POO-POWER? Why Waste Your Waste?!

The Potential for Biogas Digesters as Substitutes for Failing Septic Systems

By Benjamin Hertaus

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Faculty Readers: Derek Larson and Troy Knight

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Abstract

Individual Sewage Treatment Systems, commonly known as septic systems, are failing in the U.S. due to improper design and installation, maintenance, and use. Failure of septic systems causes harm to the environment and human health due to contact with raw sewage containing dangerous levels of pathogens and nutrients. Solutions to the problem require repair or replacement of existing conventional systems, which is costly and may result in the same installation and maintenance problems. Alternatives to conventional systems exist, one possibility being biogas digesters, a system in which bacteria in an environment devoid of oxygen are used to break down organic matter and successfully treat waste. As an added benefit to treatment, the process produces biogas, a flammable mixture made up mostly of methane and carbon dioxide, which can be used as a source of energy, and a valuable fertilizer in the form of a nutrient rich sludge.

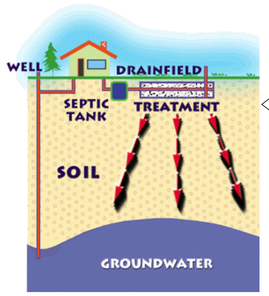
Can biogas digesters be a viable alternative, both economically and environmentally, to conventional septic systems? Biogas digester technology, from domestic to municipal scale, has successfully been used throughout the world. Small scale biogas digester use in industrialized nations, such as the potential for decentralized sewage treatment, is not viable due to economies of scale, causing high installation and maintenance costs relative to low energy and fertilizer benefits. Biogas digester application should be consider only for expanded use in large operations, while proper technical and institutional factors need to be addressed for successful management of decentralized wastewater systems.

An Alarming Number of Failing Septic Systems

Septic System Statistics in the U.S.	
Total Housing Units Served by Septic Systems:	26.1 Million (~ 25% of Pop.)
Number of Failing Systems:	Between 10 and 20%
Minnesota Statistics	
Number of Homes With Onsite Systems:	535,000
Estimated Failing Systems:	144,000 (27%)
Estimated Imminent Threats to Public Health and Safety:	64,000 (12%)
Estimated Total Failing and Imminent Threat Systems:	**208,000 (39%)**
Stearns County Statistics	
Number of Homes With Onsite Systems:	15,000
Number of Failing Systems:	4,500 (30%)
Number of Imminent Treats to Public Health and Safety:	300 (2%)
Total Failing and Imminent Threat Systems:	**4,800 (32%)**

Sources: U.S Environmental Protection Agency, Office of Water, *Decentralized Waste Treatment Systems: A Program Strategy*, 2005.
Minnesota Pollution Control Agency, *Report to Congress: 10 Year Plan To Upgrade and Maintain Minnesota's Onsite Treatment Systems, 2004.*

Failing Septic Systems: A Myriad of Environmental and Health Problems



Source: MN Pollution Control Agency

Q: What is a failing septic system?

A: A failing septic system is one that does not provide adequate treatment and may contaminate ground or surface water. A system may also pose "imminent threat to public safety" in any situation when sewage can cause direct harm.

Q: How do septic systems treat waste?

A: As seen in the figure to the left, septic systems conventionally consist of a septic tank, a distribution box, and a soil based drain field. Grease, fat and solids are allowed to collect in the tank, while the effluent (water) is allowed to flow through and be treated by anaerobic bacteria in the soil.

Q: Why do septic systems fail?

A: Septic systems fail for a variety of reasons. In general improper design or installment, failure of the homeowner to conduct proper maintenance, and over or under use result in incomplete treatment or leakage of raw sewage. A lack of education and management of installers and owners is to blame.

Q: What are the environmental and health problems associated with failing systems?

A: Failing septic systems are a significant source of groundwater contamination leading to disease outbreaks and other adverse health effects. The bacteria, protozoa, and viruses found in wastewater cause these diseases. Significant levels of nutrients in untreated sewage effects water bodies by enhancing the growth of algae and other aquatic plants, resulting in lack of oxygen, destabilizing whole aquatic communities.

Q: What is being done to fix failing septic systems?

A: Failing septic systems must be replaced or repaired in order to establish safe treatment. Conventional systems range in price from $3,000 to over $10,000, depending on site conditions and local ordinance requirements.

Are Biogas Digesters a Viable Alternative?

Q: How are biogas digesters currently being used?

Municipal:

More than 500 large waste water treatment facilities in the U.S. use anaerobic digestion to treat waste. Over 15 plants have incorporated biogas recovery systems to generate electricity to offset costs.

Agricultural:

151 commercial livestock operations within the U.S. producing an estimated 374 kilowatt hours of energy in 2009

Domestic:

Over 22 million rural agricultural households in China have installed biogas digesters, using them to provide fuel for cooking, heating, lighting, and as a source of fertilizer.

Q: What are the Uses of Biogas and Digested Material?

A: Biogas can be used as a fuel to generate electricity, heat for cooking and water, or even power automobiles. The digested material is rich in nutrients, making it desirable for agricultural use or fish feed.

Q: Should biogas digesters replace septic systems?

A: The potential amount of biogas produced from single family households is not enough to be viable economically. Biogas systems can be used successfully on larger scales, but not for domestic septic system application. Conventional systems are proven to treat waste when designed, installed, and maintained properly. Management needs to develop to foster these practices.

Methods

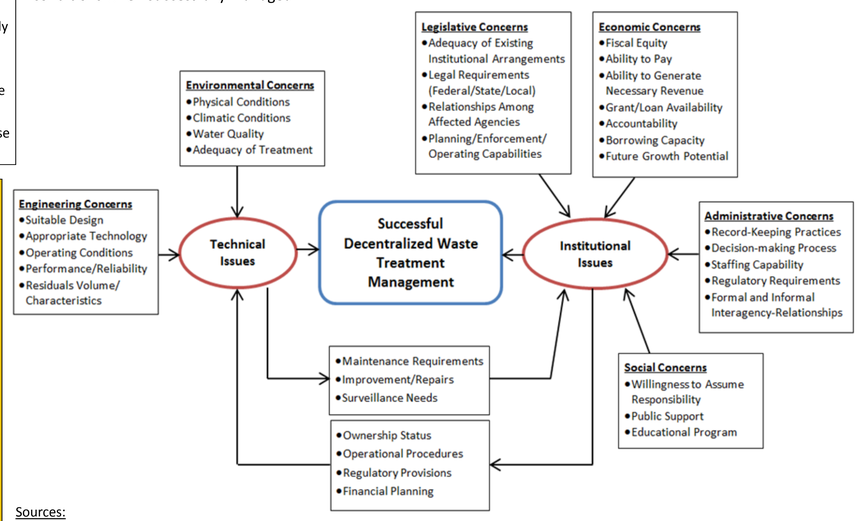
The failing septic system dilemma in the U.S. is outlined through a review of current technology, system process, governmental regulation, environmental impact, and social history of decentralized sewage treatment. Research was obtained through review of data and publications by the US Environmental Protection Agency, Minnesota Pollution Control Agency, and Stearns County Environmental Services. An understanding of biogas digester technology was obtained through analysis of biology and engineering textbooks and articles from scientific journals. The viability of biogas digester technology was realized through case study analysis of digester use in municipal, agricultural, and domestic scales throughout the world. The viability of biogas technology to replace septic systems was examined through interviews of several individuals: Stearns County Environmental Service septic inspectors Jennifer Burg and Mark Latterell, certified Minnesota septic system design professional Tim Haeg, and PinJing He, professor of State Key Laboratory of Pollution Control and Resource Reuse, College of Environmental Science and Engineering, and the Director of Institute of Waste Treatment and Reclamation of the Tongji University, China.

Conclusion

The use of biogas digesters as replacements for single resident septic systems is not economically viable due to high costs and low benefits. Regardless, biogas digester technology has successfully been used on a municipal, agricultural, and domestic scale throughout the world. Large scale biogas generation through anaerobic digestion is viable economically, producing enough biogas to lower energy costs and providing a valuable source of fertilizer for agriculture. Small scale use is only viable in developing third world countries, where fuel sources are scarce and waste management systems are needed to prevent harm to human and environmental health. Besides cheap alternative sources of energy, a need for more advanced and proven commercial biogas systems, and regulation barriers, the amount of waste generated by a single household does not have a large enough nutrient potential to produce enough biogas in a digester to be economically viable. Conventional septic systems, if installed and maintained correctly, can successfully replace failing systems. Improved education, regulation, management, and funding for septic system programs are needed to guarantee working systems and thus preserve environmental and human health.

Septic System Management: The Solution to Failing Systems

The answer to failing systems lies in successful decentralized waste management. The elements of a successful system can be seen in the adapted figure below, developed by the EPA in its *Report to Congress on Use of Decentralized Wastewater Treatment*. The report concludes decentralized systems can successfully protect public health and the environment, typically have lower capital and maintenance costs than centralized systems and are appropriate for varying site conditions when successfully managed.



Sources:

-AgSTAR. "Anaerobic Digesters Continue to Grow in the U.S. Livestock Market." U.S. Environmental Protection Agency, May 2010.

-Carl Nelson and John Lamb, The Minnesota Project, *Final Report: Haubenschild Farms Anaerobic Digester*, August 2002.

-Minnesota Pollution Control Agency, *Report to Congress: 10 Year Plan To Upgrade and Maintain Minnesota's Onsite Treatment Systems*, 2004.

-Pin Jing He, "Anaerobic Digestion: An Intriguing Long History in China," 2010.

-U.S Environmental Protection Agency, Office of Water, *Decentralized Waste Treatment Systems: A Program Strategy*, 2005.

-U.S. Environmental Protection Agency, Combined Power and Heat Partnership, *Municipal Wastewater Treatment Plants*, 7 October 2010.

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