On the Cover

Bench scale testing of biological process for hazardous waste destruction, if successful, will be followed by field testing prior to full scale implementation of process.

Director's Comment

Collaboration Essential For Optimal Progress On Hazardous Waste Issues

By Ralph R. Rumer



Ralph R. Rumer

Research and development into new and improved technologies and methods for managing hazardous waste is proceeding along two fronts: waste minimization and waste treatment. Both are important to the goal of eliminating any potential threats that these wastes may pose to the environment and to public health.

Waste minimization (pollution prevention) includes reducing the generation of hazardous wastes at the source and recycling activities, undertaken by generators, that result in reduction of the total quantity of hazardous waste and/or the toxicity of the hazardous waste. **Waste treatment** includes the full range of technologies and methods that can be applied to a waste stream (or to the clean-up of an inactive waste site) so that the treated residuals can be disposed of safely.

This issue of *Waste Management Research Report* highlights potential applications of biotechnology to hazardous waste management. The University at Buffalo Center presently supports 20 projects located at 10 different institutions. Eight of the projects are directed at developing biological processes that can be used in the treatment of hazardous wastes or at improving our understanding of the biodegradation of hazardous wastes that have been introduced into the environment.

The scope of the hazardous waste management system is very broad, involving many sectors of our society. An important issue for the Center is the question of how to encourage and develop collaboration between the various sectors of the hazardous waste system so that the full range of scientific and technical options for waste minimization and waste treatment can be explored. To address this issue, the New York State Center for Hazardous Waste Management at Buffalo recently convened a roundtable discussion on the specific topic of source reduction.

Representatives from industry, business, academia, and government participated in this roundtable discussion. The primary purpose was to identify the most promising directions for research and development aimed at achieving significant reductions in the generation of hazardous waste in New York State. A wide range of topics was discussed at the roundtable, including: the perspectives of industry on present source reduction efforts, impediments to and motivations for achieving source reduction, consequences of source reduction regulatory actions, and the role of the Center in promoting source reduction. Reference to the Buffalo Roundtable appears elsewhere in this *Report*.

Research aimed at achieving reduction of the generation of hazardous waste at its source focuses attention on the entire manufacturing system, not just on the waste streams. The elements of the system include: the selection and input of raw materials and energy, manufacturing processes, the product, and the

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Dr. Ralph R. Rumer is executive director of the New York State Center for Hazardous Waste Management at the State University of New York at Buffalo.

Director's Comment

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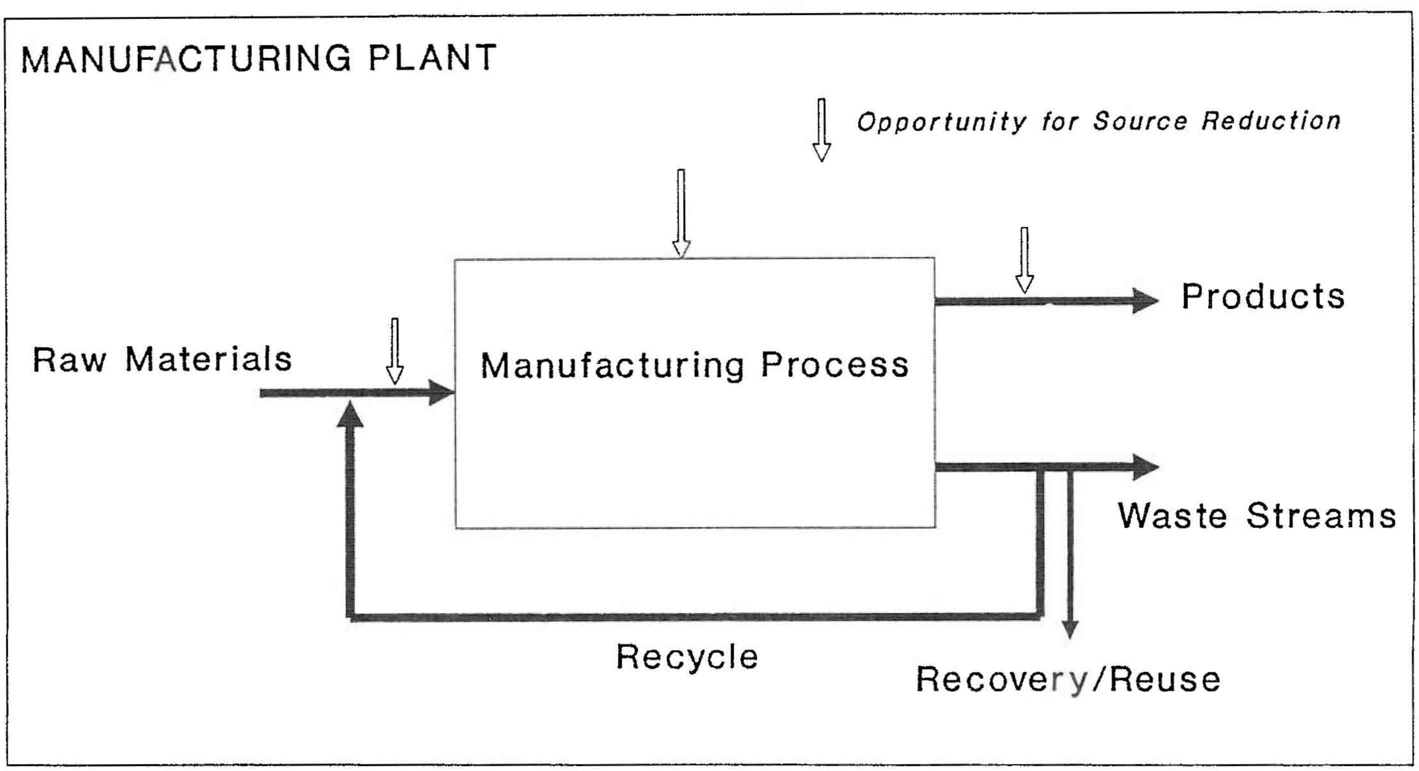
waste streams (see accompanying diagram depicting this system).

Historically, manufacturing systems have been fine-tuned to achieve product quality and maximize economic return. Tuning manufacturing systems to achieve waste reduction, as well as product quality and economic return, will require the involvement of all segments of a specific industry. There will be opportunities to enhance this tuning process through industry-university collaboration in research and development. The Center wishes to contribute to the design and operation of manufacturing systems that will generate significantly less hazardous waste than do systems now in use.

In order to expand involvement from the private sector, the Center has established a Business-Industry Affiliates Program. The Affiliates Program gives business and industry an opportunity to participate in the development and support of the Center's research program. Affiliate members include businesses and industries that generate hazardous waste; companies that transport, store, treat and dispose of hazardous waste; environmental consulting firms and contractors that provide services to government and the private sector in the management of hazardous waste, and businesses that supply technologies for improved waste treatment practices.

The effectiveness of the Center's research program depends on the involvement of all sectors of the hazardous waste system. Such collaboration will optimize the chances for success in efforts to protect the environment and human health and to reduce the escalating costs of waste management.

TYPICAL MANUFACTURING SYSTEM



"New" Biotechnology Builds On 19th Century Research Into Treatment of Wastes

By A. Scott Weber

A. Scott Weber

In recent years, the public has read with great interest and fascination about the benefits the biotechnological revolution will bring to their lives. While the majority of the early advances have been achieved in the fields of medicine and agriculture, occasionally the role of biotechnology in the treatment of hazardous wastes is highlighted. The use of biotechnology for hazardous waste treatment includes such diverse applications as remediation of contaminated soil and groundwater, cleanup of chemical spills, treatment of industrial discharges, and selective removal of metals from complex chemical mixtures to permit ultimate metals reuse. While many proclaim that the use of microorganisms to combat hazardous waste is a natural solution, the primary motivation for the use of biotechnology is economics. In addition, biotechnology is one of the few treatment technologies that offers complete destruction of the waste.

Articles proclaiming the benefits of biotechnology invariably have catchy titles such as "Microbes to the Rescue" and imply that such applications of biotechnology are new. For example, consider this quotation from "Pollution Solution," an article by Joseph Wallace that appeared in the January, 1987, issue of *US Air*:

"Straight from the pages of science fiction comes one of the most exciting new weapons against toxic sludge: the cultivation of waste-loving bacteria. This fascinating branch of biotechnology eventually may enable scientists to conquer even the most poisoned dumps and streams."

Although I take great satisfaction in my involvement with hazardous waste biodegradation research, I cannot help but experience a sense of *deja vu*.

Certainly, the desire to provide treatment for chemicals found in our waters is not a new phenomenon. More than a hundred years ago, the English River Pollution Commission of 1868 attempted to establish standards for organic carbon, heavy metals, and hydrocarbons in recognition of their undesirable nature. While more than 121 years have passed since the River Pollution Commission's recommendations, these same constituents remain the focus of many current research programs. This fact was reinforced recently by the Alaskan oil spill and the subsequent cleanup efforts in which biotechnology figures to play a prominent role. Similarly, the biodegradation of pollutants in the soil matrix lies at the very core of rural waste treatment systems, most notably the revered septic tank.

Accordingly, I often ask my students whether there really is anything new about the use of biotechnology for the management of environmental hazards. Invariably, they reach no consensus when this issue is discussed. In this article I want to highlight the past role of biotechnology in environmental management and its transition to the present needs of hazardous waste treatment. In doing so, I hope to shed some light on the question I have posed.

Past Uses of Biotechnology

"Biotechnology" is an all-encompassing word for the beneficial work of living organisms. The use of treatment processes employing microorganisms in municipal waste treatment, typically referred to as secondary treatment, has been directly responsible for effective municipal wastes management. These processes have led to significant improvements in United States water quality.

The majority of secondary treatment operations employ the activated sludge process in which microorganisms are commingled with the waste in an aerated tank. Given sufficient contact time and proper environmental and nutritional conditions, the microorganisms remove waste organics or substrates by metabolizing them to carbon dioxide, water, and minerals. Because the activated sludge process has an unequaled performance record in the treatment of municipal wastes and because it is employed currently for the treatment of hazardous wastes, its development may

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Dr. A. Scott Weber is director of the Environmental Engineering Research Laboratory at State University of New York at Buffalo.

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offer clues to future applications of hazardous waste biodegradation technologies. A brief review of the development of the activated sludge process is presented here.

The origins of the process have their roots in experimental work performed in the United States and England during the late 1800s and early 1900s. During the late 1800s, investigators became convinced that aeration was a key element in the purification of sewage, and they conducted many tests to investigate this phenomenon. Although organic removal was achieved, lengthy aeration periods were required. To reduce aeration time requirements, many experiments were conducted—with little success.

However, in 1912, an Englishman, Dr. Gilbert John Fowler, visited the United States to assess the pollution problem in New York Harbor. He also made a side visit to the Lawrence Experimental Station in Massachusetts, then a hotbed of environmental engineering research. Upon his return to England, Fowler urged two of his students to investigate new ideas he had formulated based on his observations at the Lawrence station. He suggested that the flocculent biological solids formed after aeration be captured and reused in successive tests. Each time his students repeated the experiment and reused the biological solids, the aeration time required for complete removal was decreased.

Fowler's students, Edward Ardern and William T. Lockett, referred to the sludge as "activated" in a paper they presented in 1914. Thus was born the activated sludge process.

Immediately after the development of the activated sludge process, there was much discussion of the operative waste removal mechanism. The debate focused on the pros and cons of physical versus biological removal. Even so, by the 1930s, the role that bacteria and other microorganisms play in the activated sludge process was firmly established. Between 1930 and 1950, significant advances were made in understanding the role of oxygen, temperature, pH, and nutritional needs. The result was a host of process modifications which took advantage of this new understanding.

The experiments of Jacques Monod, a researcher at the Pasteur Institute in Paris, served as the catalyst for further understanding of the activated sludge process. Monod proposed a mathematical expression that related the growth of bacteria to the concentration of substrate. In the 1950s and 1960s, the work of Monod and others led to the rapid development of kinetic models to describe the growth of bacteria and concurrent removal of substrate. Investigators built on this foundation to include such variables as temperature, pH, inhibitors, and nutritional requirements in the basic mathematical growth expressions, the same variables that had been identified only a few years earlier.

The importance of this work cannot be overstated. For the first time, the mathematical description of biological processes could be based on a conceptual understanding of the biological nature of the process rather than simply on "rules of thumb" gained through practical experience. Further development of the activated sludge process was facilitated by the formulation of system models that used kinetic rate expressions. These system models have been used to improve process understanding, predict process performance, assess new process applications, and improve process control.

In summary, a review of the development of the activated sludge process reveals logical step progressions. Initially, there was the conceptualization and successful demonstration of the process. This involved selecting a capable organism(s) and tracking the decomposition over time of waste in a reaction vessel. Once the operative removal mechanisms were delineated, work was undertaken to define the environmental and nutritional tolerances of the process. This work led to the development of mathematical descriptions of the biological reactions in the process, which in turn led to the development of process models.

Equal in importance to the advances described above, researchers and process operators came to appreciate the versatility of the activated sludge process and its natural capacity to adapt to changing conditions. This adaptability is brought about by the consortium of microorganisms present in the process and the tremendous genetic pool represented by this vast number of species. Accordingly, as new compounds have been released to municipal sewers, one or more of the indigenous strains of microorganisms have been able to synthesize the necessary enzymes to catalyze the biodegradation of these new chemicals. This adaptive capacity has been demonstrated by the successful treatment of many hazardous wastes in activated sludge treatment systems designed for municipal wastes.

Transition to Hazardous Wastes

An organic chemical may be classified as either biodegradable, persistent, or recalcitrant. Biodegradation implies a conversion of the parent compound and may or may not result in complete mineralization. Persistent compounds fail to undergo biodegradation under a specified set of conditions, but they may do so if changes to the reaction environment, nutrient availability, etc., are brought about. Recalcitrant compounds are inherently resistant to biodegradation, regardless of the conditions imposed.

Although exceptions exist, the majority of persistent and recalcitrant compounds are halogenated organic xenobiotics (substances foreign to the biosphere) synthesized by man. In general, the more heavily halogenated compounds are the most persistent. An example of this trend can be seen by comparing phenol, 2.4 dichlorophenol, and pentachlorophenol. Typically, phenol biodegradation is initiated rapidly; dichlorophenol biodegradation takes several days to initiate, and pentachlorophenol may take weeks. Slight structural variations of compounds with the same chemical composition also can affect biodegradation, as demonstrated by the more persistent nature of 2-chlorophenol as compared to 3-chlorophenol. Dioxins and polychlorinated benzenes (PCBs), reportedly some of the most carcinogenic compounds known, are heavily chlorinated complex structures. Their structural dissimilarity to biogenic materials and the degree of chlorination are prime reasons for their persistency.

Hundreds of xenobiotics, with varying degrees of persistency, can be present in any one hazardous waste. Activated sludge processes at publicly owned treatment plants have proven so effective at removing xenobiotic compounds that numerous people have advocated their use in centralized facilities for treating aqueous hazardous waste. While this proposition has merit, a recent study of an activated sludge system that was operated in a manner most conducive to the removal of persistent chemicals, revealed that the process could not meet discharge guidelines for certain chemicals emanating from organic chemical, plastic, and synthetic fiber facilities.

As guidelines become more restrictive for water-borne contaminants, the use of conventional design and operational techniques will continue to result in effluents in excess of allowable guidelines. If we are to continue to use the immense infrastructure represented by municipal wastewater treatment plants, we must elevate their treatment potential for xenobiotics. Additionally, the treatment of contaminants found in municipal and industrial effluents is only one small piece of the total picture. Processes must be developed to remediate contaminated soils, groundwater, and other situations which do not lend themselves to current biological waste treatment processes.

The obvious question that must be asked is: What must be done to improve our understanding of biotechnology so that we can develop better techniques for biodegradation of xenobiotics? Furthermore, can this development be based on the experiences gleaned from the treatment of municipal and industrial wastes? I think the answer to the above questions can best be answered by stating that new developments in biotechnology for the destruction of hazardous wastes can be guided but not confined by our past experiences and successes in municipal waste treatment.

Implementation of Biotechnology

In its most simplistic form, an implementation strategy for applying biotechnology would consist of organism selection, identification of biosystem characteristics, and full scale design and construction.

Organism Selection

The activated sludge process was developed only after a suitable population was identified. Variations of the procedure used by Arden and Lockett in 1914 are used today with great success to select and identify microbial strains capable of xenobiotic degradation. Two primary inoculum sources for this procedure are municipal activated sludge processes and contaminated sites. Municipal sources are selected because of the genetic diversity represented by their populations. Contaminated sites are chosen because of the indigenous population's history of exposure to the target chemical. In addition, other sources are being used to isolate organisms capable of xenobiotic degradation. Anaerobic organisms have been found to be very effective in dehalogenating many complex chlorinated organics, thus rendering the chemicals more susceptible to biodegradation by other organisms. The lignin degrading fungus, *Phanerochaete Chrysosporium*, has proved to be an effective polyaromatic hydrocarbon degrader (as described elsewhere in this newsletter).

Not confined to conventional isolation techniques, scientists have begun to utilize advances

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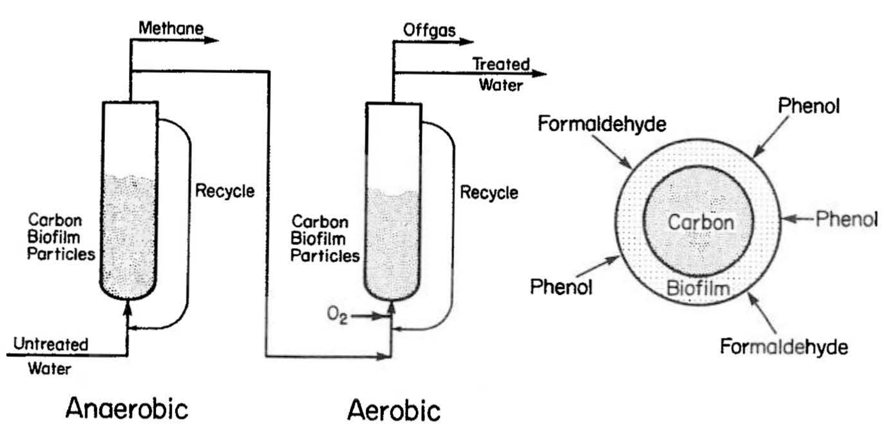
In sequenced anaerobic/aerobic biological activated carbon process used for treating high-strength organic waste, the majority of treatment occurs in the anaerobic first stage where pollutants are converted to methane gas. Activated carbon serves as surface for bacterial attachment and as an adsorbant for toxic organics.



Biotechnology

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in biotechnology to enhance the selection of capable organisms. These techniques include the use of UV light and/or chemical mutation and recombinant DNA technology. Through UV mutations, the organism's DNA is altered to enhance the probability for synthesizing an enzyme capable of waste biodegradation. Researchers are using recombinant DNA technology to transplant the genes responsible for xenobiotic degradation from one organism to another in an effort to enhance the organism's environmental tolerances, rate of biodegradation, competitiveness, and other desired attributes. Through these processes, new organisms are being evolved for use with chemicals previously considered recalcitrant. In some cases, the newly-evolved organisms are patented.

Biosystem Characteristics

While use of the above techniques has resulted in the selection and identification of organisms capable of biodegrading a wide range of persistent hazardous wastes, successful exploitation of these organisms requires mechanistic information about their growth requirements and environmental limitations. This information includes but is not limited to: the metabolic activity of the organism when in the presence of the chemical to be degraded, the effect of other chemicals on the biodegradation characteristics, the nutritional requirements of the desired organism, the environmental tolerances of the organism, and the position of the desired organism in the overall community structure (*i.e.*, will the organism be competitive and thus able to survive).

Researchers are making progress in collecting this necessary information. For example, the presence of selected solvents was found to facilitate the transport of dioxin across the bacterial cell wall and thus enhance its biodegradability. Through the process of cometabolism, concurrent use of less persistent organics has been found to facilitate the biodegradation of chemicals incapable of supporting organism growth on their own. Multivariable organism growth kinetic models are being developed to include such parameters as substrate toxicity, inhibition resulting from the presence of other organisms and environmental factors.

While controlled laboratory experiments have been the primary vehicle for gathering the mechanistic information necessary to further the science of hazardous waste biodegradation, the ultimate goal should be successful application of this technology in the field. Given the multicomponent nature of hazardous waste, the desirability of employing mixed populations, and the difficulty in predicting the interactions between one organism and a single substrate, the task seems very large.

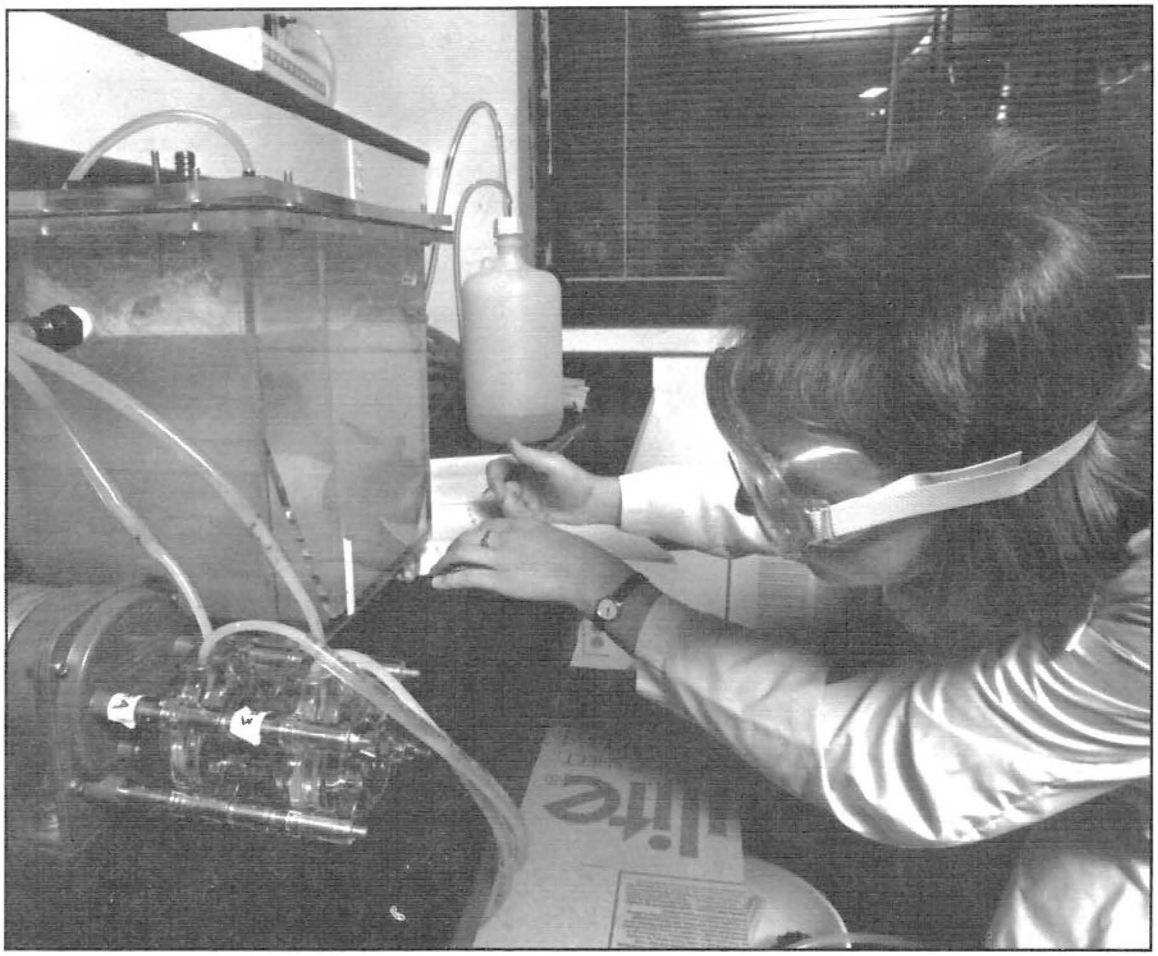
Again, our past experiences can provide some guidance in addressing these issues. Rather than attempting to predict the fate of single chemicals, we must begin to group chemicals into categories based on similar biodegradation potential as determined from controlled mechanistic studies. The need for lumped parameters was recognized early in the development of municipal waste treatment and gave rise to such parameters as biochemical oxygen demand (BOD) and total organic carbon (TOC). We also can take advantage of new tools made available through biotechnology. For example, one of the most difficult problems encountered in using mixed populations is the reliable quantification of individual organisms. The development of gene probes, which can be used to detect segments of DNA, may be instrumental in helping to overcome this problem.

Full Scale Implementation

As our understanding of the fundamental processes governing the biosystem characteristics necessary for hazardous waste biodegradation grows, we will be able to refine current system models and to develop new ones, if necessary. Such models will enable us to predict performance of full scale processes and minimize costly mistakes. However, because reliable models have yet to be developed, should we wait to proceed with full scale testing? The answer is clearly no. Some of the greatest advances in understanding the activated sludge process were acquired through full-scale operation. In fact, public health officials in the United States and England were quick to recognize the benefits of the process and built many full-scale plants before 1920, a scant six years after the process was delineated. Certainly, mistakes were made along the way, but the derived benefits greatly outweighed these setbacks. As is the case in most process engineering, many facets of operation cannot be adequately defined in a laboratory setting under closely controlled conditions and can be obtained only during full-scale operation.

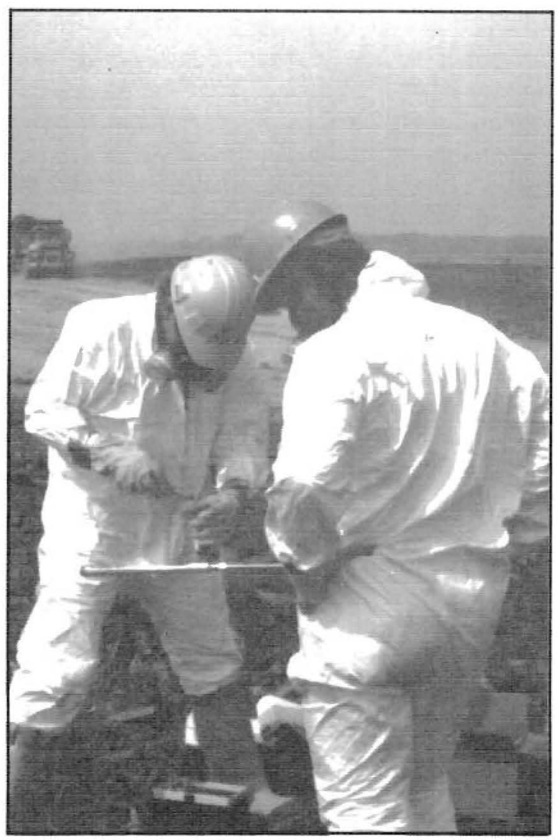
Recognizing the need for full-scale applications must, however, be balanced with the recognition that current regulatory and litigative pressures demand that field applications perform reliably and effectively. Prudence dictates that we proceed with applications that have a reasonable chance of success and that are based on the best science and engineering possible.

The remediation of soils contaminated with



Researcher assesses bacterial strains from bench scale activated sludge reactor, left, to determine their ability to degrade organic hazardous wastes. Investigators, below, examine soil characteristics to ensure optimal bioremediation of organic hazardous wastes. Photo courtesy of Waste Stream Technology, Inc., Buffalo, NY

gasoline products offers us a good example of this approach. This situation was facilitated because of the relatively few constituents in gasoline and the substantial information on the biodegradability of these constituents. For gasoline spills, the successful delivery of microorganisms and oxygen into the contaminated soil was the primary obstacle. Physical problems linked to site characteristics, such as soil type, are not addressed easily in the laboratory due to scaling uncertainties. Experiences gained from initial field applications have since been used to remediate sites contaminated with pesticides, wood preservatives, and other hazardous wastes.



Summary

Clearly, there have been and will continue to be parallels between the development of municipal and hazardous waste biodegradation technologies. It should be just as clear that if we hope to improve our understanding and performance of these technologies, we must embrace the new opportunities brought about through advances in biotechnology. There is something reassuring in the recognition that this road has been traveled before.

NETAC Formed To Foster Cooperation Among Sectors

The National Environmental Technology Applications Corporation (NETAC) was established in 1988 through a four-year Cooperative Agreement between the University of Pittsburgh Trust and the U.S. Environmental Protection Agency (EPA). NETAC is a unique organization, designed to provide an integrated and systematic approach for accelerating the development, regulatory acceptance and commercialization of priority environmental technologies from both public- and private-sector sources.

Over the last two decades, concern for the environment has risen dramatically on the list of national priorities. As a result, regulations restricting industrial air emissions, effluents, and the generation and disposal of hazardous wastes have proliferated.

In the private sector, the evolution of an environmental technology from idea to marketable product falls victim to innumerable delays for a variety of reasons: permitting, liability, and the fragmentation of the market caused by regulatory inconsistency. Federal and state environmental agencies, by virtue of their primary role as industry regulators, are faced with fundamental barriers that limit their direct involvement in encouraging the development and commericalization of the next generation of environmental technologies. The academic community contributes substantially to research and theoretical models for new technologies. Academia, however, falls short in the ability to discriminate between these same technologies on the basis of market potential or industry need, or to convey new technologies rapidly into the private sector for use there.

The creation of NETAC is a result of increased national awareness of these constraining issues. In contrast to other environmental technology organizations and research and development partnerships, NETAC focuses on the problems of moving environmental technologies from the laboratory into the marketplace.

NETAC provides a wide range of client services to technology developers and consumers alike. Services include third-party technical evaluations, market assessments, business development assistance, regulatory advice, and assistance in leveraging financial investments for promising ventures. By providing such services, NETAC intends to lower the barriers which hinder the effective and efficient introduction of a new generation of environmental technologies. NETAC offers an unprecedented opportunity for industry and academia to work in partnership with the U.S. EPA to develop real solutions to pressing national problems.

Two major NETAC studies are nearing completion. The first is a detailed needs assessment that describes and sets priorities for the environmental technology requirements of industry and the nation. The document incorporates information gained through extensive interviews with representatives from the private and public sectors. Second, NETAC is conducting extensive studies to establish, in detail, the processes by which an idea becomes a commercially viable environmental technology.

This process includes the following types of criteria: compatibility of the technology with existing and proposed environmental regulation; compatibility of technology with perceived industry needs; competitive technology with perceived industry needs; competitive technology analyses; financial and technical feasibility; and market opportunity assessment. This information will be used to assist businesses to overcome traditional barriers in the development and commercialization of environmental technologies, and thus to function in the most expeditious way.

NETAC benefits from the tremendous variety and impressive nature of the supporting institutions to which it has access. Key among these benefits are: a substantial commitment of support by the University of Pittsburgh; NETAC's location at the University of Pittsburgh Applied Research Center, a facility which comprises 863,000 square feet of offices, laboratories, and support facilities; and good working relationships with numerous environmental and research organizations and state and federal agencies.

NETAC is a not-for-profit corporation. It functions as a bridge between industry, government and academia, expressly to facilitate commercialization of priority environmental technologies. If you are interested in further information about NETAC, or would like assistance with commercializing or locating an environmental technology, please contact:

Jack Adams
Vice President, Marketing and Finance
NETAC
615 William Pitt Way
Pittsburgh, PA 15238
or call (412) 826-5511.

Center at Buffalo Offers Summary Of Roundtable

The New York State Center for Hazardous Waste Management offers a summary white paper on the "Roundtable Discussion on Source Reduction," sponsored by the Center in May, 1989, at the Center for Tomorrow on the State University of New York at Buffalo campus.

The Center for Hazardous Waste Management assigns highest priority to funding research and development in the area of source reduction, defined as in-plant practices that reduce, avoid, or eliminate the generation of hazardous waste. Source reduction reduces in turn both public health and environmental risks. The Solid and Hazardous Waste Management Policy and Planning Law, enacted by the New York State Legislature in 1987, establishes a hierarchy of preferred waste management practices and calls for reduction or elimination of hazardous waste generation to the maximum extent practical (Chapter 618). The spring roundtable discussion was a response to the primacy of source reduction.

Representatives of business, industry, academia, and government gathered to identify the most promising directions for research and development aimed at reducing the generation of hazardous waste in New York State. A secondary purpose for the roundtable was the identification of issues and considerations that could inhibit or impede development of a cooperative industry/university research program conducted under the auspices of the Center for Hazardous Waste Management.

Specific objectives of the roundtable included:

- Better understanding of industrial attitudes and needs in the area of source reduction.
- Better understanding of how the Center for Hazardous Waste Management can foster research on source reduction, including identification of specific needs.
- Development of collaborative industry/university programs in research, training, and technology transfer that will facilitate source reduction.

Interested persons may write the Center for a copy of the summary white paper at:

New York State Center for Hazardous Waste Management
207 Jarvis Hall
State University of New York at Buffalo
Buffalo, NY 14260

NETAC Conference Highlights Cooperation Between U.S. and Canada

The National Environmental Technology Applications Corporation (NETAC) at the University of Pittsburgh, the Canadian Government Trade Office in Pittsburgh, the Pittsburgh Chamber of Commerce, and the Provinces of Ontario and Quebec co-sponsored an international conference in Pittsburgh the first week in October to showcase the newest in environmental technology and to encourage increased bilateral trade. Some 300 persons representing industry, finance, and government attended the two-day session.

Representatives of 12 Western Pennsylvania and 12 Canadian companies discussed their firms' advances in air pollution control, treatment of water and other liquids, hazardous and solid waste treatment and disposal, and analytical instrumentation technologies. NETAC and Canadian officials explained how they can help firms expand across the U.S./Canadian border, find a joint-venture or trade partner, and best take advantage of the recently concluded trade agreement between the two countries.

Foundation Offers Conference Summary

The Freshwater Foundation will offer a bound summary of recommendations from its 1989 national conference, "Groundwater and Agrichemicals: Suggested Policy Directions for 1990." Conference recommendations also will be presented at a Congressional briefing in early 1990.

Participants focused on policy constraints and potential solutions to the problems of agrichemical use and groundwater protection. The purpose of the fall meeting was to help assure the implementation of reasonable policies, with appropriate incentives and flexibility. Conference recommendations will contribute to the 1990 farm bill in Congress and to the USDA's Water Quality Initiative.

The Freshwater Foundation is located at 2500 Shadywood Road, P.O. Box 90, Navarre, MN 55392-0090. It is a public, nonprofit foundation.

ESF Researcher Investigates Organopollutant Degradation By Lignin-Degrading Fungi

By K. E. Hammel

Kenneth E. Hammel

The lignin-degrading fungi that cause white rot of wood have recently become the object of increasing attention from workers in the hazardous waste field. These organisms normally grow on decaying wood and forest litter. They are biochemically unique in that they can rapidly depolymerize and mineralize lignin, a complex, irregular, nonhydrolyzable, and environmentally persistent wood polymer of phenylpropane subunits. Lignin contains numerous substructures that are also found in common organic pollutants, e.g. phenolics, anisoles, aryl-o-diethers, and biphenyls.

Lignin's exceptional recalcitrance to attack by most microbes has led many researchers to surmise that any organism capable of mineralizing it must have highly nonspecific oxidizing systems that could be applicable to aromatic pollutants as well. It has accordingly been proposed that ligninolytic fungi might be useful in hazardous waste biotreatment programs. In the last five years, a number of metabolic studies have indicated that this might be the case.

Chlorophenols, chloroanilines, polycyclic aromatic hydrocarbons, and certain polychlorinated biphenyls have all been reported to undergo extensive degradation when incubated with cultures of the thermotolerant white rot basidiomycete *Phanerochaete chrysosporium*. In most cases, an appreciable fraction (10-50 percent) of the added pollutant was completely oxidized to carbon dioxide, which bespeaks an unusually effective and broad-spectrum oxidative system in this fungus.

It is now known that the biodegradative abilities of lignin-degrading fungi are due, in part, to extracellular oxidative enzymes that these organisms secrete. These enzymes are peroxidases, *i.e.*, they employ hydrogen peroxide, which the fungus also produces extracellularly, as the electron acceptor in a variety of biochemical oxidations. The natural function of this enzyme system is to give the organism access to wood polysaccharides, normally embedded in and protected by lignin, that can support fungal growth.

We and others have recently shown that the extracellular lignin peroxidases of *P. chrysosporium* also catalyze the oxidation of a wide variety of aromatic pollutants, including certain polycyclic aromatic hydrocarbons and polychlorinated phenols. The products of these enzymatic reactions are quinones, and polychlorinated substrates are partially dechlorinated during the oxidative process. For example, we have found that 2,4,6-trichlorophenol, a toxic EPA priority pollutant found in paper mill effluents, is quantitatively oxidized by lignin peroxidases to give 2,6-dichloro-p-benzoquinone. Similarly, we have demonstrated that anthracene and pyrene, which are polycyclic aromatic hydrocarbons present in creosote, as well as in gasoline and diesel exhaust, are oxidized to anthraquinone and pyrene quinones *in vitro*. What is not yet clear is whether these enzymes function in the main biodegrad-

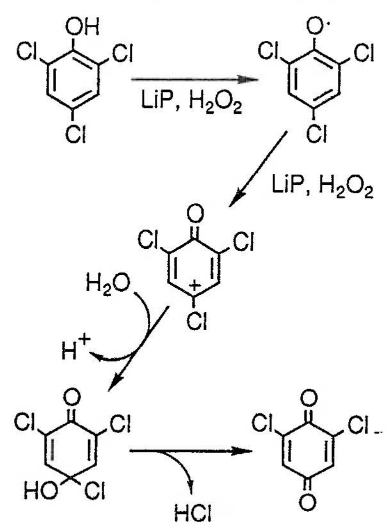


Figure 1. Mechanism for the oxidative 4-dechlorination of 2,4,6-trichlorophenol by H_2O_2 and lignin peroxidase (LiP).

Dr. Kenneth E. Hammel is an assistant professor on the Faculty of Chemistry at State University of New York College of Environmental Science and Forestry (SUNY-ESF) in Syracuse. *The project described above is supported by a grant from the New York State Center for Hazardous Waste Management and by U.S. Environmental Protection Agency (EPA) Co-op Research Agreement #813530.*

ative pathway for aromatic pollutant oxidation by ligninolytic fungi *in vivo*.

To address this questions, we are now studying the degradation of anthracene by *P. chrysosporium* in detail. Preliminary data indicate that this aromatic hydrocarbon is oxidized to anthraquinone in fungal cultures, and that the quinone is an intermediate in the oxidation of anthracene to carbon dioxide. It is noteworthy that eukaryotes have not previously been known to cleave the aromatic ring of any polycyclic aromatic hydrocarbon. These results, accordingly, suggest the existence of a novel type of metabolic pathway for aromatic catabolism in ligninolytic fungi.

We are presently developing methods that use ceramic bead-immobilized fungal cultures to enhance the production of the lignin peroxidases that are evidently instrumental in this process. We have found that these enzymes can be produced repeatedly from one immobilized fungal culture through at least eight draw and fill cycles. Other workers have obtained similar results recently with cultures of *P. chrysosporium* inoculated onto rotating biological contactor disks.

Immobilized cultures of ligninolytic fungi show considerable promise for the batchwise treatment of contaminated waters, and methods are now under development in several laboratories to extend these results to continuous bench-scale treatment systems.

References:

Hammel, K. E.; Kalyanaraman, B., and Kirk, T. K. (1986) "Oxidation of polycyclic aromatic hydrocarbons and dibenzo[p]dioxins by *Phanerochaete chrysosporium* ligninase," *J. Biol. Chem.* 261:16948-16952 Hammel, K. E., and Tardone, P. J. (1988) "The oxidative 4-dechlorination of polychlorinated phenols is catalyzed by extracellular fungal lignin peroxidases," *Biochemistry* 27:6563-6568

Vitrification Topic Of Joint Program

The American Society of Mechanical Engineers (ASME) and the U.S. Bureau of Mines recently announced a joint, $1.2 million research program to study vitrification of the residue, principally ash, from incineration of municipal waste. Federal and state agencies and corporations will provide funding for the program.

Vitrification, the fusion of municipal waste into a glassy material usable in construction, could offer towns and cities a commercially competitive method of treatment that could reduce the volume of residue and convert it into a marketable product, according to Francis W. Holm, chairman of the ASME committee on industrial and municipal wastes.

Research Focus

Research will focus on the overall feasibility of vitrifying residue from grate and fly-ash combined and from fly-ash alone, said Herbert I. Hollander, a co-director of the program. Investigators hope to confirm that vitrified incinerator residue is environmentally benign, denser than the original residue, and energy-efficient to produce. In addition, researchers will investigate optimal conditions and operating constraints for running electric arc furnaces. The work should identify potential uses and markets for vitrified residue, limitations on its use, and the amount and nature of any residual material, emission, or effluent.

Ward O. Winer of the Georgia Institute of Technology in Atlanta, ASME vice president for research, says the program is the largest research activity ever launched by the 119,000-member society and the first laboratory study to be undertaken by the ASME Center for Research and Development since its establishment in 1985. The Center's research committee will serve as overall manager of the program, and the U.S. Bureau of Mines will conduct the laboratory studies at its research center in Albany, OR.

Support Pledged

Among the government agencies promising support, in addition to the Bureau of Mines, are the U.S. Department of Energy, the New York State Energy Research and Development Authority, the New York State Department of Environmental Conservation, and the New York City Department of Sanitation. The ASME Solid Waste Processing Division also will support the program, and eight corporate sponsors had pledged research funding by late summer, 1989.

Interested persons may write Dr. Howard Clark, ASME Center for Research and Technology Development, Suite 216, 1825 K Street, N.W., Washington, DC 20006-1202, or call (202) 785-3756.

Cornell Simulation Project To Focus on Overfire Region Of Mass Burn Incinerators

Note: The New York State Solid Waste Combustion Institute at Cornell University has established a Combustion Simulation Laboratory to explore and develop numerical simulation tools for the description of incineration processes. A major advantage of such tools, as opposed to traditional design tools, is that they allow the exploration of alternative facility designs to enhance combustion. In particular, a wide range of design options can be considered, and dependence on physical laboratory and pilot plant studies can be reduced.

Simulation laboratory models will enable researchers to study incineration processes and designs that lead to disposal of solid waste in an environmentally sound and efficient manner. The laboratory at Cornell University is under the direction of Dr. Frederick Gouldin and will be available to researchers in New York State.

By M. Ravichandran and F. C. Gouldin

Mass burn incinerators can be considered the workhorses of the municipal waste incineration industry. From projections for the future in the United States, it seems that they will continue in that role because:

a) Mass burn incinerators make very modest demands on the feed.
b) They have evolved toward fairly robust design configuration.

Through this evolution, mass burn incinerators have been able to satisfy the primary requirement of incineration, *i.e.*, reduction of volume to one-tenth of feed.

The energy crisis of the 1970s shifted the focus of incinerator design from volume reduction to energy extraction. Consequently, utility boiler furnace concepts for efficient combustion, *e.g.*, suspension burning, were employed in refuse derived fuel (RDF) incinerators. Well-publicized, repeated engineering failures in RDF installations heightened understanding of the special problems posed by the heterogeneous nature of the waste stream. The result was an increased reliance on mass burn incinerators.

In the meantime, the economics of incineration acquired new dimensions. Decreasing availability and increasing cost of landfill capacity provided a new impetus for the industry to modernize its workhouse. At the same time, increased sensitivity of the public to environmental consequences of incineration, such as potential contamination, by residues and effluents, added to the cost of waste disposal and refocused attention on energy extraction as a way to offset such costs. The viability of mass burn incinerators may well depend on their ability to effect the required volume reduction while enabling improved energy extraction and limiting environmental impact to "acceptable" levels.

These multifarious objectives lead to potentially opposing pulls in the areas of design and process control. In the past, robustness and improved plant availability have been achieved by using very conservative approaches to design and control. Typically, large quantities of excess air are used to reduce the risk of accelerated corrosion due to occurrence of alternating reducing and oxidizing atmospheres. This results in lowered combustion efficiences. Use of low gas velocities to minimize particle carry-over (for reducing slagging and erosion) and to increase the residence time has resulted in excessively large units.

To minimize tube failures and hence achieve a higher plant availability, lower superheater temperatures have been employed, resulting in a lowering of the quality of energy and consequently of its price. Some of the above strategies have necessitated the use of lower furnace temperatures, resulting in decreased energy conversion efficiencies. Combustion temperature also have direct consequences for environmental impact, *e.g.*, the survival of dioxin precursors and NO_x formation. The fact that the feed/waste stream is heterogeneous in terms of many material attributes, such as dispersibility, size distribution, composition, burnability, and heating value, clearly adds to the complexity of the emerging optimization problem.

In light of the above, it is clear that incinerator design and operation must shift from a "feasible solution" mode to a "constrained optimization" mode. Reliance on past experience and empirical

Dr. Frederick C. Gouldin is director of the Combustion Simulation Laboratory of the New York Solid Waste Combustion Institute at Cornell University. Dr. M. Ravichandran is a post-doctoral fellow at the institute. He develops computer simulation of combustion processes and design in the SWCI Combustion Simulation Laboratory.

information alone is no longer adequate tor this task. There is an increasing need for the development of simulation models applicable to problems arising in incinerator design and operation.

The complexity of the incinerator system seems to rule out at this time the possibility of developing a rigorous simulation model covering the bulk of the processes comprising the system. The design and operation of the grate system seems to be governed primarily by its ability to handle the feed and transport it through drying, ignition, and burn-out phases. Also, the heterogeneous nature of the feed, the wide disparity between solid and gas phase residence times, and the consequent importance of "material handling" aspects indicate that past experience is likely to be a dominant factor in the evolution of the design of the grate system.

The after-furnace heat transfer sections are quite similar to their counterparts in utility boiler installations, except for the changes that account for the increased fouling and corrosion potential of incinerator furnace gases. On the other hand, the overfire waterwall region of the mass burn incinerator envelops some of the important (causal, rate-determining) and relatively more optimizable processes governing the efficiency of energy conversion, as well as the formation or destruction of pollutants, thereby making it a meaningful and worthwhile focus for flow and combustion simulation.

Like other processes employing a burning fuel bed, the incinerator overfire region has suitably placed air jets to help effect complete combustion, to induce turbulence, to increase retention time, and to control temperature by dilution of furnace gases. Effective mixing is especially critical in the case of incinerators because of the inherent propensity for by-pass due to the heterogeneous nature of the feed. Other important processes occurring in the overfire region include chemical reactions affecting NO_x, CO oxidation, reactions involving heavy metals and chlorinated hydrocarbons (including dioxins and furans), fly ash transport, and radiative heat transfer.

The flow in the overfire region can be characterized for modeling purposes as two-phase, three-dimensional, turbulent reactive flow with radiative heat transfer. Accumulated modeling experience in the case of utility boiler furnaces/gas turbine combusters indicates that it is computationally prohibitive to solve the resulting fully coupled equations modeling (detailed) kinetics, flow, and heat transfer. Some simplification/decoupling is necessary. We propose to carry out the simulation through the following steps:

1. The governing differential equations for mass, momentum, energy, and species concentration will be solved numerically, using physical models to take into account the effects of turbulence, chemical reaction, and radiation. Turbulence will be modeled using the gradient diffusion approach[1], by which the relevant turbulent exchange coefficients are derivable from a turbulent viscosity in which distribution is determined by solving two differential equations, *viz*, one for turbulent kinetic energy and another for its dissipation. Effects of radiation will be modeled using a six-fluz model[2] with the radiation flux equations coupled to the energy equation through its source term. Chemical reaction will be modeled by assuming local equilibrium. This enables the composition to be completely determined by a single variable in the form of a conserved scalar[3] that can be represented by a one/two parameter probability density function. To avoid the need for detailed calculation near the wall, appropriate "wall functions"[4] will be employed.

2. The exact boundary conditions, particularly for the off-gas from the bed entering the furnace volume, are not known. A parametric analysis will be done to determine the influence of these conditions on combustion. The scattering and absorption coefficients required for the determination of the radiation fluxes will be fine-tuned, using initial estimates based on utility boiler furnace simulation literature.

3. Finite rate kinetics will be directly introduced, if necessary, through the use of a partial equilibrium (chemical reaction) model by employing an appropriately defined reaction progress variable. The number of individual reactions that can be included is expected to be limited.[5] The prediction of the distributions of species that are not included will be attempted by prescribing the time-temperature history previously determined.

4. Since the simulation model is based on certain approximations and empirical information, validation of the model is desirable. Data from measurements on full-scale incinerators, where available, and data from laboratory model studies will be used for validation.

The resulting simulation model for the overfire region of mass burn incinerators will be beneficial in several ways. In general, it will provide a test of the adequacy of current knowledge for the understanding of incinerator design and operation. In particular, we hope to address the follow-

Continued on page 14

ing questions, directly or indirectly:

1. What is the effect of different combustion chamber configurations, including their relationship to the direction of material flow in the bed and secondary air jet placement, on mixing effectiveness and fly ash carry-over?
2. How can mixing and combustion be improved by varying the secondary air jet flow parameters?
3. What are the implications of a given design for infurance pollution control options such as "Thermal $DeNO_x$" and the destruction of chlorinated hydrocarbon species?
4. How do different configurations fare in terms of their sensitivity to feed variability, turn-down operation, and the occurrence of upset conditions?

In addition, the simulation model should help determine the limits to increases in "plant availability," improvements in "steam quality," and reductions in pollutant emissions through combustion chamber modifications. This would help in the evolution of optimal scale removal strategies, optimal super heater material specifica-

Continued from page 13

tions, and optimal gas cleaning strategies.

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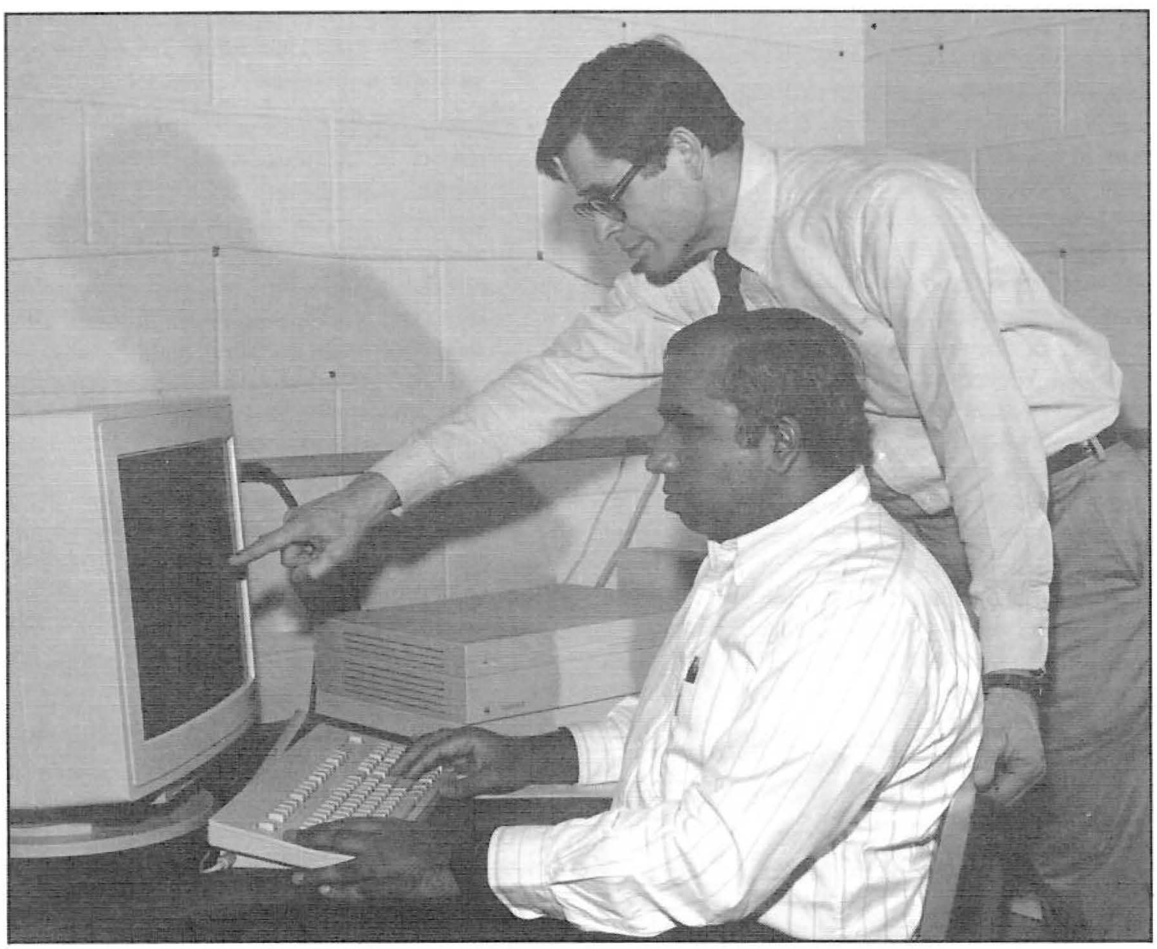
[1]Correlations due to fluctuating variables are taken to be proportional to the gradient of the applicable mean flow quantity through a constant related to the appropriate turbulent exchange coefficient.

[2]The model supposes that radiation is collimated into beams that are aligned with the three coordinate directions and six flux intensities (one for the positive and one for the negative in each of the coordinate directions) are defined at any point.

[3]This is typically a normalized variable derived from species mass fractions.

[4]These functions are derived from empirical laws that connect wall conditions (e.g., wall shear stress and heat flux, temperature) to the dependent variables just outside the viscous sublayer. Viscous effects are dominant in the sublayer, and high Reynold number turbulence models are not applicable.

[5]The exact number will be determined by a trade-off involving the numerical stability and accuracy of the solutions and the associated computation times.



Frederick Gouldin, standing, and M. Ravichandran develop computer simulation of incinerator combustion in the Combustion Simulation Laboratory of the New York State Solid Waste Combustion Institute at Cornell University. Photo by Stephen R. Singer

Biodegradable Plastics Subject of Research At Stony Brook

By Vincent T. Breslin and Sheldon J. Reaven

Plastics presently account for about seven percent of the weight of municipal solid waste in the United States. Many properties of plastics that make them ideally suited for the manufacture of a wide variety of products also contribute to their being considered an environmental contaminant. Many plastics in the waste stream are lightweight, floatable, and resistant to degradation in the natural environment. Thus, plastic debris is often found throughout our environment, from city streets to the furthest reaches of the world's oceans.

Plastic debris was a major component of the recent washup of floatables on beaches throughout the Northeast. These washups heightened public awareness of the negative impacts of plastic waste, particularly at sea. As a result, local, national, and international agencies are recommending legislation that would ban certain types of plastic packaging and require the use of rapidly degradable plastics. Suffolk County in New York State has enacted one of the strictest such laws in the country. The law itself, and a six-month moratorium on its taking effect, have been the subjects of a series of see-saw battles in court and in the Suffolk County Legislature.

Additives Enhance Degradation

Rapidly degradable plastics are manufactured using additives that enhance the breakdown of the plastic product when it enters the environment. The most widely used, rapidly degradable plastics are generally either photodegradable or biodegradable. Photodegradable and biodegradable plastics are polymeric materials that disintegrate under environmental conditions in a reasonable and demonstrable period of time. The primary mechanisms of the degradation of photo- and biodegradable plastics are exposure to sunlight or the action of microorganisms, respectively.

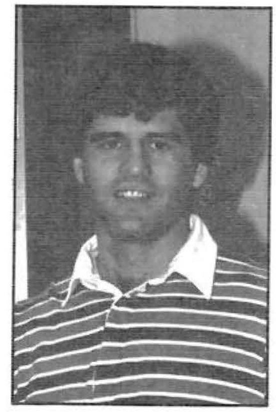
The time required for degradation can vary from periods on the order of weeks to years. Degradation time depends on properties of the material itself (e.g., resin, thickness, additives) and on environmental factors (e.g., moisture, oxygen, temperature, depth). One complication in drafting laws and regulations concerning degradable plastics has been that there are many, often conflicting, definitions, and measures of degradation itself

Cornstarch, because it is low in cost and readily degradable, often is the additive of choice in manufacturing biodegradable plastic products. The Archer Daniels Midland (ADM) company of Decatur, Ill., recently developed a variety of cornstarch-based plastic material. Using recently developed manufacturing technology, ADM has produced polyethylene films, high density polyethylene bottles, injection molded polypropylene parts, and styrofoam sheets containing the cornstarch additive.

Both proper and improper disposal of plastic exposes the material to a wide variety of environments. As the use of biodegradable plastic increases in lieu of conventional plastics, we can expect discarded biodegradable plastics to be exposed to a variety of environmental conditions. The rate and extent of degradation of cornstarch-based plastics when they enter the environment are not well known now. The Waste Management Institute at the State University of New York at Stony Brook is currently conducting research to determine the rate and extent of degradation of cornstarch-based plastics.

The research program investigates the process of degradation of cornstarch degradable plastics placed in landfills, compost, soils, and the marine environment. The physical and chemical characteristics of degradable samples periodically returned from the exposure sites will be examined.

Tensile properties of the pre-placement samples and samples retrieved from the exposure sites will



Vincent T. Breslin

Sheldon J. Reaven

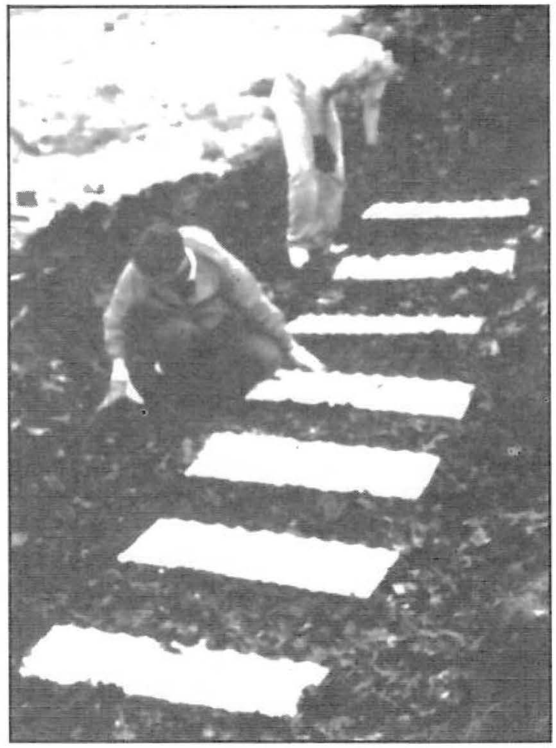
The two-year project outlined above began in April, 1989, and is sponsored by the Archer Daniels Midland Company, Decatur, Ill. Dr. Vincent T. Breslin is a Senior Research Scientist at the Waste Management Institute, Marine Sciences Research Center, State University of New York at Stony Brook. Dr. Sheldon J. Reaven is an associate professor of Technology and Society at the university and holds a joint appointment at the Marine Sciences Research Center where he is also an associate professor.

Plastic Continued from page 15

be measured to assess changes in the strength of the plastics following exposure. Researchers use Fourier transform infrared spectroscopy and 13C NMR to investigate changes in the chemical properties of the exposed plastics. Finally, a series of bioassay studies are planned using sensitive marine phytoplankton to test for toxicity of the degradation by-products.

While the WMI/ADM investigations are largely basic research, the results may help answer several practical questions about plastics waste management and the role of degradable plastics. These questions include:

- Are there health or environmental risks associated with degradable plastics (e.g., from plastic dust or from leachate)?
- How do degradable plastics affect shelf life, function, and costs of such items as bags and containers?
- How might degradable plastics best be tailored for special uses (e.g., agricultural mulch films, shipboard plastics)?
- How might the wider use of degradable plastics affect plastics recycling (especially that of commingled plastics), and how might degradable plastics be tailored (e.g., by blending in additives) to avoid any problems?
- How could landfill waste volumes be affected?



Researchers place samples of plastics in compost site to monitor degradation of various types of plastic.

The controversy over the use of biodegradable plastics versus nondegradable plastics will undoubtedly continue as long as these questions remain unanswered. We are hopeful that this research project will help provide the information necessary to make informed choices.

Incubator Nurtures Business Starts

The 40,000-square-foot University at Buffalo Foundation, Inc. Incubator is a high-tech facility, built with state and private funds, that nurtures technically-based businesses through their commercialization phase. The facility is adjacent to the North Campus of State University of New York at Buffalo.

The Western New York Technology Development Center (TDC), which has a successful track record of assistance to new businesses, manages the facility. Since 1983, the TDC has assisted the start-up of more than 25 technical companies. Those companies now have annual sales of over $5 million and employ more than 150 persons.

Start-up assistance to new companies includes subsidized rents, business plan and market analysis reviews, and no-cost counseling on financial and legal matters. Assistance in locating seed capital through local investors and leveraged borrowing through local development agencies also is available.

Facilities at the incubator include both wet and dry laboratories (with gas, compressed air, and vacuum lines; deionized water, and fume hoods), office space, and common services including reception, conference rooms, copy and facsimile machines, and secretarial help.

The facillity also houses "anchor" tenants, established technical companies that pay market rental rates and can serve as models for new, start-up companies. One such company is Recra Environmental, Inc., an analytical services firm that established a New Business Incubation Division at the facility to screen new technology concepts in waste reduction and waste treatment. Recra's first venture, Electro-Pure Systems, Inc., will concentrate on the development of an "alternating current electrocoagulation" process for reducing the volume and hazard potential of aqueous waste streams. Researchers at the University at Buffalo are participating in the research and development of this technology under a contract with the New York State Center for Hazardous Waste Management.

Stony Brook Researchers Investigate Shell Disease Found In New York Bight

By Randall R. Young

Shellfishermen working the waters off the continental shelf near the New York Bight have complained recently that an unreasonably high percentage of their crab and lobster catches are afflicted with a shell disease. They attribute the problem to the disposal of municipal sewage sludge at the 106-mile Deepwater Dumpsite, located 115 nautical miles offshore. The site is the federally-designated area in the Atlantic Ocean for the disposal of some New York/New Jersey sewage sludge.

The Waste Management Institute of the Marine Sciences Research Center at State University of New York at Stony Brook has undertaken a preliminary study of the shell disease complaint. Investigators will quantify the prevalence and severity of shell disease among red crab (*Geryon quinquedens*) inhabiting submarine canyons northeast of the 106-mile dumpsite and begin a database that can be used in further study of this phenomenon in relation to ocean waste disposal.

Shell disease, or burned-spot disease, is the necrosis of crustacean exoskeletal tissue caused by the invasion of the integument by chitinoclastic pathogens, which are ubiquitous in the marine environment. The disease appears to be most prevalent in areas where crustacean populations are highly stressed, and has been observed in many species of crustaceans around the world.

A direct relationship between the ocean dumping of sewage sludge and the incidence of shell disease has not been determined, although some previous studies have suggested that a relationship may exist. In an attempt to evaluate this suggestion, specimens from the study areas were ranked according to a disease severity index. Rankings were tabulated to make possible future comparisons with other populations both within and outside the same study areas.

Specimens from the submarine canyons were subject to histopathological examinations, and

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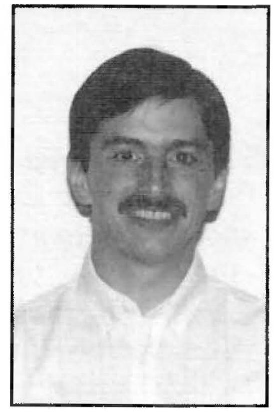
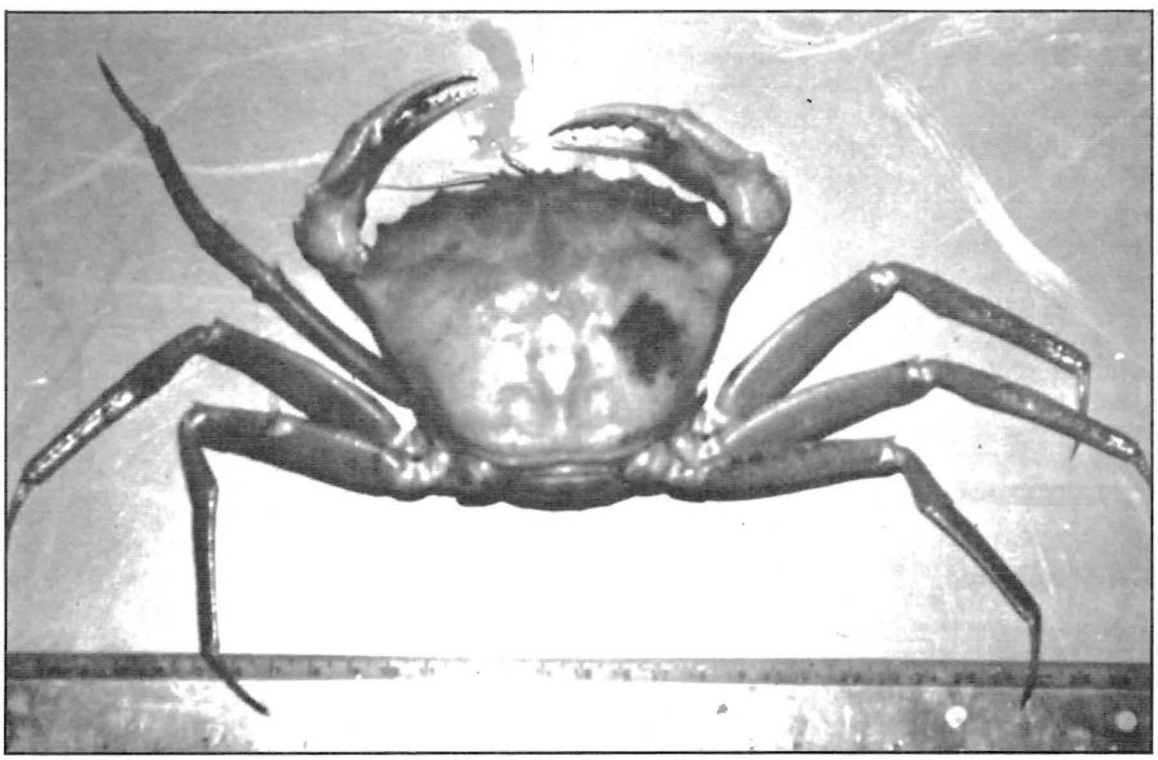
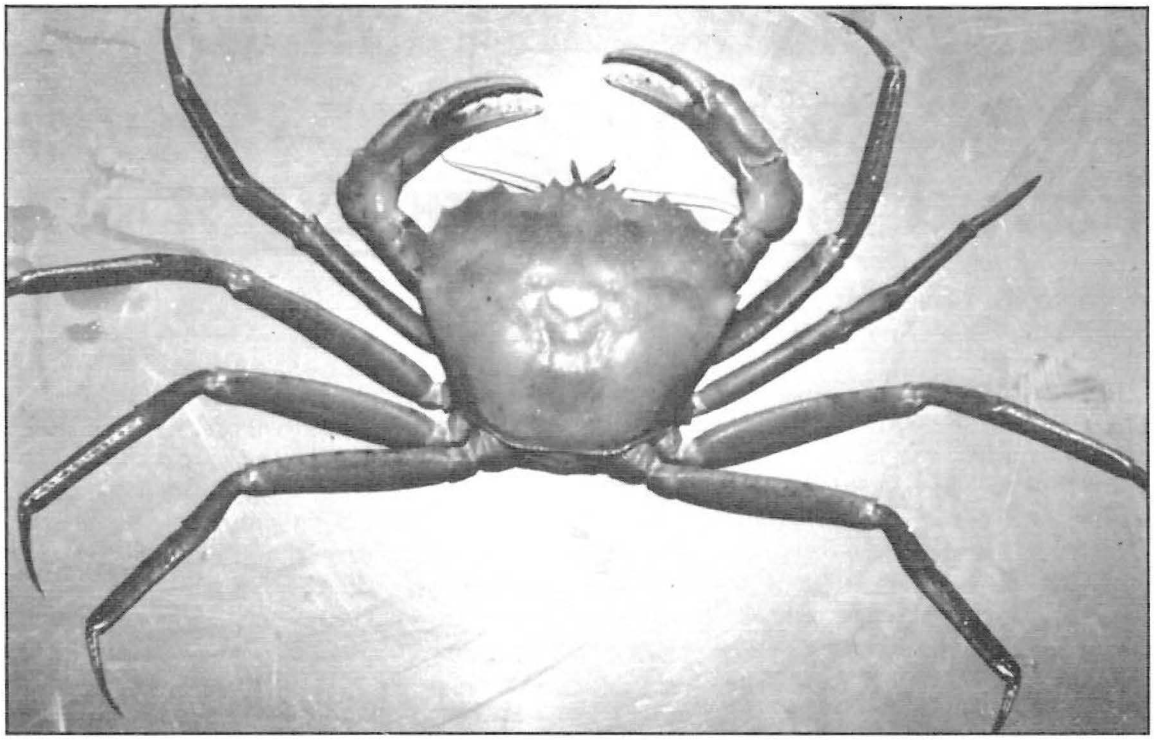
Randall R. Young is a graduate student studying shell disease at the Marine Sciences Research Center, State University of New York at Stony Brook.



Randall R. Young



Crab pictured on preceding page shows symptoms of shell disease. Crab at right exhibits healthy shell.



Shell Disease

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microorganisms taken from shell lesions were cultured at the Marine Biological Laboratory in Woods Hole, Mass., to determine which species of bacteria and fungi were present in the lesions. In addition, two independent laboratories have been contracted to perform tissue analyses on samples to determine body burdens of selected organic compounds and metals.

Disease Predates Dumping

Subsequent comparisons between different data sets may show whether shell disease prevalence and severity are equally distributed geographically and whether the disease occurred in red crabs prior to sewage sludge dumping. The first such comparison was made using preserved specimens in the crustacean collection of the Smithsonian Institution. Animals from various geographic locations and from as long as 100 years ago were examined. This work confirmed the existence of shell disease among New York Bight red crabs well before the commencement of sewage dumping.

Additional cruises to collect lobsters and crabs from the waters in and around the 106-mile disposal site as well as from distant, non-impacted reference areas have been proposed. Also, the Institute has participated in a joint Environmental Protection Agency/National Oceanic and Atmospheric Administration working group studying the issue.

These preliminary investigations will be helpful in determining the nature of the condition, but closer examination is necessary before conclusions can be made concerning a relationship between the incidence of shell disease and the current disposal practices at the 106-mile dumpsite.

WMI at Stony Brook Offers New Booklet

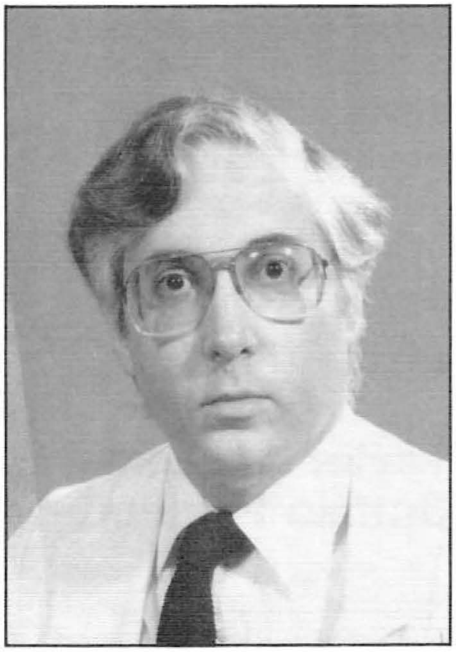
The Marine Science Research Center at State University of New York at Stony Brook offers a pocket-sized booklet, *Floatable Wastes and the Region's Beaches: Answers to Some Common Questions*. The publication, developed in cooperation with the COAST Institute, answers the most frequently asked questions about floatable wastes and beach wash-ups. The booklet costs $4 per copy to cover printing costs and shipping.

Interested persons should make checks payable to the Stony Brook Foundation and order booklets from:

Waste Management Institute
Marine Sciences Research Center
State University of New York
Stony Brook, NY 11794-5000

Also available are two free flyers prepared and published by the Waste Management Institute and the COAST Institute: a fact sheet on AIDS and medical waste in the ocean, and answers to general questions about floatable wastes. Interested persons may call Sheila Charnon at (516) 632-8704.

Notes and Announcements



William H. Greene

Physician To Fill Joint Appointment

Dr. William H. Greene, clinical associate professor of medicine at University Hospital, State University of New York at Stony Brook, has accepted a joint appointment at the university's Waste Management Institute. Dr. Greene serves on several panels concerned with medical wastes, including the Medical Waste Committee of the Society of Hospital Epidemiologists of America (SHEA). He will contribute his expertise to the institute's continuing work in the area of medical wastes.

A graduate of Yale University, Dr. Greene earned his medical degree at the State University of New York Health Sciences Center at Brooklyn. He did post-graduate work in internal medicine, medical oncology, and infectious diseases at the Yale Medical School and the National Cancer Institute of the National Institutes of Health, Bethesda, MD.

In addition to his interest in medical wastes, Dr. Greene has done research in the areas of opportunistic infections and investigational antibiotics. He is an external peer-reviewer for the Public Health Service Agency for Toxic Substances and Disease Registry report on health implications of medical waste disposal.

Brownawell Joins Research Staff At Stony Brook

Dr. Bruce Brownawell, an environmental chemist, recently joined the staff of the Waste Management Institute at the Marine Sciences Research Center, State University of New York at Stony Brook. Brownawell will contribute his scientific expertise to the study of numerous environmental issues, including problems related to protecting the groundwater resources of Long Island.

His research focuses on the biogeochemical processes that affect organic compounds (primarily hydrophobic pollutant compounds), in coastal, estuarine, and groundwater environments. He has studied the adsorption and physical behavior of several classes of organic pollutants, including PCBs, pesticides, and detergents. His goal is to understand how the physical-chemical form of an organic pollutant (*i.e.* dissolved in water, complexed, or bound to soil or sediment) affects its transport, uptake by organisms, and transformation reactions.

Brownawell earned a Ph.D. degree at the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Oceanography. He conducted post-doctoral research at Oregon State University.

Buffalo Center Sets November 30 Proposal Deadline

November 30 is the deadline for submitting research proposals to the New York State Center for Hazardous Waste Management, State University of New York at Buffalo.

For a copy of the solicitation, write:
New York State Center for
Hazardous Waste Management
207 Jarvis Hall
State University of New York at Buffalo
Buffalo, NY 14260
or call, (716) 636-3446.

Bruce Brownawell

Legislative Commission Schedules Conference In Winter, 1990

The New York State Legislative Commission on Solid Waste Management will sponsor its 1990 Conference on Solid Waste Management and Materials Policy January 31 through February 2 at the New York Penta Hotel in New York City.

Interested persons should write the Commission for information or registration materials at:
Agency Building 4
Fifth Floor
Albany, NY 12248
or call (518) 455-3711.

Cornell Institute Solicits Proposals

The New York State Solid Waste Combustion Institute is soliciting research proposals this fall. Persons interested in receiving a copy of the solicitation should contact:
New York State Solid Waste
Combustion Institute
Attention: Dr. K. Skelton
468 Hollister Hall
Cornell University
Ithaca, NY 14853

HMCI Schedules November Meeting

The Hazardous Materials Control Institute will sponsor its second National Medical and Infectious Waste Conference November 27 through 29 at the Omni Shorham in Washington, DC. Registration fee for the conference is $425.

Affiliates for the three-day conference include:

- American Biological Safety Association
- Association for Practitioners of Infection Control
- Duke University Medical Center
- National Solid Waste Management Association
- Society of Hospital Epidemiologists of America
- Uniformed Services University of the Health Sciences
- University of North Carolina School of Public Health
- U.S. Army Environmental Hygiene Agency
- U.S. Environmental Protection Agency
- U.S. Public Health Service, Center for Disease Control and Agency for Toxic Substances and Disease Registry

Address of the Hazardous Material Control Research Institute is:
9300 Columbia Boulevard
Silver Spring, MD 20910-1702

EPA, States, Industry Fund Packaging Study

The Council of State Governments (CSG) has received funds from the U.S. Environmental Protection Agency (EPA), several states, and packaging industry associations for a study of packaging materials in the solid waste stream. Energy Systems Research Group, Inc. (ESRG) of Boston, MA, will conduct the study and announce its findings by the end of 1990.

Research will assess the environmental impact of 16 types of packaging production processes that use both virgin and recycled materials; solid waste system impact of each packaging type; impact of public policy measures such as bans and taxes on packaging source reduction, and sales and employment impacts of packaging changes.

Project director John Schall of ESRG says that study results should provide a basis for public policy on packaging. ESRG is a non-profit research and consulting group. The CSG is a national, non-partisan, non-profit organization that serves state governments.

Cornell WMI Offers Summary

The Cornell University Waste Management Institute is analyzing the probable technical, economic, and environmental impacts of proposed new regulations that would tighten standards for existing incinerator facilities in New York State. The regulations, prepared this fall by the New York State Department of Environmental Conservation (DEC), follow aggressive regulations adopted by the state in 1988 that limit emissions of particulates, acid gases, dioxins, and other pollutants from future solid waste incineration facilities.

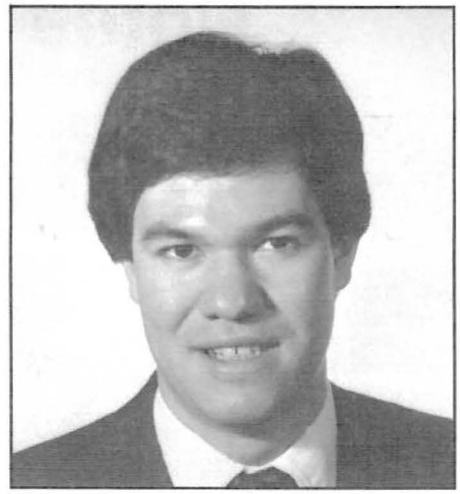
The Cornell study will include 12 incineration facilities where approximately 2.8 million of the 20 million tons of municipal solid waste managed in New York State are incinerated. Preliminary findings suggest costs of $30 to $60 million.

A summary of the impact analysis will be available later this month. Interested persons may write the Cornell Waste Management Institute, 468 Hollister Hall, Ithaca, NY 14853.

New Conference Slated In June

The Institute for International Research will launch a new conference and exhibition, "Solid Waste and Recycling Technology, 1990," June 13 through 15 in Detroit Hall of the Cobo Conference/Exhibition Center, Detroit, MI. The conference will focus on basic recycling, advanced recycling, marketing of recyclable goods, incineration and waste-to-energy, and landfill issues.

Interested persons may contact:
Rachelle Scheinbach
Executive Director
Institute for International Research—Bellevue
13555 Bel-Red Road
Bellevue, WA 98009



Stewart W. Taylor

Taylor Accepts Buffalo Position

Dr. Stewart W. Taylor recently accepted a position in the Department of Civil Engineering at State University of New York at Buffalo. He investigates the physical, chemical, and biological transformations of hazardous wastes in the subsurface environment, with application to practical, field-scale remediation efforts.

Taylor's most recent research involved an experimental and theoretical study to assess changes in permeability, porosity, and dispersivity of a porous medium under conditions of biostimulation. He worked as a senior engineer with Bechtel Corporation in California and as a hydraulic engineer with Howard, Needles, Tammen, and Bergendoff in Missouri.

Taylor is a graduate of the University of Kansas. He earned a master's degree at Colorado State University and a Ph.D. at Princeton University.

Council Releases Model Legislation

The Council of State Governments (CSG) recently approved model legislation, aimed at reducing hazardous waste generated by industry, for inclusion in the 1990 edition of Suggested State Legislation.

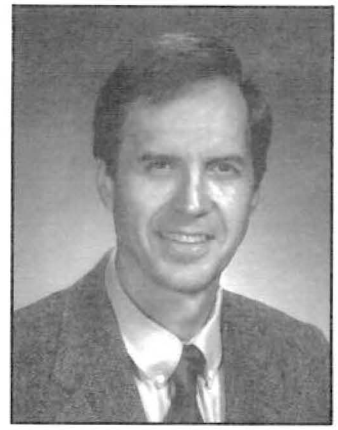
The model bill, written by a special CSG task force, combines legislation from Kentucky, Oregon, North Carolina, New York, and Minnesota.

Copies of the bill are available from the CSG Center for Environment and Natural Resources (606) 231-1882.

Guest Comment

Partnerships For Progress

By Milton L. Norsworthy



Milton L. Norsworthy

To compete in the world economy, the business community emphasizes "total quality management," which requires each member of an organization to see other members as customers. We should use this concept in dealing with environmental issues. Industry, government, academia, environmentalists, and the public must view each other and the environment itself as customers.

Groups must develop partnerships and respect for each other if there is to be progress. Using inputs from every group, we can establish alternative solutions to environmental problems. We must get away from the negativism that leads to stagnation and move to a cooperative, proactive approach that will foster progress and the implementation of new technology.

The recent round table discussion sponsored by the New York State Center for Hazardous Waste Management exemplifies the proactive approach. The roundtable focused on identifying the most promising directions for research and development aimed at reducing the generation of hazardous waste in New York State. The meeting also was a forum for identifying issues that could inhibit development of a cooperative industry/university research program under the auspices of the Center.

Participants identified several areas in which the Buffalo Center can be a focal point for "partnerships for progress." It can promote education and outreach programs; establish source reduction priorities; coordinate university/industry research on generic treatment processes and basic unit operations; develop formal university/industry partnerships that protect confidentiality; lead in identifying technologically feasible approaches to source reduction, and develop links between university and industry research programs.

We must recognize that every environmental solution will have a trade-off and that the nation has finite resources. We must establish priorities and use each waste-management tool—landfills, recycling, source reduction, product changes, new raw materials—where it best applies. Once we accept new standards and technology, we must make the resources widely available and cost-effective.

We should publicize all progress on the environmental front in order to recognize achievement, stimulate innovation, and educate the public. Consensus (government must assume leadership) can define where we are today and where we need to be. Up-front, honest communication can lead to the establishment of standards and the implementation of new technology. A team with a common goal and understanding of each group's needs can achieve environmental improvement without significant negative impact on the nation's standard of living.

We must seek a middle ground, accepting that in a democracy no one group can force its standards on the public. Industry and academia, working in partnership, can develop technology, establish priorities, set objective and realistic standards, and foster acceptance of new technology on a timely basis. Government must work with all other sectors to assure fair and equitable administration of laws.

With better communication through cooperative partnerships, we can progress to a cleaner, safer environment; a happier public, and a "satisfied customer."

Milton L. Norsworthy is plant manager at the Olin Corporation in Charleston, TN. He was a charter member of the executive board of the New York State Center for Hazardous Waste Management at Buffalo.

Waste Management Research **Report**

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