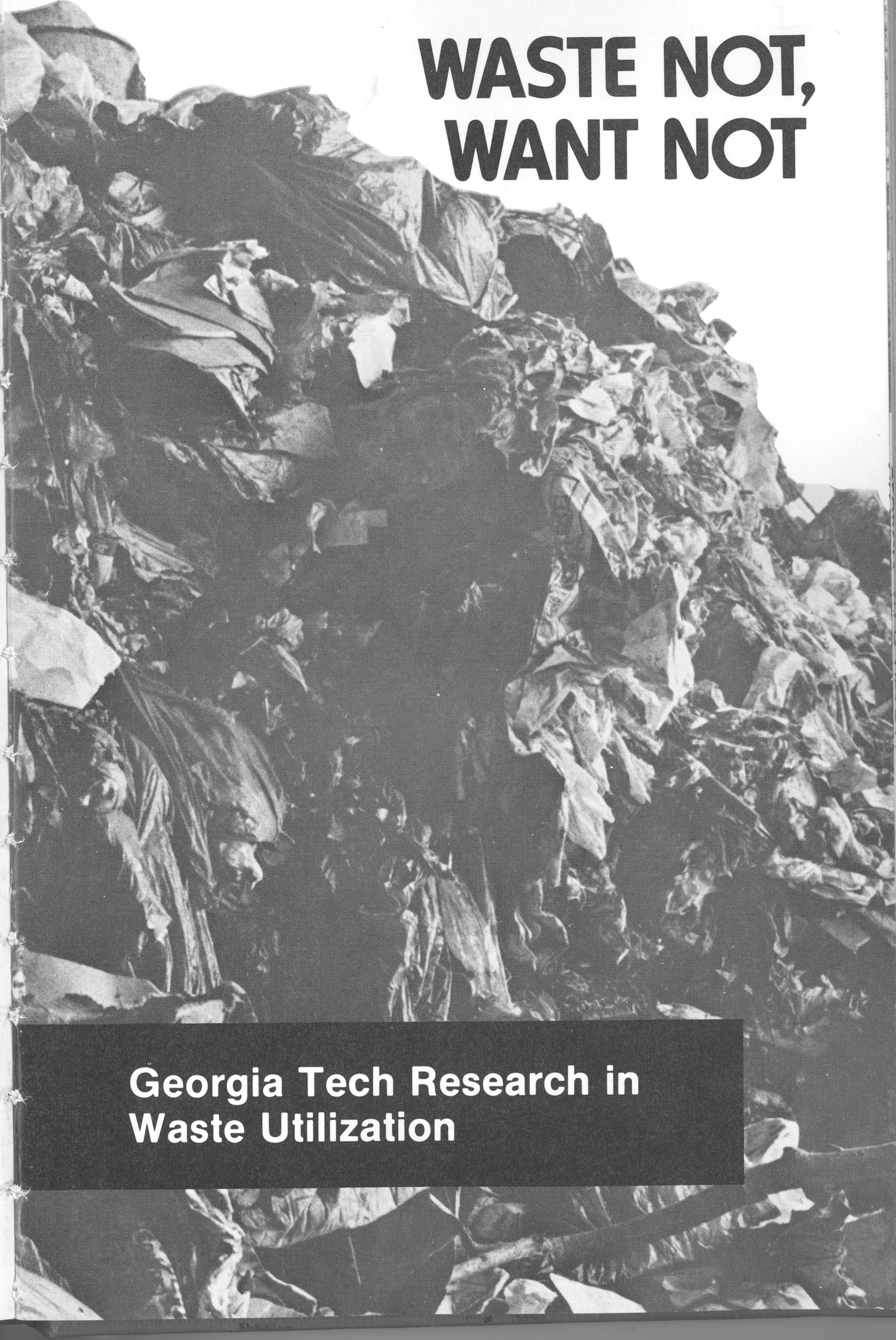
WASTE NOT, WANT NOT



Georgia Tech Research in Waste Utilization

This booklet is the first of a series of monographs published by the Engineering Experiment Station at the Georgia Institute of Technology. The monographs will focus on research topics of vital and current interest to the public and will emphasize research at the Engineering Experiment Station and elsewhere at Georgia Tech.

Waste Not, Want Not

Waste. It used to be easy to throw something away. That was before strict environmental and health standards, rising costs and energy shortages.

Waste. It used to be that waste was not important enough to stand alone as a research grant or a seminar. Today, however, the subject of waste commands big-time attention and awesome figures.

- 900,000 tons of livestock waste amass daily in the U.S.
- 500,000,000 tons of dry forestry wastes, including 70,000,000 tons of readily collectible residues, are generated yearly in the U.S.
- 1,500 tons of municipal solid wastes are collected within the city limits of Atlanta every day.
- For every bale (500 lbs.) of cotton, there are 600 lbs. of associated waste.

On top of that is heaped other agricultural crop and forestry wastes, not counting wasted water and heat from poultry plants, textile industries and even bakery ovens. Tons and tons of waste have become more than a pinpointing irritation in the back of our minds. Waste is a real problem with far-reaching consequences for business, industry and government as well as for the individual and his future.

Waste. And more waste. What are we going to do with it?

It All Started with Peanuts

Researchers at the Georgia Institute of Technology have been working diligently in the area of waste utilization for some time, and one could say it all started with peanuts.

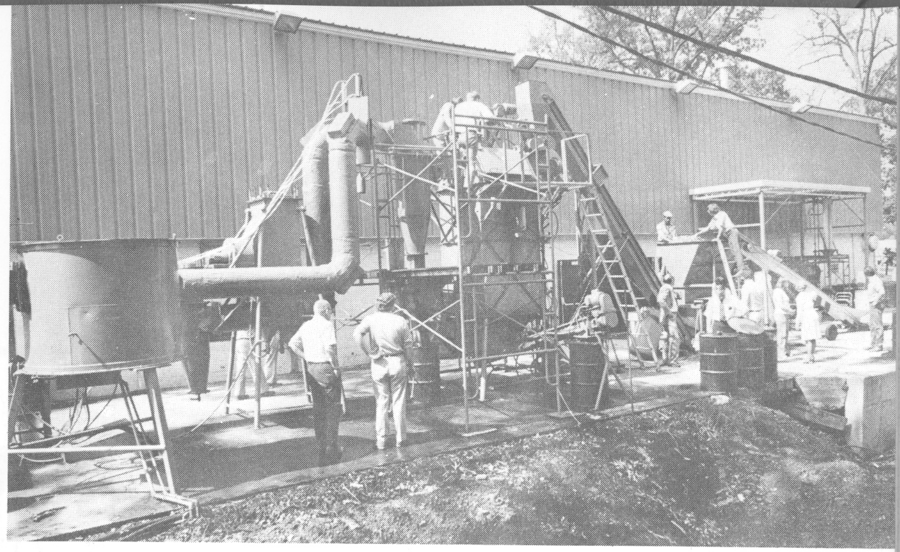
Several years ago, the peanut industry was having difficulty disposing of tons and tons of peanut hulls without creating a pollution problem. Georgia Tech was asked for help, and researchers did more than merely dispose of the hulls in an environmentally safe way. They developed a system which converted this waste into useful products.

The system, which uses a process called PYROLYSIS (pi-rol-i-sus), was successfully developed for peanut hulls, and at the same time a more profitable market for the raw hulls emerged. The pyrolysis system experienced early success!

Furthermore, the system's later success with wood waste was but a preview of the capability for disposal of municipal solid waste and sewage sludge while producing solid, liquid and gaseous fuels and activable carbon for wastewater treatment. Pyrolysis reduces disposal costs, is versatile, virtually eliminates pollution and helps pay for itself.

Pyrolysis is an old concept which has been used in crude fashion since early civilization. It consists of the decomposition of organic material, such as agricultural materials, with heat. Georgia Tech's pyrolysis system is unique in that the resulting by-products are: an organic liquid oil, a combustible gas and a solid (char), all useful products.

Finding clean, economical ways of dealing with waste is a goal of business, industry and government. Georgia Tech's pyrolysis system offers a technically feasible and innovate approach to present-day waste problems.



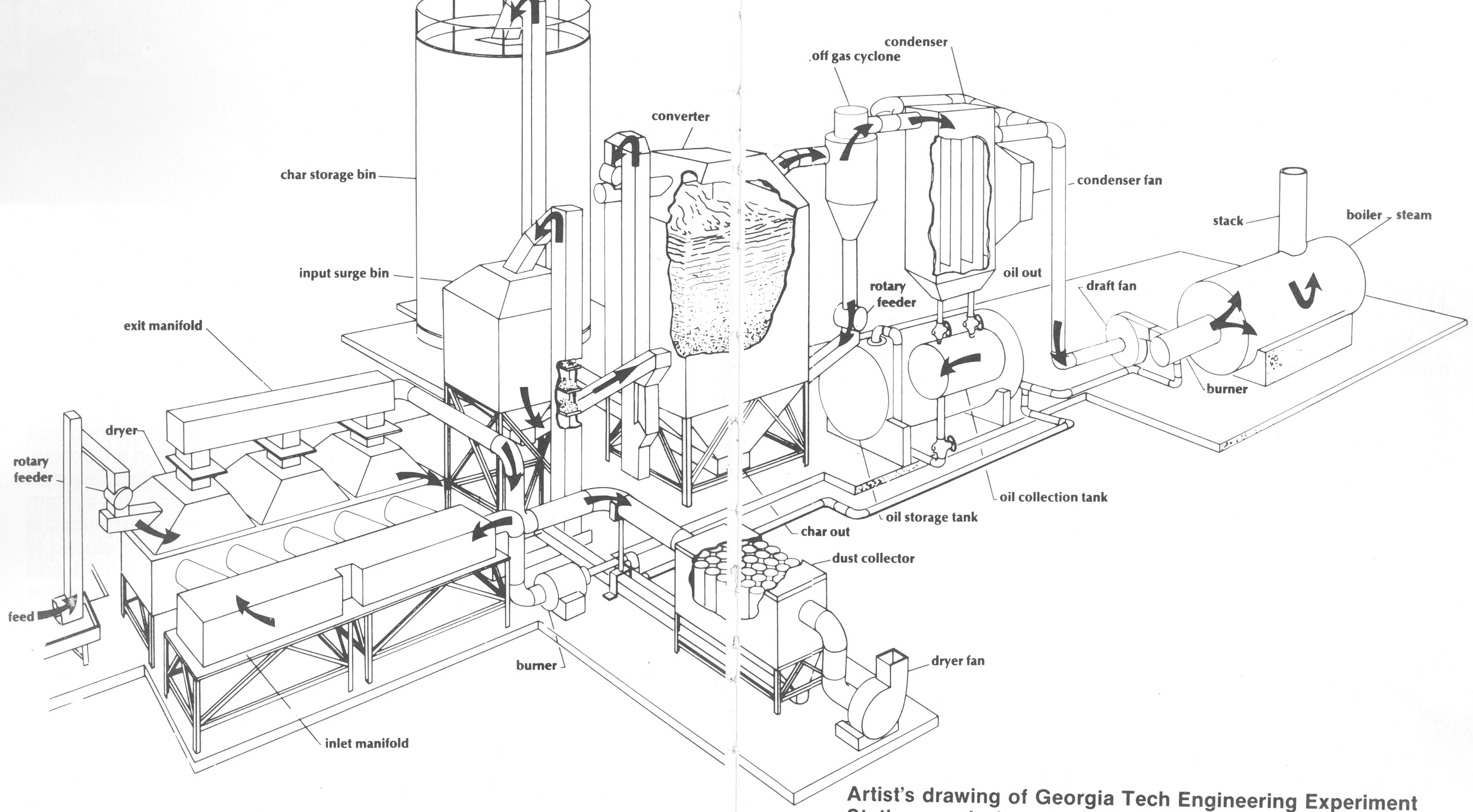
The Georgia Tech pyrolysis system converts waste materials to useful fuels.

The steady-flow pyrolysis process involves conversion of the wastes in a porous, vertical bed. Its advantages include simplicity and low temperature operation. These features, together, lead to a highly economical design. Also, the system is self-sustaining and requires a minimum of processing of materials prior to recycling.

A large 50 dry ton per day demonstration plant, owned and operated by the Tech-Air Corporation, is located in a Cordele, Georgia, woodyard and operates on wastes from the saw mill. In successful operation for more than three years, this system was field tested for two years prior to that. The char produced is sold for charcoal briquets, and the pyrolytic oil produced is sold as a fuel. A portion of the gas is used to dry the feed, and the remainder is flared. A dryer which utilizes hot combustion gases from the off-gas burner reduces the water content of the initially wet wastes to less than 10 percent.

Another attractive feature is the cleanliness of its exhaust which is completely invisible to the eye. An analysis of the combustion stack gases was made, and comparison of these data with the Environmental Protection Agency exhaust standards reveals that the system easily meets all federal standards.

A recent Georgia Tech experiment involved operating a spark-ignition truck engine on simulated non-condensible pyrolysis gas, and the experiment was successful despite initial pessimism from outside sources. An electric generator or even an automobile could be operated by an engine fueled with the pyrolytic gas. Other possibilities loom.



Artist's drawing of Georgia Tech Engineering Experiment Station pyrolysis system, licensed to Tech-Air Corporation. Drawing* is from a Tech-Air copyright, 1976.

*Some system components not to scale.

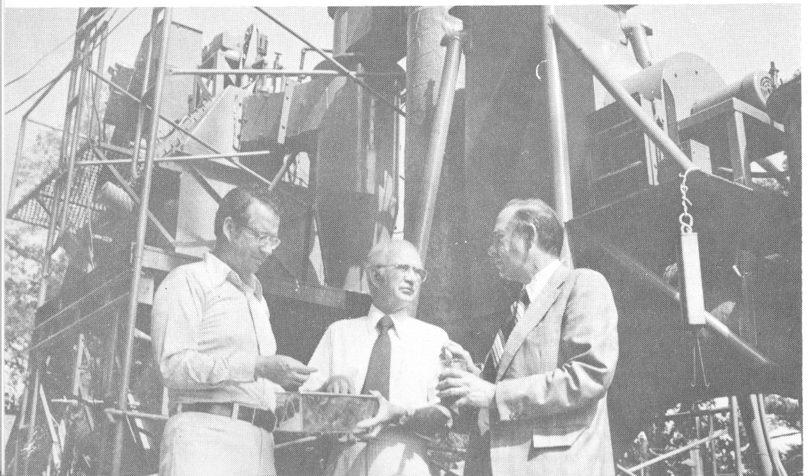
Municipal Waste and Pyrolysis

In the area of municipal waste, a year of research has shown a definite technical feasibility of processing the waste in a pyrolysis converter. Pyrolysis would be one component of an overall system for treating municipal wastes. First, most metals would be removed, air-classification would separate heavy materials, and then shredding would follow. After this "front-end treatment," waste consisting of mostly plastics, paper and cardboard would be fed into the pyrolysis unit. The resulting gas and oil become energy sources; the char which contains carbon can be activated and used in sewage and industrial wastewater treatment plants, or it can be used as a solid fuel.

Wood Wastes and Pyrolysis

Disposing of wood wastes is troublesome and costly, especially in Georgia, where the land area is at least 63 percent trees. Stringent air quality standards make burning difficult and expensive, and wasting a potential fuel is unacceptable to many citizens in this age of growing energy awareness. It is increasingly important to identify, plan and utilize all potential energy sources, and Georgia Tech researchers have found wood wastes to be one good resource.

Discussing clean-burning fuels produced from the pyrolysis system: Dr. Thomas Stelson, Georgia Tech's Vice President for Research; Dr. James Knight, Resource Utilization Branch; and Dr. Donald Grace, Director of Tech's Engineering Experiment Station.



The sawdust, tree bark and wood chips which have created a massive disposal problem for independent saw mill operators and wood pulp processors have considerable energy potential when used as a boiler fuel, as input for the pyrolysis system or as power plant fuel.

Char and oil produced from wood wastes are virtually sulfur and nitrogen free. Combustion and emission tests performed by the Energy Research and Development Administration (ERDA) on Cordele char and oil showed that char can be blended with high-sulfur coal so that the fuel mixture meets emission regulations. Furthermore, their tests showed that pulverized char and pyrolytic oil can be blended with high-sulfur No. 6 fuel oil so this char-oil slurry, when burned in an oil-fired boiler, also meets emission regulations — only a collection system for the smaller, finer particles may be required. The use of these very clean fuels, therefore, help us cope with "dirty" fuels.

Demonstrating the benefit from investing in research, Georgia Tech's pyrolysis system is suitable for processing organic wastes from mixed municipal solid wastes, sewage sludge, carpet scraps, plastics, manure, packaging, pecan shells, cotton gin waste as well as nonmetallic automobile wastes.

Pyrolysis is but one of many options that Georgia Tech engineers and scientists use to help with the national problem of what to do with waste.

Proteins from Wastes

Another ongoing research program in waste utilization involves the isolation of protein from a waste product of the peanut oil extraction process. The study focuses on converting a low grade waste material called peanut meal and/or presscake, into two very useful products, both of which should be marketable.

This waste material was often used for animal feed, but its use was restricted because of too high an aflatoxin (poison) content. Consequently, the material is suitable only for fertilizer and of lesser value to the industry. Depending upon its source, peanut meal and presscake contains 45-55 percent protein which is much needed to supply world dietary needs and to provide the protein requirements of many industrial food products. In addition to protein, the peanut by-product also contains small quantities of oil, starches, sugars and quite a volume of insoluble fiber.

On learning that the material was not used for animal feed because of the aflatoxin content, Georgia Tech suggested that a process previously discovered at Tech be applied to recover in usable form the proteins of the restricted waste stocks. The USDA National Peanut Research Laboratory at Dawson, Georgia, cooperated in the research, and the testing was successful.

In addition to the elimination of toxic materials, the process appeared to have two further advantages. By starting with a low-oil raw material, a virtually oil-free protein can be obtained without excessive processing. The resulting protein would bring a better price in industrial and food uses than it would as an animal feed.

In the Georgia Tech process, the protein is extracted in pure form, free of aflatoxins. The fiber, sugar, starches and that portion of the protein which does not extract as the isolate are combined to make a soft, tan-colored animal feed with a caramel-like fragrance. Any oil present is recovered as marketable peanut oil. The protein, a fine, off-white powder, appears to be suitable for human consumption and for industrial applications such as paper manufacture and cosmetics. Recoveries of protein have reached 85 percent.

A research grant from the Georgia Agricultural Commodity Commission for Peanuts enabled Tech to study the commercial potential of the process. Work was directed primarily toward evaluating economic aspects, including capital outlay, operating costs and the ecological impact of commercial operation. The next step is upgrading the process to pilot scale level.

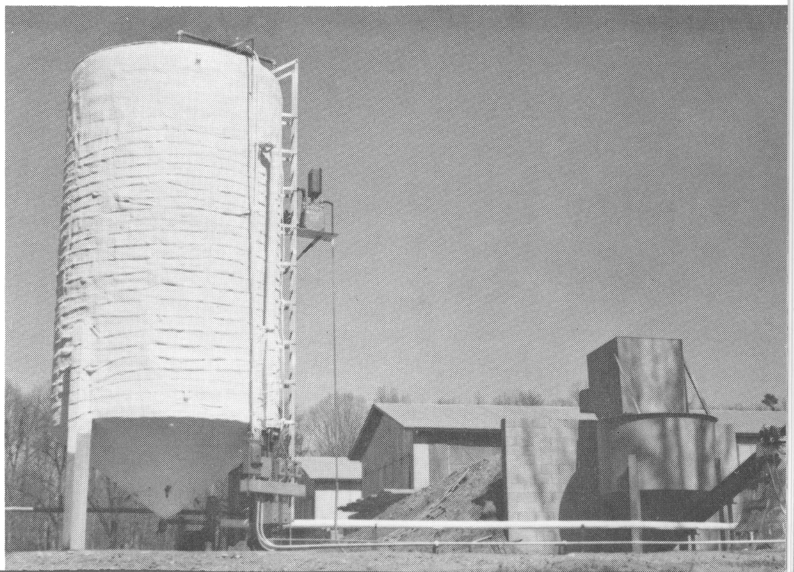
Animal Wastes

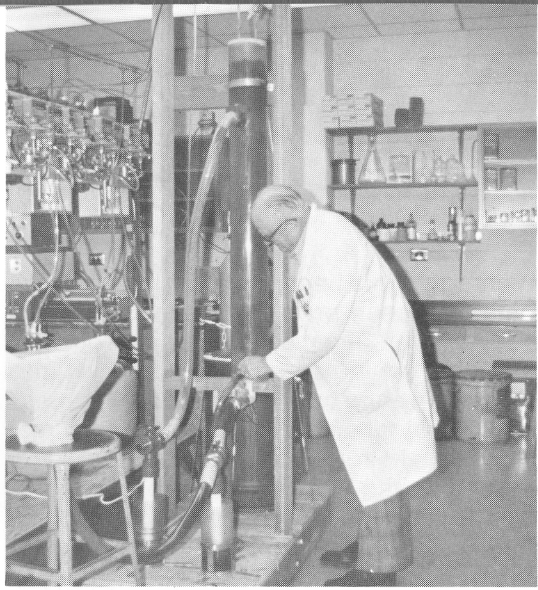
Before the current energy crisis became so apparent, there was a growing waste disposal problem in the livestock industry. This developed over a period of years from the concentration of the poultry, swine and cattle industries into extremely intensive operations and by an increased awareness of the environmental impact of such concentrated animal wastes. As the Environmental Protection Agency (EPA) and the various local agencies began to crack down on the odor, stream pollution runoff and health problems created by disposal methods, the livestock industry was forced to look at new ways to handle its wastes.

Georgia Tech studies developed a system using "anaerobic (an-a-ro-bik) digestion," a process which involves the digesting of organic (derived from living organisms) materials by various bacteria in an oxygen-free atmosphere. This process produces a mixture of methane and carbon dioxide as a gas by-product along with useful and harmless solid and liquid effluents.

The "biogas" product may be used directly as a fuel or converted to pipeline quality to supplement natural gas supplies. The solid product of the effluent may be used as a fertilizer or feed supplement to an animal diet. Again, waste can be converted into something useful.

Georgia Tech's 10,000-gallon anaerobic digestion system converts manure into energy.





Researcher checks the digestive flow of manure in a plug-flow digester system at Georgia Tech's Engineering Experiment Station.

Anaerobic digestion is a valuable process for:

(1) Disposing of an undesirable waste
(2) Generating a usable fuel (methane)
(3) Enhancing the value of the waste solids as a feed supplement or a fertilizer
(4) Removing odor and health problems

Initial work proved the feasibility of producing a fuel from poultry manures which may, in the case of a poultry processing plant, be used to heat the operation and also provide an enriched solid animal feedstock.

Currently, Georgia Tech is testing a 10,000-gallon anaerobic digester located at a poultry breeder operation near Cumming, Georgia. The system consists of a holding tank, a mix tank and a digester, all fully instrumented. Capabilities of pressure variation, temperature variation and hydrogen injection are added for test purposes. The major capital equipment items are available for further development research in waste utilization, and many scale-up problems that confront other research organizations have been solved. The system is also automated with electric controls and sensors for measuring and controlling batch loadings and effective reactor volume.

The anaerobic digester was designed intentionally to be as versatile as possible in terms of chemical reactor design. No one has, as yet, determined what reactor process mode is optimal for the anaerobic digestion of animal or poultry wastes. Georgia Tech's digester can be operated in ten different

process configurations. Not only is the unit one of the largest of its kind, but it is also probably the most versatile yet designed. Very significantly, it allows the determination of pollution control and waste management technology sub-systems which are optimal for not just a single but for a number of modes of operation for anaerobic digestion.

So through intensive research efforts, the livestock industry now has an option for disposing of its massive amounts of wastes without damage to the environment and with a possible alternate energy source as a result.

Wastewaters and Sewage Sludge

Engineering and scientific expertise and experience continue to be applied to other areas of waste-related problems which need attention. A perennial concern is municipal and industrial sewage sludge. Describing it as a suspended mass is an understatement because this residue is like the dregs of waste, an offensive reality and a paragon of challenge to both the mind and senses. It is what is left after anaerobic or aerobic digestion of waste occurs, for example, in a sewage treatment plant.

Wastewater treatment is becoming so large and so expensive that any ideas for reducing overall costs are considered worthy of study. Several years ago a Georgia Tech scientist was involved in designing a joint wastewater treatment facility located in Macon, Georgia, which treats a mixture of domestic and paper mill wastewater. The observation was made that infra-red photon energy reduced the volume of activated sludge by a factor of approximately two. At the time at which the phenomenon was first observed, no way of applying it for improving the effluent to the river was conceived. It is now being considered for decreasing the volume of waste-activated sludge that must be handled at this facility and at other wastewater treatment plants.

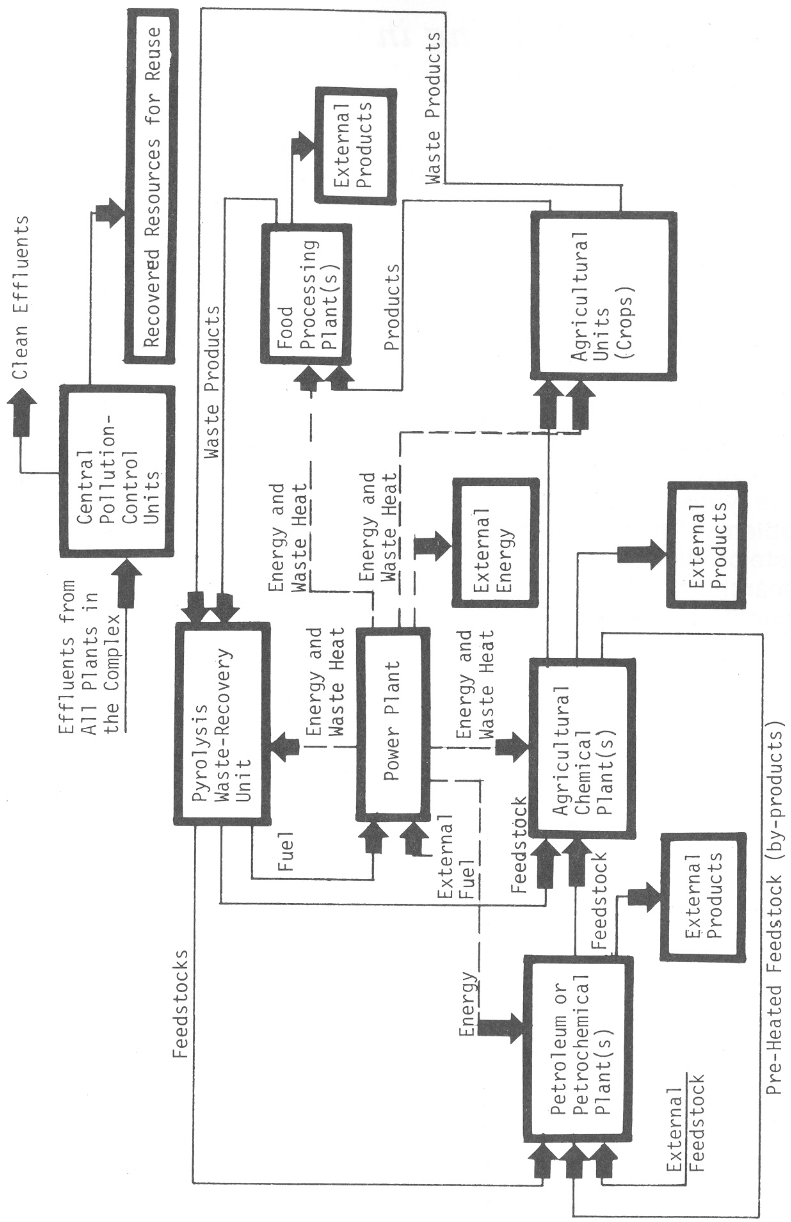
will evaluate gas production and composition generated by the anaerobic decomposition of the waste, thus allowing for evaluation of some possible energy recovery with methane as a possible fuel supplement in future engineering designs for landfill systems.

In a related study, Georgia Tech researchers are conducting a study for the Fulton County Commission which will assess the feasibility of utilizing methane gas currently being produced at municipal solid waste treatment facilities. The study focuses on the volume versus cost of sludge gas recaptured at major local treatment plants, the energy characteristics of the gas and the potential uses.

Synergistic Co-siting of Industrial Activities

Industry is the focus of another Tech project to extend and broaden research in "synergistic co-siting of industrial activities." Such a concept involves two or more industrial plants' cooperating and interacting on the same location and providing mutual beneficial use of plant wastes, energy, raw materials, land, co-products and transportation facilities, to name but a few. Such "hooking-up" of industries would allow, for example, a synthetic chemicals company and a plant that produces fabrics or carpets to reduce greatly the net energy input and waste products. One plant could be discarding that which the other plant needed.

Since industry has a major impact on both the nation's energy and environment, Georgia Tech's development of unique, creative ways for industry to solve some of these problems is gaining increasing recognition and financial support.



Hypothetical Example of Synergistic Co-Siting Possibility

Georgia Tech Leading in Waste Conversion

Many years ago, Georgia Tech researchers were aware that an "out of sight-out of mind" attitude toward waste was not realistic or smart. Burning it, dumping it into oceans, lakes or streams or waiting for it to decompose produced debts in resources, money and health. Georgia Tech continues to lead the way to noteworthy achievements and exciting new possibilities in waste utilization and waste-related problems. Business, industry and government as well as the individual will hopefully consider waste in a new light. Perhaps the word itself will be obsolete in future years as such situations as the energy crisis make discarding waste an extravagence.

Converting waste into something useful is a reality . . . for some types of waste. There is no promise of one solution to all problems. There is hope, however, that a solution to each waste problem will be acceptable and economically feasible as research and development devise new technology to better serve the needs of mankind.

For further information, contact:
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