

Aerobic and Anaerobic Digestion and Types of Decomposition

Objective

In this lesson we will answer the following question:

- Is aerobic and anaerobic digestion?
- What occurs in each of these processes?
- What are the three types of decomposition, and what occurs in each of these processes?

Lecture

Introduction

Microorganisms, like all living things, **require food for growth**. Biological sewage treatment consists of a step-by-step, continuous, sequenced attack on the organic compounds found in wastewater and upon which the microbes feed.

In the following sections we will look at the processes of **aerobic** and **anaerobic digestion** and the **decomposition** of waste in each process.

Aerobic Digestion/ Decomposition

Aerobic digestion of waste is the natural biological degradation and purification process in which bacteria that thrive ([flourish](#)) in oxygen-rich environments break down and digest the waste.

During oxidation process, pollutants are broken down into carbon dioxide (CO₂), water (H₂O), nitrates, sulphates and biomass (microorganisms). By operating the oxygen supply with **aerators**, the process can be significantly accelerated. **Of all the biological treatment methods, aerobic digestion is the most widespread process that is used throughout the world.**

Biological and chemical oxygen demand

Aerobic bacteria demand oxygen to decompose dissolved pollutants. Large amounts of pollutants require large quantities of bacteria; therefore the demand for oxygen will be high.

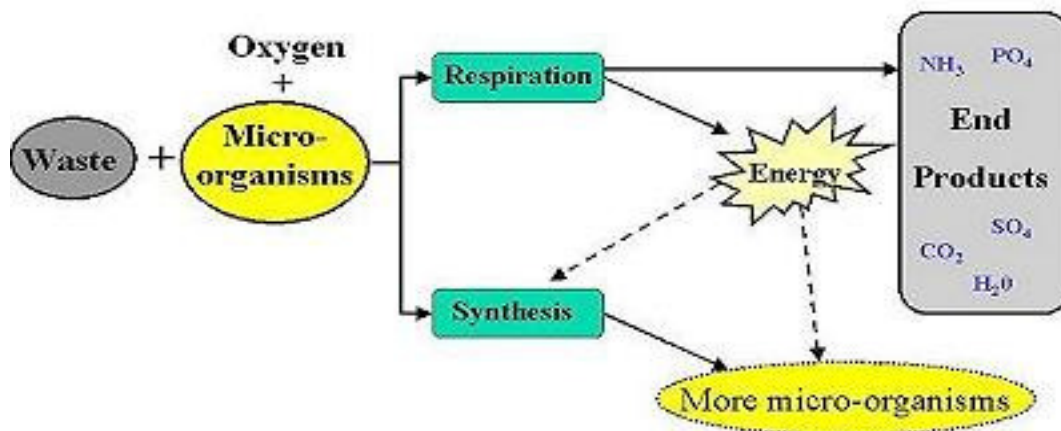
The Biological Oxygen Demand (BOD) is a measure of the quantity of dissolved organic pollutants that can be removed in biological oxidation by the bacteria. It is expressed in **mg/l**.

The Chemical Oxygen Demand (COD) measures the quantity of dissolved organic pollutants that can be removed in chemical oxidation, by adding strong acids. It is expressed in **mg/l**.

The **BOD/COD** gives an indication of the fraction of pollutants in the wastewater that is biodegradable.

Advantages of Aerobic Digestion

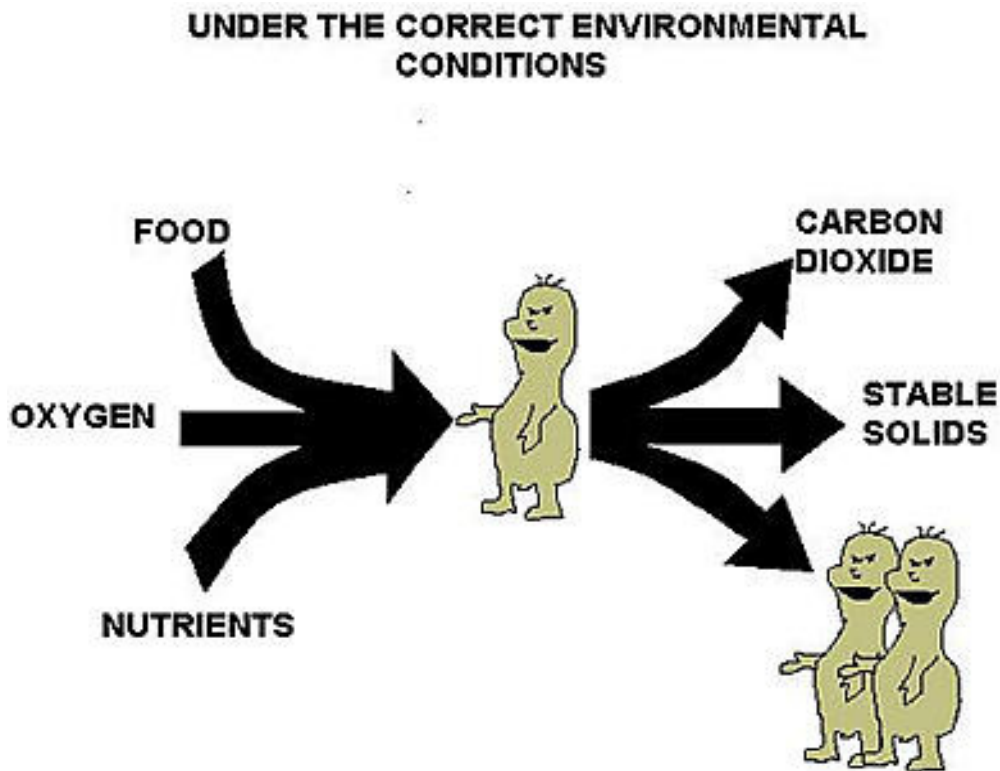
Aerobic bacteria are very efficient in breaking down waste products. The result of this is; aerobic treatment usually yields better effluent quality than that obtained in anaerobic processes. The aerobic pathway also releases a substantial amount of energy. A portion is used by the microorganisms for synthesis and growth of new microorganisms.



Path of Aerobic Digestion

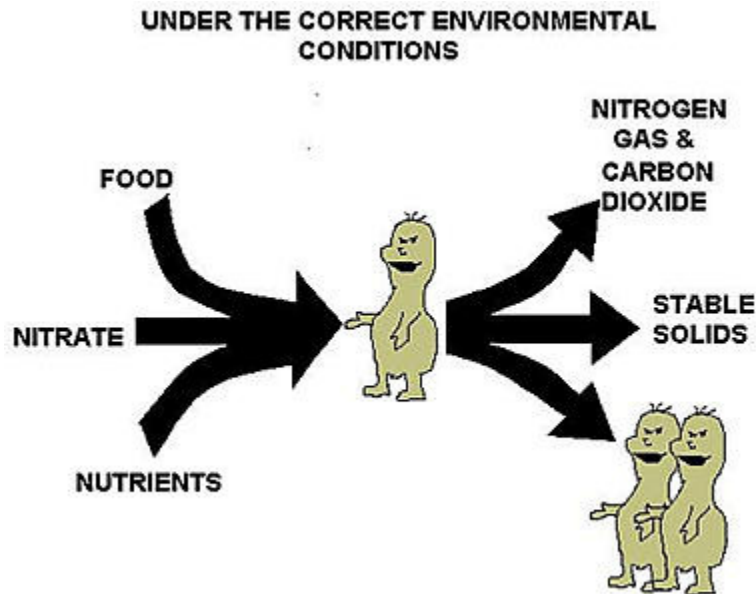
Aerobic Decomposition

A biological process, in which, organisms use available organic matter to support biological activity. The process uses organic matter, nutrients, and dissolved oxygen, and produces stable solids, carbon dioxide, and more organisms. The microorganisms which can only survive in aerobic conditions are known as aerobic organisms. In sewer lines the sewage becomes anoxic(supportive) if left for a few hours and becomes anaerobic if left for more than 1 1/2 days. Anoxic organisms work well with aerobic and anaerobic organisms. Facultative and anoxic are basically the same concept.



Anoxic Decomposition

A biological process in which a **certain group of microorganisms** use chemically combined oxygen such as that found in nitrite and nitrate. These organisms consume organic matter to support life functions. They use organic matter, combined oxygen from nitrate, and nutrients to produce nitrogen gas, carbon dioxide, stable solids and more organisms.



Anaerobic Digestion

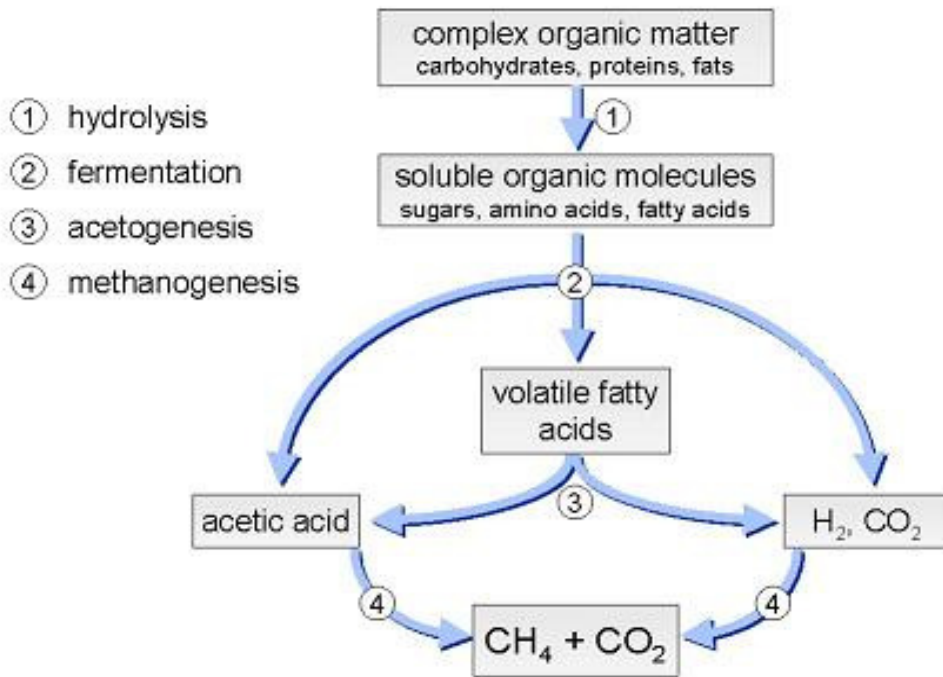
Anaerobic digestion is a complex biochemical reaction carried out in a number of steps by several types of microorganisms that require little or no oxygen to live. During this process, a gas that is mainly composed of **methane and carbon dioxide**, also referred to as biogas, is produced. The amount of gas produced varies with the amount of organic waste fed to the digester and temperature influences the rate of decomposition and gas production.

Anaerobic digestion occurs in four steps:

- **Hydrolysis** : Complex organic matter is decomposed into simple soluble organic molecules using water to split the chemical bonds between the substances.
- **Fermentation or Acidogenesis**: The chemical decomposition of carbohydrates by enzymes, bacteria, yeasts, or molds in the absence of oxygen.
- **Acetogenesis**: The fermentation products are converted into acetate, hydrogen and carbon dioxide by what are known as acetogenic bacteria.
- **Methanogenesis**: Is formed from acetate and hydrogen/carbon dioxide by methanogenic bacteria.

The acetogenic bacteria grow in close association with the methanogenic bacteria during the fourth stage of the process. The reason for this is that the conversion of the fermentation products by the acetogens is thermodynamically only if the hydrogen concentration is kept sufficiently low. This requires a close relationship between both classes of bacteria.

The anaerobic process only takes place under strict anaerobic conditions. It requires specific adapted bio-solids and particular process conditions, which are considerably different from those needed for aerobic treatment.



Path of Anaerobic Digestion

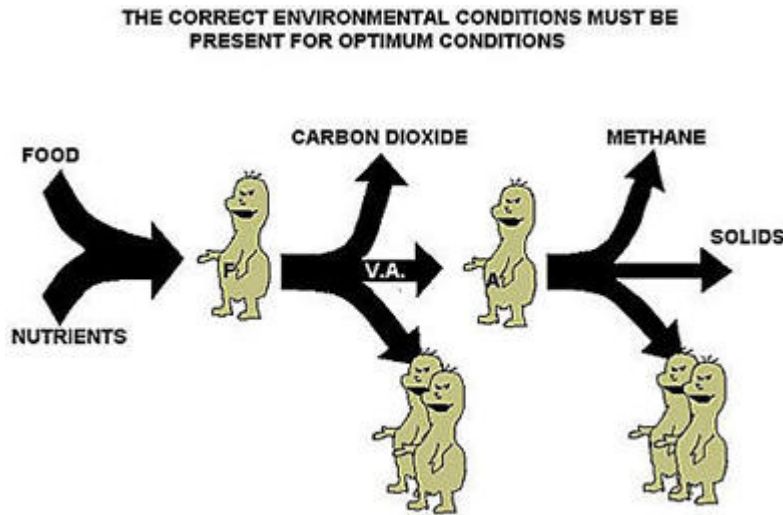
Advantages of Anaerobic Digestion

Wastewater pollutants are transformed into methane, carbon dioxide and smaller amount of bio-solids. The biomass growth is much lower compared to those in the aerobic processes. They are also much more compact than the aerobic bio-solids.

Anaerobic Decomposition

A biological process, in which, decomposition of organic matter occurs without oxygen. Two processes occur during anaerobic decomposition. First, facultative acid forming bacteria use organic matter as a food source and produce volatile (organic) acids, gases such as carbon dioxide and hydrogen sulfide, stable solids and more facultative organisms. Second, anaerobic methane formers use the volatile acids as a food source and produce methane gas, stable solids and more

anaerobic methane formers. The methane gas produced by the process is usable as a fuel. The methane former works slower than the acid former, therefore the pH has to stay constant consistently, slightly basic, to optimize the creation of methane. You need to constantly feed it sodium bicarbonate to keep it basic.



Review

The aerobic, anoxic, and anaerobic process helps prepare the waste for decomposition by attacking the organic compounds that in wastewater. In aerobic decomposition the only microorganisms that can survive are the aerobic organisms. In anoxic decomposition the microorganisms use chemically combined oxygen that is found in nitrite and nitrate. In this process the organisms consume the organic matter to help support their life functions. In the first stage of anaerobic decomposition, acid forming bacteria use the organic matter for food which produces volatile gases, acids and facultative organisms. Second stage methane formers use the volatile acids as a food source and that produces more gases. This gas can be used as fuel.

Assignment

Answer the following questions and email your answers to mahendrapct@gmail.com What occurs in aerobic and anaerobic digestion?

1. What do aerobic bacteria demand for decomposition of pollutants?
2. How are BOD and COD measured?
3. List two advantages of aerobic digestion?
4. What is aerobic decomposition?
5. What is anoxic decomposition?

6. List the four steps in anaerobic digestion and explain each.
7. List two advantages of anaerobic digestion.
8. What is formed in the first and second stages of anaerobic decomposition?
9. What must be feed in anaerobic decomposition to keep the pH constant?