Home & Environment

Wastewater Biological Oxygen Demand in Septic Systems

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Household wastewater contains a mix of chemicals, impurities, and other materials. One of the most important of these materials is organic matter, which is composed of carbon (C), nitrogen and oxygen. In septic systems, C comes from the digested and undigested food we eat, as well as the microorganisms that live in the system.

The amount of biodegradable C found in septic systems is important, because by measuring it, we can determine the waste stream's biochemical oxygen demand (or, BOD). BOD refers to the amount of oxygen microorganisms must consume in order to oxidize (that is, break down) all the organic compounds in a liter of wastewater. This is important, because a high BOD number means potential septic system problems for homeowners, while a low BOD means fewer problems for homeowners.

This publication describes the environmental impacts of BOD, shows how BOD is distributed in septic systems, and describes remediation strategies for excess BOD.

Environmental Impacts of BOD

BOD tests measure the BOD over a five-day period instead of the total BOD. This five-day test, called a BOD_5, is typically about 70 percent of the waste stream's total BOD. We use BOD_5 out of convenience because it could take a very long time to determine the total amount of BOD. The remainder of this publication will refer to BOD.

The risk of groundwater contamination from excess BOD from a properly sited, designed, constructed, and maintained septic system is slight. Most of a waste stream's BOD is removed in the septic tank, while the BOD associated with suspended particulate matter that makes it to a septic system's soil absorption field is removed by the soil-trench infiltrative surface and biological mat (biomat). The dissolved BOD that makes it into the soil is quickly removed through aerobic biological processes in the soil. If excess biodegradable C finds its way to surface or groundwater it can result in low dissolved oxygen

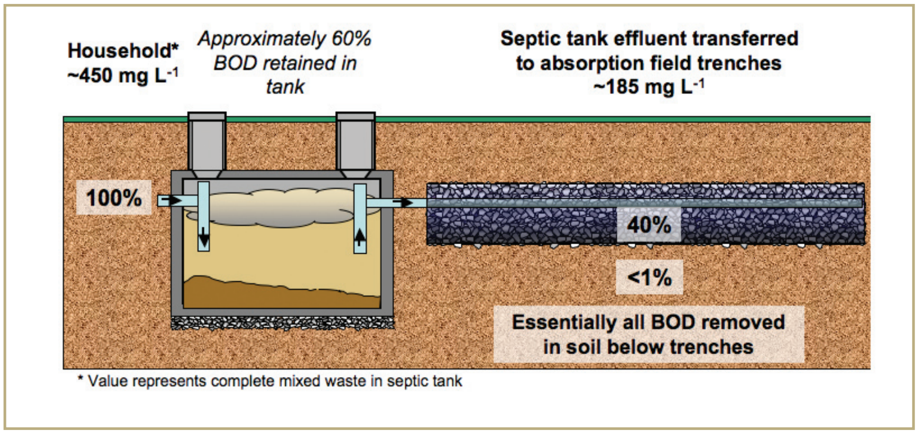

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Figure 1. *The majority of household BOD in a conventional trench septic system accumulates in the septic tank. Approximately 40 percent of the BOD is transferred to the soil absorption field trenches where it is a food source for microbes. Less than 1 percent of the BOD moves to the soil below the absorption field.*

concentrations in water and create taste and odor problems in well water.

Distribution of C in Septic System

Under proper site and operating conditions, septic systems remove more than 95 percent of a waste stream's BOD. About 60 percent of the C that makes up the incoming BOD is removed in the septic tank during the settling processes. The remaining 40 percent of BOD enters the soil absorption field trenches. Much of the BOD in this effluent is composed of particulate matter, which is trapped at the gravel-soil interface in the soil trench (in traditional septic systems), or in the sand (in elevated-sand mound septic systems). In either case, microorganisms break down and use the biodegradable C.

At the trench-soil interface, microbial populations grow according to the amount of biodegradable organic matter that flows out of the septic tank. This growth results in a thick layer of cells, commonly called a biomat. This biomat is where the bulk of biological wastewater treatment occurs in a septic system soil absorption field.

In properly operating absorption fields, the biomat is in equilibrium — that is, about as many cells are growing as are dying. But if organic matter is added to the system faster than the biomat can decompose it, the biomat thickens and subsequently reduces the wastewater infiltration rate in the trench. This typically leads to a systemwide reduction in the rate wastewater is dispersed in the soil absorption field.

Other factors can affect biomat development, such as hydraulic loading rates, soil temperatures, and the maintenance performed on the system.

When the hydraulic loading rate (the rate at which wastewater enters a septic system) exceeds the wastewater infiltration rate, septic tank effluent begins to back up in the soil absorption trenches. If this process continues, the result is septic tank effluent backing up into the home or breaking out on the ground surface.

Remediation Strategies

Since most of the C in a septic system is stored in the sludge at the bottom of the septic tank, pumping the tank at regular intervals helps to maintain a functioning soil absorption field — we recommend pumping every three to five years for most homes. Installing an effluent filter on a septic tank's outlet baffle is an excellent way to help keep the C-containing solids from leaving the septic tank and protect the soil absorption field. For more about septic tanks and effluent filters, see Purdue Extension publication HENV-5-W, *Septic Tanks: Primary Treatment Device of Your Septic System*, http://www.ces.purdue.edu/extmedia/HENV/HENV-5-W.pdf.

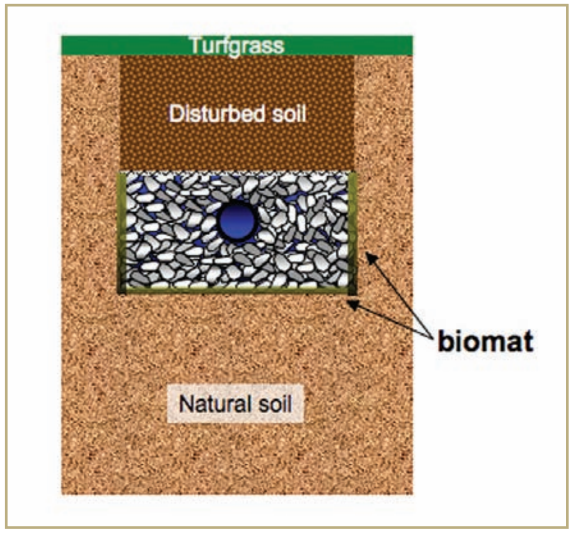

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Figure 2. *Cross-section view of a gravel soil absorption field trench. A thick layer of cells, commonly called a biomat, forms at the soil-trench interface to feed on the organic matter that flows out of the septic tank.*

Joe Yahner

Figure 3. *Septic system failure, which can be caused if the biomat at the soil-trench interface becomes too thick for wastewater to flow through, often results in septic tank effluent surfacing on the lawn.*

If the biomat in your septic system is already too thick, resting the soil absorption field for an extended period (such as 6-12 months) can renovate the system by cutting off the biomat's food source (C supply) and allowing microorganisms to catch up by consuming the built up organic matter in the biomat. This essentially starves the microbial population and, over time, reduces the biomat's thickness and restores the soil's infiltration capacity.

Unless you can take an extended vacation away from home, however, an alternative method of handling effluent must be found while resting the soil absorption field. One alternative is to construct and use an additional soil absorption field. Other alternatives include adding a secondary or "pretreatment" device to your septic system (such as an aerobic treatment unit, wetland, or sand filter) to remove much of the excess BOD.

These devices require regular maintenance, and often involve pumps and controls, and are commonly installed between the septic tank and the soil absorption field. Still, such treatment devices have been found to restore the original functioning of the soil absorption system in a matter of months. Contact your local health department for more information about adding treatment components to your system (for a list of Indiana health departments, visit http://www.in.gov/isdh/links/local_dep/index.htm).

Summary

While the "biomat" in the gravel-soil interface of a septic system's soil absorption field is critical for wastewater treatment, biomats that become too thick due to excess C or water can reduce the system's effectiveness and result in system failure. Normally, there are three options for reducing the BOD load on the soil absorption field and correcting this problem:

1. Construct an additional soil absorption field
2. Rest the absorption field for an extended period
3. Install a secondary treatment unit

References

Data presented in this publication is from the U.S. EPA's *Onsite Wastewater Treatment Systems Manual* (2002) and from *Small and Decentralized Wastewater Management Systems* by Ronald W. Crites and George Tchobanoglous (1998).

Other Purdue Extension bulletins in this series

HENV-1-W, *Septic System Failure*, http://www.ces.purdue.edu/extmedia/HENV/HENV-1-W.pdf.

HENV-2-W, *Increasing the Longevity of Your Septic System*, http://www.ces.purdue.edu/extmedia/HENV/HENV-2-W.pdf.

HENV-3-W, *Turfgrass Color: Indicator of Septic System Performance*, http://www.ces.purdue.edu/extmedia/HENV/HENV-3-W.pdf.

HENV-4-W, *Septic System Distribution Boxes: Importance of Equal Distribution in Trenches*, http://www.ces.purdue.edu/extmedia/HENV/HENV-4-W.pdf.

HENV-5-W, *Septic Tanks: The Primary Treatment Device of Your Septic System*, http://www.ces.purdue.edu/extmedia/HENV/HENV-5-W.pdf.

HENV-6-W, *Grandfathered Septic Systems: Location and Replacement/Repair*, http://www.ces.purdue.edu/extmedia/HENV/HENV-6-W.pdf.

HENV-7-W, *Indiana Soils and Septic Systems*, http://www.ces.purdue.edu/extmedia/HENV/HENV-7-W.pdf.

HENV-8-W, *Gravel and Gravelless Trench Soil Absorption Fields*, http://www.ces.purdue.edu/extmedia/HENV/HENV-8-W.pdf.

HENV-9-W, *Water Use and Septic System Performance*, http://www.ces.purdue.edu/extmedia/HENV/HENV-9-W.pdf

HENV-10-W, *Septic Systems in Flooded and Wet Soil Conditions*, http://www.ces.purdue.edu/extmedia/HENV/HENV-10-W.pdf.

HENV-11-W, *Obtaining a Septic System Permit,* http://www.ces.purdue.edu/extmedia/HENV/HENV-11-W.pdf.

HENV-12-W, *Seasonally High Water Tables and Septic Systems*, http://www.ces.purdue.edu/extmedia/HENV/HENV-12-W.pdf.

HENV-13-W, *Septic System Additives*, http://www.ces.purdue.edu/extmedia/HENV/HENV-13-W.pdf.

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