

ENERGY CONSUMPTION, CONSERVATION AND RECOVERY
IN
MUNICIPAL WASTEWATER TREATMENT - AN OVERVIEW

by
Maurice F. Bender

DISCLAIMER
This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Prepared for
Seminar on
Aquaculture Systems for Wastewater Treatment
Davis, California
September 11-12, 1979

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED
EB



ARGONNE NATIONAL LABORATORY, ARGONNE, ILLINOIS

**Operated under Contract W-31-109-Eng-38 for the
U. S. DEPARTMENT OF ENERGY**

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

The facilities of Argonne National Laboratory are owned by the United States Government. Under the terms of a contract (W-31-109-Eng-38) among the U. S. Department of Energy, Argonne Universities Association and The University of Chicago, the University employs the staff and operates the Laboratory in accordance with policies and programs formulated, approved and reviewed by the Association.

MEMBERS OF ARGONNE UNIVERSITIES ASSOCIATION

The University of Arizona	The University of Kansas	The Ohio State University
Carnegie-Mellon University	Kansas State University	Ohio University
Case Western Reserve University	Loyola University of Chicago	The Pennsylvania State University
The University of Chicago	Marquette University	Purdue University
University of Cincinnati	The University of Michigan	Saint Louis University
Illinois Institute of Technology	Michigan State University	Southern Illinois University
University of Illinois	University of Minnesota	The University of Texas at Austin
Indiana University	University of Missouri	Washington University
The University of Iowa	Northwestern University	Wayne State University
Iowa State University	University of Notre Dame	The University of Wisconsin-Madison

NOTICE

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for any third party's use or the results of such use of any information, apparatus, product or process disclosed in this report, or represents that its use by such third party would not infringe privately owned rights. Mention of commercial products, their manufacturers, or their suppliers in this publication does not imply or connote approval or disapproval of the product by Argonne National Laboratory or the United States Government.

ENERGY CONSUMPTION, CONSERVATION AND RECOVERY
IN MUNICIPAL WASTEWATER TREATMENT - AN OVERVIEW*

Maurice F. Bender
Argonne National Laboratory
Argonne, Illinois

Abstract

The potentials for energy consumption, conservation and recovery at municipal wastewater treatment plants are relatively small compared to the national energy figures. Nevertheless they are significant, particularly to local owners and operators. Estimates of energy consumption, as well as opportunities for conservation and energy recovery in municipal wastewater treatment operations, are reviewed. The relationship between energy conservation and aquaculture based wastewater treatment systems is also introduced. Finally, current Department of Energy activities in this area are presented.

When we speak of energy consumption in wastewater treatment in relation to the natural energy consumption figures, we speak of relatively small numbers. Although there is considerable variability in the figures currently available, a commonly accepted range of values is that municipal wastewater treatment accounts for about 0.1 to 0.3 percent of the nation's energy usage. This amounted to about 0.15 quads or 0.15×10^{15} Btu's in 1978. We also anticipate that, except for unforeseen major breakthroughs in energy conservation and recovery technology by 1990, we can expect this energy usage to roughly double to about 0.26 quads. Again, there is some difference of opinion on this estimate. The doubling can be attributed to an increased volume of wastewater and to the higher degree of treatment required to meet more stringent Federal and state limitations. The relationship comes about because it becomes increasingly difficult to remove wastewater constituents as the degree of treatment required increases. Traditionally, the more sophisticated the removal process, the more energy required to extract a given mass of pollutant from the waste stream. Advanced treatment processes, for example, often require large quantities of chemicals that require energy intensive methods of production.

Although the numbers are relatively small on a national usage scale, they are significant, particularly on a local level. The cost of supplying energy to a typical wastewater treatment plant generally represents between 20 and 40% of the overall operating budget. In general, the energy consumption by municipal treatment plants represents an estimated one quarter to one-third of the

*Presented at the "Seminar on Aquaculture Systems for Wastewater Treatment."
University of California Extension. University of California, Davis.
September 11 and 12, 1979.

energy purchased by many local governments. Depending upon the scenarios employed we are speaking of an increased cost of approximately one-half to one billion dollars to municipal governments through the year 1990. Consequently, there is or should be strong motivation for support, at the local level, to meet the goals for energy conservation in wastewater treatment. Professionals will have to become increasingly better informed of energy considerations in the planning, design, construction, operation and maintenance of wastewater treatment plants. The Department of Energy and the Environmental Protection Agency have embarked on such efforts and I will speak further on this subject a bit later.

Energy considerations are closely related to a number of design factors employed in the planning and designing of an overall wastewater treatment process. The actual energy consumption by a given plant is a function of such variables as the location of the plant, the treatment processes employed, the age of the plant and the effluent limitations that have to be met. The cost of the energy, calculated over the lifetime of the plant, must be coupled with these considerations.

One of the greatest opportunities for energy conservation in wastewater treatment plants lies with the energy currently consumed by prime movers such as pumps and blowers. Based upon reviews of detailed energy audits of specific plants, such as the energy audit for the West Southwest Plant of the Metropolitan Sanitary District of Greater Chicago, it becomes apparent that 90% or more of the energy consumed at most plants can be attributed to prime movers. At the West Southwest Plant the total energy consumption in 1976 was about 2.5 billion kilowatt hours (kWh) of which 2.2 kWh were attributed to prime movers. A notable fact is that due to the large amounts of energy consumed in pumping air into an activated sludge system, this type of treatment is one of the most energy-intensive processes employed in wastewater treatment.

The optimization of the pumping operations to reduce energy consumption, therefore, should be a focal point for energy reduction. There are three general areas for optimizing the energy efficiency in pumping operations. They are: 1) the selection of the appropriate pumps for a given job, 2) optimizing overall system performance, and 3) the proper operation and maintenance of the pumps. It should be noted that this major consumptive use of energy in most plants is also inherently a problem in aquaculture wastewater systems, and optimization of pumps selection, operation and maintenance should be considered in these systems as well.

There are a number of opportunities for increased energy conservation and recovery which I want to touch upon. (John Beneman, one of the speakers in our session, will speak further on the subject of energy recovery.) These opportunities include the following:

- improved dewatering methods in the context of an optimum sludge management strategy,
- increased utilization of sludge digestion gas,
- use of chemicals or other materials which require less energy in their production than are currently employed,

- more energy efficient design of treatment plant buildings,
- the use of small turbine-generators at the outfalls from wastewater treatment plants,
- combined sludge and solid waste energy recovery systems.

These are just a few of the areas where we can develop more energy efficient and generally more cost effective system while meeting water quality requirements.

I will now spend a few minutes discussing DOE's activities and plans in this area. In particular, I will talk about the Urban Waste and Municipal Systems Branch in the Office of Conservation. Don Walter is the Branch Chief.

DOE has recently completed a draft program plan for energy conservation and recovery in wastewater treatment plants. Although I believe it will require considerable reworking, it is extremely gratifying to some of us who have nurtured such an effort. The plan is directed towards stimulating the development and commercialization of technologies to reduce the energy requirements and to increase the efficiency of wastewater and water treatment processes. For the near term, it places a strong emphasis upon retrofitting existing plants. The emphasis is upon working closely with the EPA, and Department of the Interior, and other agencies, in complementing their objectives, as well as working towards DOE's objectives.

Although DOE's current state of activities with regard to energy in wastewater treatment can be summarized as being in a planning stage, there are several additional efforts which have some relevance here, three of which I would like to mention: 1) along with EPA, DOE is funding the development of a manual for energy conservation and recovery in municipal wastewater treatment plants. It will be published as part of the EPA Technology Transfer series, 2) DOE is participating in the Reedy-Creek Project, which was previously discussed in this conference, 3) the DOE is sponsoring a conference on the subject of Energy Optimization of Water and Wastewater Management to be held in New Orleans on December 10-13. Announcements on the table in the back of the room describe the conference further.

Finally, I would like to address the question: Where does wastewater aquaculture lie in DOE's current plans? Frankly, the answer is that it is not currently a part of the plans. This does not imply that DOE is not interested but I believe a stronger argument has to be made concerning the energy conservation and recovery opportunities which can arise from the use of wastewater aquaculture systems. I am convinced that there are such opportunities. Some time back, while providing technical consulting support to DOE, I worked towards achieving DOE participation in the Reedy Creek (Disney World, Florida) aquaculture effort. I felt that there was sufficient energy conservation potential in such systems to warrant DOE getting its feet wet and yet not getting bogged down. I also believe we now need to quantify the energy conservation and recovery in wastewater aquaculture units as a basis for comparison with conventional processing units. Implicitly, the use of aquaculture processing units should result in the use of less energy than conventional treatment, assuming effluent limitations can be met. We know that about 80% of the sewage districts in the

U.S. have treatment facilities with capacities of one million gallons per day or less (this capacity serves about 10,000 municipal residents). Because of economy-of-scale principles, aquaculture-based treatment systems may become attractive for some of these smaller plants, particularly in light of the schedule for treatment requirements. The potential energy conservation and by-product utilization characteristics of aquaculture-based wastewater treatment may further the acceptance of such systems as alternative technologies.

Thank you.