Anaerobic bacteria are bacteria that do not require oxygen, some of which only survive in conditions lacking in oxygen. Methanogens, which play the important role of producing methane in anaerobic digestion, are anaerobic bacteria. Methanogens may be found in the stomachs of certain animals, making it possible for the process of anaerobic digestion to be performed using the wastes of these certain animals along with other organic materials. Methanogens are well known for surviving in extreme conditions (i.e. glaciers, earth’s mantle), so once the process of anaerobic digestion has begun and progressed to the final stage of methanogenesis, it can be expected for the system to continue producing methane as long as organic materials are provided.

Organic wastes may be divided into three categories: carbohydrates, proteins and fats. Each of these are broken down throughout the anaerobic digestion process into smaller and smaller molecules, until significant amounts of only carbon dioxide, acetic acid and hydrogen remain. These are then used as the main ingredients in the implementation of the resultant biogas, and though the biogas still contains carbon dioxide, it is still potent.

Organic wastes go through three phases during anaerobic digestion. These phases are: hydrolysis, acidogenesis, acetogenesis, and methanogenesis. All of these stages involve many different types of bacteria, working in harmony to produce mainly CO2 and CH4 as products of the digestion process (Shah, Mahmood, Shah, Pervez, & Asad, 2014). Each of these phases involves the breakdown of the many different types of compounds found in organic wastes into compounds that may provide energy for one of the next processes or be used to provide energy in some other part of the process.

The first phase, hydrolysis, is when compounds breaks down due to reactions with water. This process can be performed by organisms with the help of a type of enzymes called hydrolases. These enzymes are used to break down polymers like protein, nucleotides, sugars and starch, and fats (Phillips, 2017). These complex molecules are broken down into monosaccharides, amino acids and fatty acids by hydrolytic bacteria (Shah et al. 2014). The speed of this process is determined by a number of factors, such as pH and temperature that affect the performance of the hydrolytic bacteria.

During the acidogenesis phase, simpler chemical substances are converted into organic acids, alcohols, aldehydes, CO2, and H2 by acidifying bacteria. When proteins are decomposed, amino acids and peptides are formed, which can give energy to anaerobic bacteria. The conversion of simpler chemical substances may be achieved through hydrogenation and dehydrogenation performed by the bacteria. Methanogens may directly use the acetates, CO2 and H2 as energy sources. New products may not be used methanogenic bacteria, but rather by the bacteria in the process of acetogenesis. It is during this process that ammonia and hydrogen sulfide are produced, which are what give the entire process a disgusting rotten egg smell. (Shah et al. 2014)

During acetogenesis, acetate bacteria convert the products of acidogenesis into acetates and hydrogen, which can be used in the next phase. During acetogenesis, hydrogen is released, which is actually toxic to the organisms carrying out the process, so a balance has to be released between the microorganisms that produce hydrogen and those that consume it. (Shah et al. 2014)

During Methanogenesis, methane is produced by methanogenic bacteria. This methane is produced from the products of the previous phases, mainly acetic acid, H2, CO2. Much of the CH4 is a result of the conversion of acetic acid, despite there only being a few types of bacteria capable of this, while only 30% of the methane comes from CO2 reduction. During this process of CO2 reduction, H2 is consumed rapidly, allowing the bacteria previously mentioned in acidogenesis to develop more quickly. As a result, a large quantity of the gas produced remains as CO2, since only some of it is converted into methane. The result of this entire process is a biogas composed mainly of carbon dioxide (CO2) and methane (CH4) as well as hydrogen sulfide.

In digestion plants that use animal manure as a main component in feeding the digester, the remaining solid waste is called slurry, and this slurry is significantly higher in ammonium (NH4) than pure manure, as the process of anaerobic digestion removes other chemicals that may have diluted it (Bonten, Zwart, Rietra, Postma, & Haas, 2014). Ammonium is a form of nitrogen that is ideal for use by plants, because it is a salt, unlike other gaseous forms of the molecule. Thus, the high quantity of ammonium found in bio plant slurry makes it ideal for use on crops.

If the final goal is a biogas with a much higher concentration of methane, to be used as fuel without wasting space on unnecessary gases, the resultant biogas may be run through a trap to remove extra carbon dioxide, which is not at all flammable, and reduces the quality of the resultant gas. The resultant biogas of the digestion is highly flammable, and must be treated very carefully for this reason. The best way to store this biogas is in steel cylinders, like containers used for flammable gas.

Biogas with a higher concentration of methane may be used as fuel for vehicles, while biogas of all concentrations can be used in a generator to produce electricity, through combustion. When the biogas is lit, the only thing that is burning at significant quantities is the methane, since carbon dioxide is not at all flammable. Because of this, if the purpose is to get the purest methane possible, it may be best to remove the carbon dioxide When methane burns, its carbon and hydrogen bonds break, both of which then react to oxygen in the air to produce carbon dioxide and water. The resultant carbon dioxide is much better for the environment than simply releasing methane into the air, because methane has much more intense heat retentive properties that cause it to be many times more impactful on the environment than carbon dioxide. Because of this, it is much better for the environment to take the biogas resulting from the decay of organic matter and - rather than allowing it to release methane into the atmosphere - to burn it off in a generator. For this reason, many landfills will vent the accumulated methane from waste and burn it off.

In sum, if a dairy farm were to use the waste of its cattle to feed an anaerobic digester, it could easily create enough energy to power itself, as well as feed more energy into the grid, if the digestion is performed on a large enough scale. In fact, there are many farms that already perform this act, having recognized its cost saving nature. It is also possible to create enough energy from small household size farm digesters to power stoves by simply using the biogas in its gaseous form, without converting it into electrical energy, to burn off and heat a stove or oven.