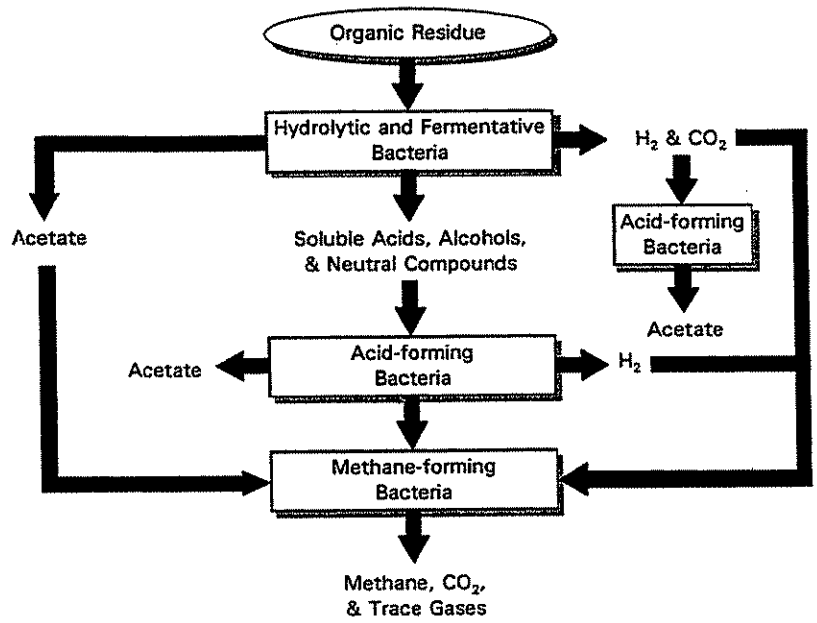
2.0 INTRODUCTION TO ANAEROBIC DIGESTION

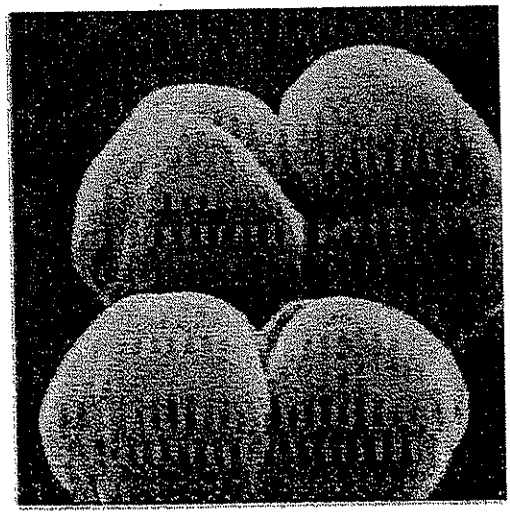
Biogas is formed solely through the activity of bacteria, unlike composting in which fungi and lower creatures are also involved in the degradation process. Microbial growth and biogas production are very slow at ambient temperatures. They tend to occur naturally wherever high concentrations of wet organic matter accumulate in the absence of dissolved oxygen, most commonly in the bottom sediments of lakes and ponds, in swamps, peat bogs, intestines of animals, and in the anaerobic interiors of landfill sites.

FIGURE 2.1: The Anaerobic Digestion Process



The overall process of AD occurs through the symbiotic action of a complex bacteria consortium, as shown by Figure 2.1. Hydrolytic microorganisms, including common food spoilage bacteria, break down complex organic wastes. These subunits are then fermented into short-chain fatty acids, carbon dioxide, and hydrogen gases.

Methanogenic bacteria



Syntrophic microorganisms then convert the complex mixture of short-chain fatty acids to acetic acid with the release of more carbon dioxide, and hydrogen gases. Finally, methanogenesis produces biogas from the acetic acid, hydrogen and carbon dioxide. Biogas is a mixture of methane, carbon dioxide, and numerous trace elements. According to some, the two key biological issues are determining the most favorable conditions for each process stage and how non-optimal circumstances affect each process stage as a whole, and the governing role of hydrogen generation and consumption.[1]

[1] Rivard, C; Boone, D. (1995). "The Anaerobic Digestion Process." *Second Biomass Conference of the Americas; August 21-24, 1995, Portland Oregon.* Golden, CO: National Renewable Energy Laboratory, pp. 785-790.

Sulfate-reducing bacteria, which reduce sulfates and other sulfur compounds to hydrogen sulfide, are also present during the process. Most of the hydrogen sulfide reacts with iron and other heavy metal salts to form insoluble sulfides, but there will always be some hydrogen sulfide in the biogas.

The widespread natural occurrence of methane bacteria demonstrates that AD can take place over a wide temperature range from 40°F to more than 212°F and at a variety of moisture contents from around 60% to more than 99%. This distinguishes the methane bacteria favorably from most aerobic microorganisms involved in the composting process.

AD occurs in the psychrophilic temperature range (less than 68°F), and is routinely observed in marsh gas and in the ambient temperature lagoons used for livestock. Conventional anaerobic digesters, as will be explained in greater detail, are commonly designed to operate in either the mesophilic temperature range (95°-105°F) or thermophilic temperature range (125°-135°F).

There are usually two reasons why the mesophilic and thermophilic temperatures are preferred. First, a higher loading rate of organic materials can be processed and, because a shorter hydraulic retention time[2] (HRT) is associated with higher temperatures, increased outputs for a given digester capacity result. Second, as will be discussed in more detail in Section 2.6, higher temperatures increase the destruction of pathogens present in raw manure.