Keep Manure out of The Creek and Thousands of Fish will Call You Friend

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Fish have a hard time when it comes to finding enough oxygen to breathe. Oxygen must first dissolve into water before their gills can extract it. Oxygen dissolved in water is called dissolved oxygen (believe it or not) and it is usually referred to by the initials DO. If oxygen is used by plants and animals faster than it can dissolve into the water, DO concentration drops. If DO drops far enough, fish can no longer extract oxygen and they die.

There are two ways adding manure to water speeds up DO depletion.

The first one is eutrophication. Eutrophication occurs when excess plant nutrients cause algae, plankton, and aquatic plants to flourish. During the day, these organisms pump oxygen into the water. At night they remove oxygen. If nighttime removal outpaces daytime replenishment, DO drops to zero. Eutrophication takes place in lakes, reservoirs, and estuaries -- often far downstream from where the nutrients were introduced.

The second cause of DO depletion occurs when the organisms that decompose organic matter remove oxygen faster than it can be replaced. Nature stores energy as organic matter. Oxygen is a key ingredient in unlocking this energy. Paper is made almost entirely of organic matter. Burning a sheet of paper removes oxygen from the atmosphere. If you put a bucket on top of the burning paper, the fire will go out as soon as the oxygen is consumed. Aerobic microorganisms use the energy stored in organic matter to reproduce and grow. And just like a fire, these organisms consume oxygen from the environment. If they take too much DO from water, they and everything else living in the water dies.

Dissolved oxygen depletion due to microbial blooms happens close to the source of organic matter addition.

Microbial blooms are so devastating that the ability of organic matter to remove oxygen from water is the primary way we measure the pollutant strength of wastewater and manure. The two basic parameters are Oxygen Demand and Respiration Rate. The relationship between oxygen demand and respiration rate is illustrated in Figure 1.

Let's say wastewater is placed in a sealed container with an infinite amount of DO. The curve in Figure 1 represents the cumulative amount of DO removed from the liquid as microorganisms eat the organic matter. To determine the amount of DO removed from the liquid at any point in time, draw a line up from the x axis until you reach the curve, then pivot 90^{o} to the left, and extend the line until you reach the y axis. The value given on the y axis is cumulative DO removed (mg) from the liquid, divided by the volume of liquid (L). This value is the oxygen demand of the OM. It is called "demand ", because the oxygen demand test was originally devised so sewage treatment plant operators could decide how much oxygen to pump into wastewater to degrade its organic matter. A common way of expressing oxygen demand is BOD. The initials BOD stand for Biological Oxygen Demand. BOD comes in two varieties: Ultimate BOD (BOD_u) and Five Day BOD (BOD_5). BOD_u is the total amount of oxygen needed to completely degrade organic matter. In Figure 1, BOD_u of the material in the bottle is 510 mg DO per liter. It usually takes 30 to 60 days to completely use up all the organic matter in wastes. To shorten the BOD test, we only measure the DO removed in the first 5 days of the experiment. Five days is important because this is the typical amount of time it takes wastewater to flow through a sewage treatment plant. The BOD_5 of the material in the bottle in Figure 1 is 390 mg DO per liter.

Respiration rate is the slope of the cumulative DO removal cure in the BOD test. As you can see in Figure 1, respiration rate is constantly changing over time. Oxygen removal rate is great early on in the test as the organisms consume the readily available energy. Further along, oxygen consumption

slows as the food supply dries up. To calculate respiration rate, pick any point on the curve and draw a line with a slope equal to slope of the curve at that point. Units for respiration rate are the slope (mg/time) divided by the volume (L).

Manure has been used in agriculture as long as man has raised animals and grown crops. It is a great source of organic matter and plant nutrients. Organic matter provided by manure builds soil moisture holding capacity, nutrient holding capacity, and particle aggregation. Decomposing soil organic matter supplies nutrients to the soil. The nutrients in manure and lagoon effluent add fertilizer elements directly to the soil.

Manure organic matter and nutrients, so good for soil, are a disaster when they hit water. In the next issue of OK pork partner, I will outline the steps to take when manure is spilled directly into or is spilt in a location making it likely to flow into aquatic habitats.

To read more about organic matter and how it is measured see OSU Factsheet BAE-1760, *Organic Matter Content of Wastewater and Manure*. This factsheet, and many others, can be found at http://osuwastemanage.bae.okstate.edu/ .

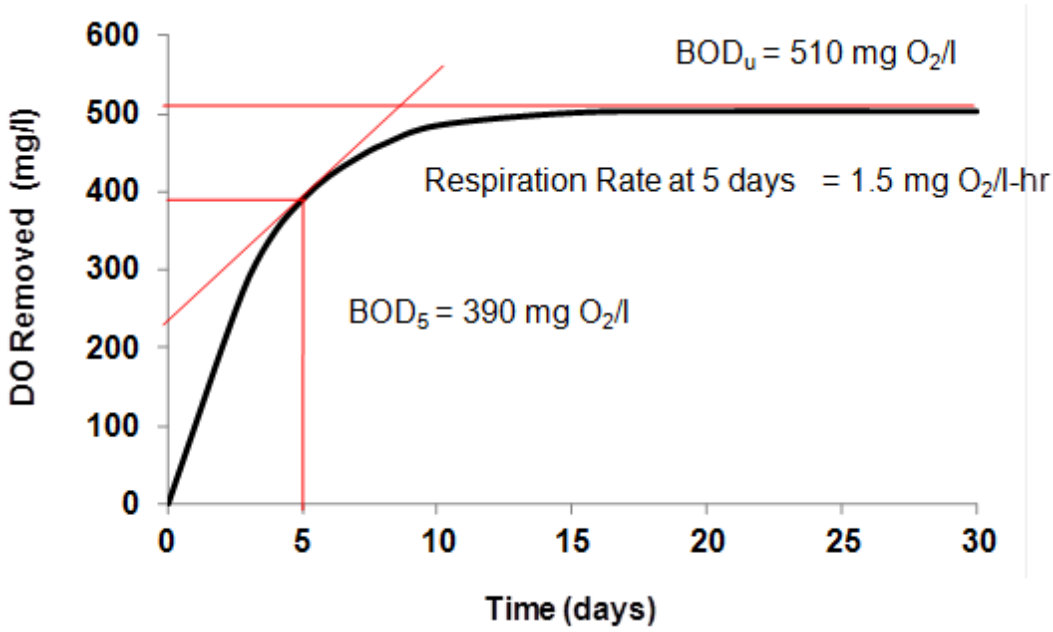

Figure 1. Relationship between Respiration Rate, BOD_5, and BOD_u and a DO Removal Curve, from OSU Factsheet BAE-1760, *Organic Matter Content of Wastewater and Manure*.