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OVERCOMMING THE LIMITATIONS IN ANAEROBIC DIGESTION OF DAIRY WASTE

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The primary objective of dairy managers is to maintain animal health for quality milk production while eliminating adverse environmental impacts. Animal health is enhanced through the use of sand bedding and the rapid removal of manure from the dairy environment. As a result, manure flush systems in conjunction with sand bedding are used at large commercial dairies. Sand is removed from the manure, washed, dried, and reused for animal bedding. Since bacteria do not grow well on sand, disease can be controlled. Preventing the open decomposition of manure through the use of flush systems limits animal disease while eliminating odor, and other adverse atmospheric impacts.

Ideally the sand laden manure waste stream is treated to remove the sand and nutrients for reuse on the dairy or adjacent farmland. A variety of treatment techniques are available to prevent odor while recovering the nutrient laden solids. Anaerobic digestion is the treatment technique of choice since the organic solids can be converted to gas and subsequently energy and heat. Unfortunately, the use of sand bedding and manure flush systems is *not* compatible with conventional anaerobic waste treatment. The manure slurry must be diluted to separate the sand. If the sand is not completely separated it will accumulate in the digestion tanks.

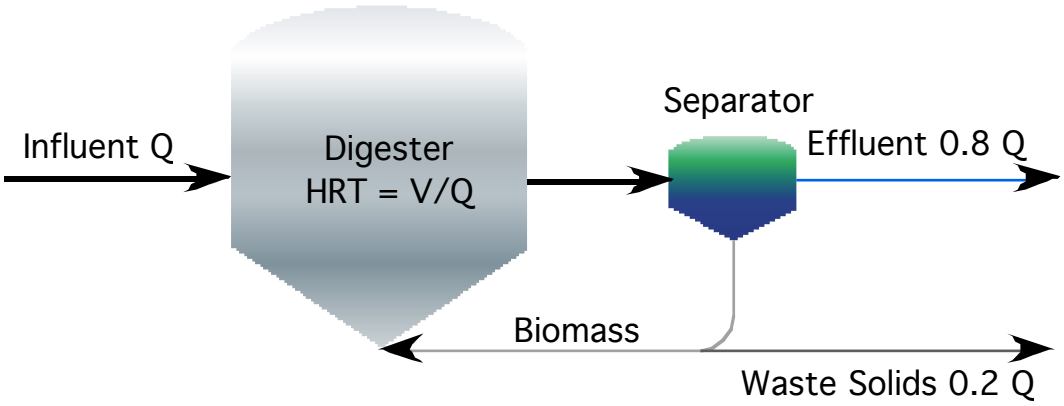
The quantity of waste to be treated is substantially increased through dilution. Conventional anaerobic treatment of the diluted waste is not economical because of the large tank volumes required.

Over the past 30 years improved anaerobic digestion techniques have been developed and applied to a wide variety of waste materials. The improvements include a variety of fixed film and retained biomass reactors. These systems maintain substantial quantities of anaerobic bacteria as films or pellets, which rapidly convert organic waste to gas. The systems are very effective in treating soluble waste but are not particularly effective in treating slurries containing particulate mater that must be broken down prior to assimilation within the film. The well-established anaerobic “contact” process remains the most effective

means of rapidly converting waste slurries to gas. Over the past 10 years significant improvements have been made to the "contact" process. Our AGF process is one of those improvements.

The anaerobic "contact" process was developed 60 years ago. It has been applied to a variety of waste materials since that time. It's most prominent use has been in the meat packing industry where it is used to convert meat-processing waste to gas. An odorless stable product is produced. The traditional contact process is depicted in Figure 1. It consists of an anaerobic digester followed by a separator that removes the anaerobic bacteria from the effluent stream and returns the bacteria to the anaerobic digester. The traditional method of separation through gravity clarification is cumbersome and far less effective than the AGF process. The development of the AGF (Anoxic Gas Flotation US patent 5,015,384) process significantly improved the removal and concentration of anaerobic bacteria. As a result, the size of anaerobic digestion tanks is considerably reduced. Dilute waste can be treated in digesters sized for concentrated waste. A majority of the sand can now be removed through dilution prior to digestion.

Figure 1 – Anaerobic Contact Process



Sand remaining in the waste still poses a problem since any residual sand will drop out in the digester or accumulate in the recycled biomass. The "contact" digestion system will eventually cease to function. The accumulation of inorganic refractory solids in the digester can be eliminated through the removal of sand by dilution and density separation prior to recycle (US patent 6,113,786)

The contact process can also be inhibited by the accumulation of refractory (non degradable or slowly degradable) organic material such as seeds and wood. This organic material can be removed through a variety of means prior to concentrating the bacterial biomass (US patent 6,309,547).

The method of separating the flocculent bacteria that are responsible for particulate hydrolysis is extremely important. Traditional clarifiers are not as effective as flotation separators since anaerobic bacteria tend to attach to the gas bubbles and float. However, flotation separators are complex mechanical devices requiring internal mechanical collectors and a large surface area. Fortunately, improved flotation separators have been developed that are non-mechanical and require less than a quarter of the area of traditional flotation separators (US patent pending).

Although anaerobic digestion produces a stable residual solid product, the residual solids still contain a substantial number of bacterial pathogens. The solids can be applied to agricultural fields but cannot be sold or given to the public. Traditional methods of addressing this problem include the use of thermophilic digestion or pasteurization prior to digestion. Both of these techniques require large quantities of heat. In most cases they cannot be used to digest diluted waste because of the quantities of heat required. The AGF pasteurization process provides a means of pasteurizing and re-digesting the solids for maximum gas production while using less than a quarter of the energy typically required (US patent 6,113,789)

The liquid byproduct of anaerobic digestion typically contains odorous organic acids and large quantities of ammonia nitrogen and hydrogen sulfide that are eventually discharged to the atmosphere. Such discharges are a significant environmental problem. Typically the ammonia nitrogen present in the liquid effluent represents more than 50% of the total manure nitrogen processed. A substantial portion of the hydrogen sulfide and ammonia nitrogen subsequently discharged to the atmosphere can be removed and sequestered with organic solids, thus eliminating a significant environmental problem associated with the anaerobic digestion of dairy manure (US patent pending). This option conserves the nitrogen for crop use rather than converting the ammonia to nitrogen gas through the traditional approach of nitrification and denitrification.

The technologies referenced above permit the anaerobic digestion of dilute waste containing refractory organic and inorganic materials. The technologies also maximize the production of energy while producing a nutrient rich waste solids product free of pathogens and an effluent from which odors (organic acids) and gaseous products (ammonia and hydrogen sulfide) have been substantially removed and sequestered for reuse. The solid product contains substantially all of the nitrogen and phosphorus. Pollution of the surface and groundwater and air is eliminated.