

Chapter 1: Introduction

Anaerobic digestion is a biological process that can yield a variety of benefits. Although on-farm anaerobic digesters are common in other jurisdictions, this industry is in the initial phase of development in British Columbia (BC). The Ministry of Environment (MOE) has written this guideline to assist the increasing number of agricultural operators in BC that have expressed a strong interest in building anaerobic digestion facilities.

This guideline provides an overview of the current MOE regulatory framework, including an introduction to the *Environmental Management Act*, Waste Discharge Regulation, Agricultural Waste Control Regulation, and Organic Matter Recycling Regulation. Guidance is also provided on acceptable feedstocks, nutrient management planning, waste discharges and best management practices.

1.1 Who this Guideline is For

This guideline is intended for proponents of on-farm anaerobic digestion projects. If your project is not located on a farm, this guideline may be used to provide a general overview of the approval process and assist in identifying waste streams from the facility.

1.2 What is Anaerobic Digestion

Anaerobic digestion is the process by which organic matter (e.g., manure) is broken down in the absence of oxygen, producing biogas and other by-products. The process generally requires a 15 to 40 day in-tank retention time with temperatures ranging from 35 to 55° C, depending on the process. The technology has been shown to reduce odours and pathogens by over 90%; however, while nitrogen availability increases, the nutrient content and total volume of material are not significantly reduced. The raw biogas is most commonly used to generate electricity through cogeneration or upgraded to natural gas. On average, raw biogas contains 60% methane and 40% carbon dioxide. In order to meet the natural gas grid injection standards, the carbon dioxide must be removed and a concentration of approximately 96% methane obtained.

1.3 Benefits of Anaerobic Digestion

Anaerobic digestion is a technology which can both produce renewable natural energy and also more effectively manage manure. Other benefits include the reduction of odours, pathogens, weed seeds and greenhouse gas (GHG) emissions.

The process also produces by-products (liquid and solid digestate) which can be an additional revenue source for the farm. The digestate can be used as fertilizer, animal bedding or further processed and sold, e.g., as compost.

On-farm anaerobic digesters may also be eligible to generate and sell carbon offsets. Carbon offsets are generated when a person voluntarily undertakes a project or action that reduces the amount of GHG emissions entering the atmosphere, prevents GHG emissions from entering the atmosphere, or increases the amount of GHG emissions being taken out of the atmosphere. Anaerobic digestion projects can reduce emissions in two ways, by combusting captured methane gas from organics into the less potent carbon dioxide gas, or by displacing fossil-fuel natural gas consumption through the utilization of biogas or biomethane.

Legitimate carbon offsets can be sold to either non-regulated voluntary consumers, or to regulated entities that are legally mandated to reduce their GHG emissions, such as the BC Provincial Government through the Pacific Carbon Trust. In order to be sold on a particular carbon market, carbon offsets must meet certain market-specific eligibility requirements. The Emissions Offset Regulation, under the *BC Greenhouse Gas Reduction Targets Act*, defines requirements for carbon offsets being bought by the Pacific Carbon Trust. More information on selling carbon offsets to the Pacific Carbon Trust is provided in the guidance document available at:

<http://www.pacificcarbontrust.ca/Publications/PCTGuidanceBooklet/tabid/158/Default.aspx>.

1.4 Types of Anaerobic Digesters

The actual process of producing biogas through anaerobic digestion can be carried out in several different ways. The two main features that differentiate one type from another are physical digester configuration and choice of process temperature.

The physical configuration of the digester affects biogas production efficiency, retention time and homogeneity of feedstock. Digesters are often divided into complete mix systems, plug flow systems, fixed film systems, upflow anaerobic sludge blanket (UASB), covered lagoon or vertical/horizontal dry digesters. The most likely systems for on-farm application in BC are complete mix and plug flow. For more information on the different digester types and their respective attributes refer to Appendix C of the report “Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Columbia”¹.

¹Appendix C:

http://www.bcic.ca/images/stories/publications/lifesciences/feasibility_study_anaerobic_appendices.pdf

1.5 Process Temperatures

The process temperatures are usually categorized as mesophilic digestion at temperatures near 37° C and thermophilic digestion, which occurs at approximately 55° C. For very cold climates there are also companies that provide systems for psychrophilic digestion at temperatures below 25° C, but these systems are not common and would likely not be prevalent in BC. Thermophilic digestion results in better pathogen control and higher rates of biogas production but is more complex and harder to control. Mesophilic digestion is the most common type for on-farm application. It provides a highly stable process that requires relatively low maintenance while at the same time resulting in some pathogen control and reasonable biogas production.

1.6 Microbiological Decomposition of Organic Compounds to Biogas

In the biogas process, organic molecules (proteins, fats and sugars) are successively broken down to methane and carbon dioxide, i.e., biogas. The process only works effectively in the presence of several different groups of microorganisms. In order for methane to be the main final product, the various kinds of microbes must cooperate in a specific pattern. A biogas plant is operated in such a way that nutrient availability (choice of feedstock combination) and internal digester environment (pH, digester temperature, ammonia concentration, etc.) favour the species of microbes and the cooperative pattern that maximizes the methane yield. Although the process is fairly robust, it is very important that the delicately balanced conditions are kept stable to achieve the best possible methane production. Frequent and/or substantial changes to important conditions, such as the feedstock composition, are detrimental to biogas production, and by extension, counterproductive to the economic viability of the operation. A simplified process description of the step-wise decomposition is provided in Figure 1.

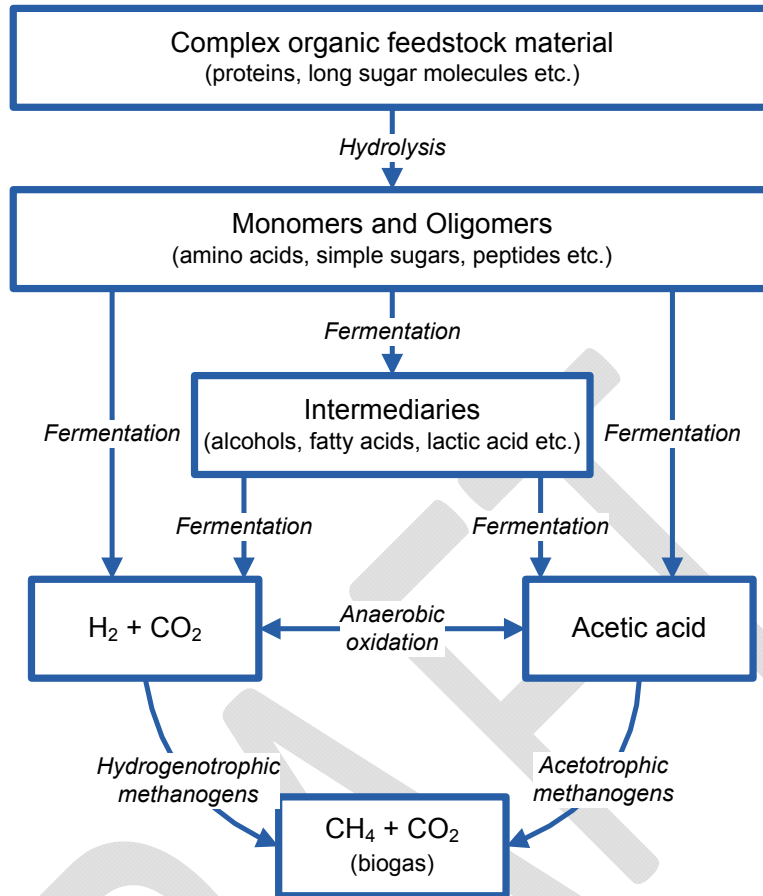


Figure 1. Simplified Process Description of Step-wise Decomposition of Complex Organic Molecules to Biogas