Canadian Food Inspection Agency | Agence canadienne d'inspection des aliments

Canadian Food Inspection Agency




Our vision:
To excel as a science-based regulator, trusted and respected by Canadians and the international community.

Our mission:
Dedicated to safeguarding food, animals and plants, which enhances the health and well-being of Canada's people, environment and economy.

Anaerobic Digestion (AD)

Process specifications and Regulation in Canada

August 5, 2016

Canada

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Literature Review

Drivers:

- Growing pressures to divert organic waste from landfills
- Increased interests in using AD as a treatment process

Purpose:

- Describe AD technology, summarize the process parameters and procedures employed to reduce the presence of contaminants of concern
- Summarize the Canadian Provincial regulations governing the use of digestate and compare them to international standards, norms and practices
- Identify the potential benefits and risks associated with digestates
- Describe potential measures to mitigate risks to human, plant, animal health and the environment

In order to → Design the most appropriate regulatory controls and approaches

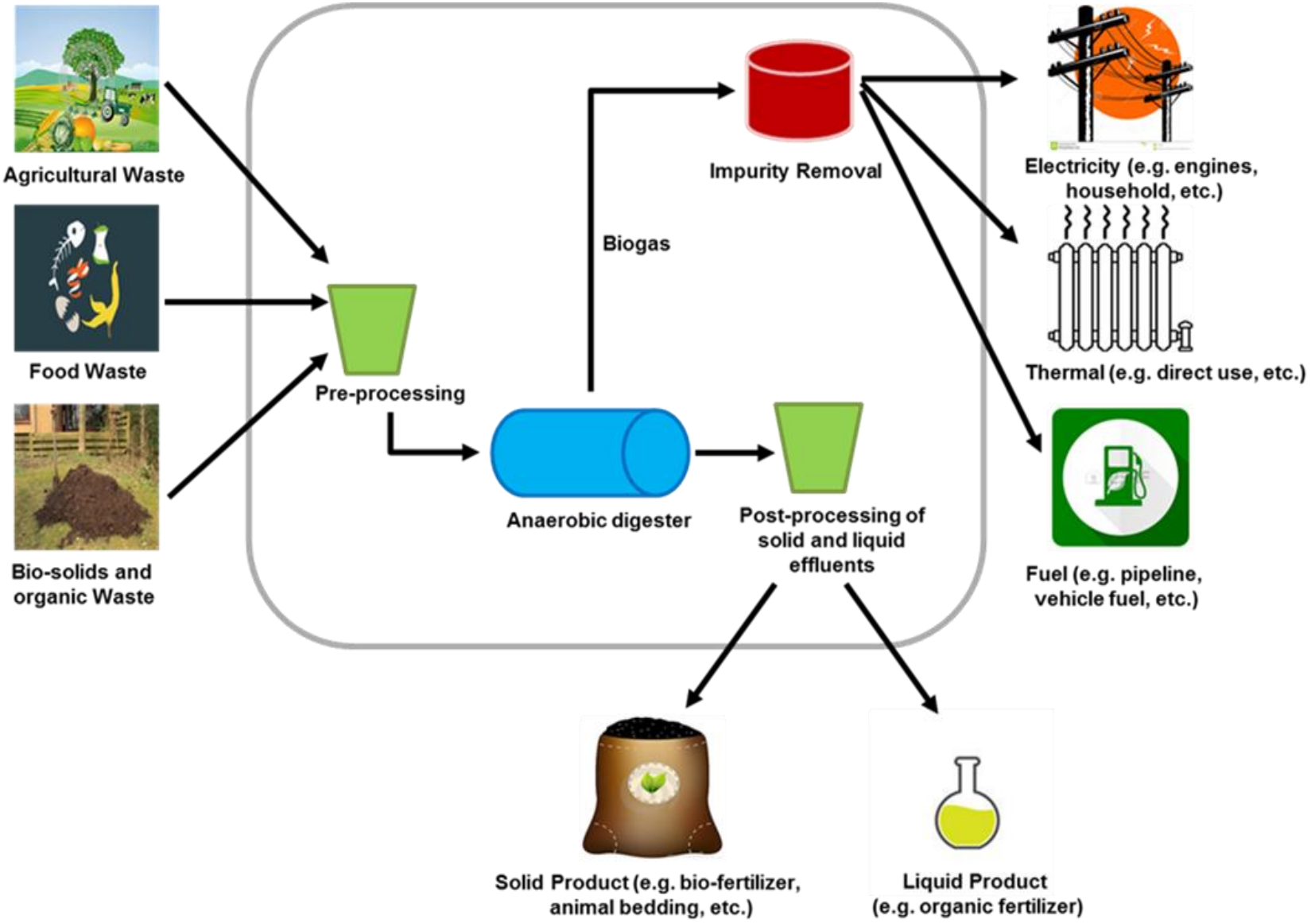
The Technology

Anaerobic digestion is a series of biological processes in which micro-organisms break down biodegradable material in the absence of oxygen into biogas and digestate.

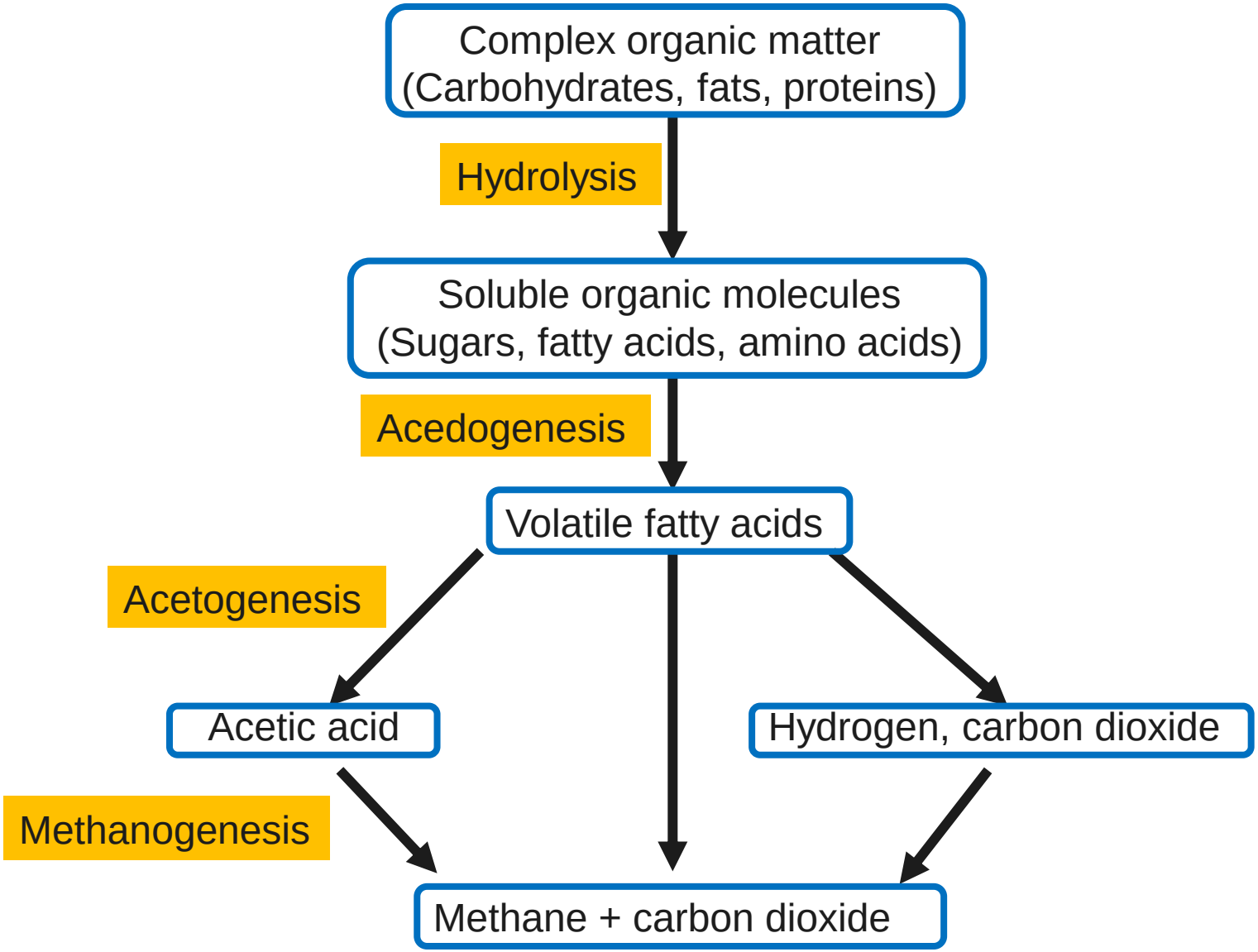
- Biogas is a combustible gas (mostly composed of methane) that can be utilized to generate electricity and heat, or can be processed into renewable natural gas and transportation fuels.

- The digestate is solid humus-like matter that can be used in agriculture as fertilizer or as soil conditioner/supplement.

Schematic Of Anaerobic Digestion Process

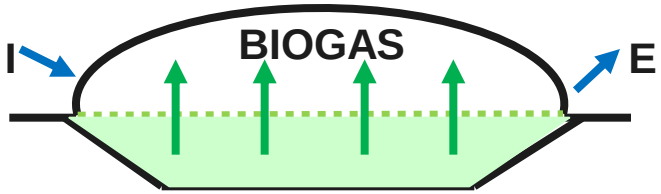


Steps in Anaerobic Digestion Process

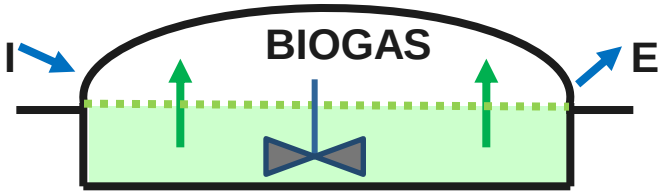


Types Of Digesters

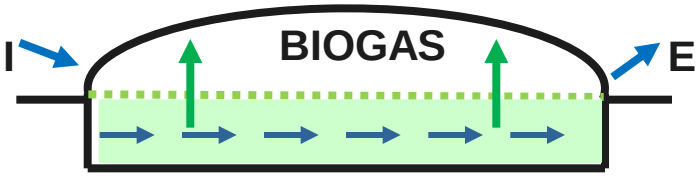
1. Covered Lagoon



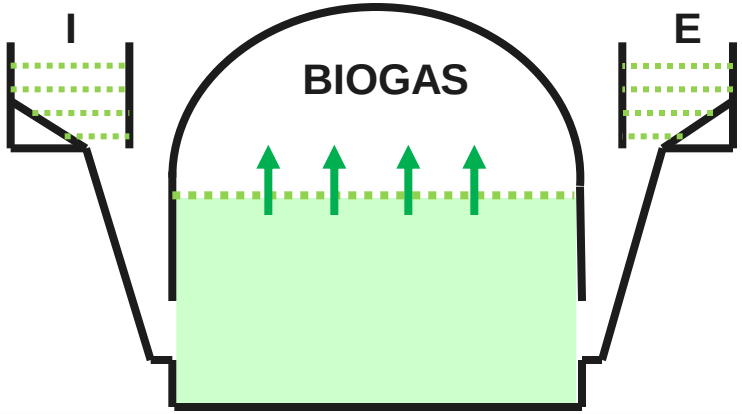
2. Complete Mix



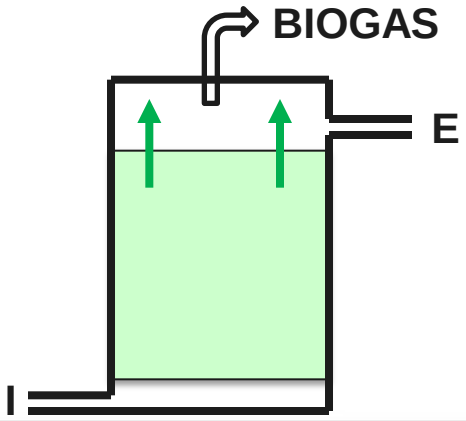
3. Plug Flow



4. Small Fixed Dome



5. Fixed Film



I- Influent
E- Effluent

Parameters Affecting The AD Process

1. pH

- Optimal pH range: 6.5-7.5

2. Temperature

- Mesophilic: 25-40°C
- Thermophilic: 50-65°C

3. Hydraulic Retention Time (HRT)

- Mesophilic Digesters: 10-40 days
- Thermophilic Digesters: 12-14 days

4. Organic Loading Rate (OLR)

- Overloading the digester- lower production of biogas due to accumulation of inhibitory substances

Parameters Affecting The AD Process cont'd

5. Total Solids (TS) Content

- Low solids: less than 10%
- Medium solids: 15-20%
- High solids: 22-40%

6. Carbon to Nitrogen Ratio (C:N)

- Optimal ratio: 20-30
- High C:N ratio: rapid consumption of nitrogen and lower biogas production
- Lower C:N ratio: Ammonia accumulation leads to exceeding pH, which is toxic for methanogens

7. Mixing

- Improves contact between micro-organisms and the feedstock
- Improves bacterial population ability to obtain nutrients
- prevents scum formation and avoids temperature gradients within the digester

Positive List of Feedstocks

Input Material Source	Example/Specification
Parks, gardens, cemeteries and other green spaces	Leaves, grass, branches, fruit, flowers, plants
Households	Bio-waste from households: Fruit and vegetable, coffee and tea, food
Caterers and restaurants	Remainders from fruit, vegetable, coffee, tea, food
Food and beverage related retail premises	Bio-waste from markets, food and feed remainders
Food and beverage processing plants	Food waste, food washing waste, sludge from food and feed processing plants
Horticulture	Leaves, grass, branches, fruit, flowers, plants, bark, weeds, soil attached to plant parts and peat
Agriculture	Straw, manure, harvest remainders, silage, plant material, energy crops and catch crops
Fishery and aquaculture	Slaughter waste and fodder residues from traditional fisheries and aquaculture industry, crustacean shells and similar residues, seaweed
Animal by-products	Manure, animal carcasses, pet food and feeding stuffs of animal origin, blood, placenta, wool, feathers, hair, horns, and raw milk originating from live disease free animals, etc.

Source: Nutrient Management Act, 2002, Ontario Regulation 267/03, Schedule 1, Schedule 2 and Schedule 3.

Materials to be Avoided from Feedstock

Input Material	Example/Specification
Hazardous waste	Product from chemical industries
Solvents	Volatile organic compound that is used as a cleaning agent, diluent, dissolver, thinner, or viscosity reducer or for a similar purpose
Resins and plastics	Plastic bottles, carrier bags, bin linings, packaging films, etc.
Petroleum by-products/ hydrocarbon fuels	Products from petroleum refining industries
Catering waste from means of international transport	Airplane food waste, cruise ship food waste, etc.
Specified risk material (SRM) or waste containing SRM	As defined by the Canadian Food Inspection Agency

Source:

- *Nutrient Management Act*, 2002, Ontario Regulation 267/03, Schedule 1, Schedule 2 and Schedule 3.
- On-Farm Anaerobic Digestion Waste Discharge Authorization Guidelines by British Columbia Ministry of Environment (May 2014)

Quality Control of Digestates

1) Chemical Contaminants

- Usually comes from human sources such as sewage and includes inorganic materials such as heavy metals and Persistent Organic Pollutants (POPs)
- Agricultural by-products also contain small quantities of antibiotics, disinfectants, and ammonium

Mitigation procedures

- Using high quality feedstock that is within the permitted limits for chemical contaminants, can greatly reduce the risks

Quality Control of Digestates cont'd

2) Biological Contaminants

- If the process specifications are not followed properly, there is an increased probability of presence of plant animal or human pathogens in the final product

Mitigation procedures

- Feedstock types, pre-treatment of feedstocks
- Time-temperature combination regimens such as pasteurization of the raw substrate can be performed at 70 °C for 1 h

Quality Control of Digestates cont'd

3) Physical Contaminants

- Non- or low-digestible materials e.g. plastic, glass, metal scrap, stones, sand, wood etc.

Mitigation procedures

- Sorting at source or by onsite separation (mechanically, magnetically, or by other means)

- Physical barriers like sieves, stone traps or protection grills can be installed

Quality Control of Digestates cont'd

2. **Environmental risk**

The application of digestate at times of the year when there is little plant uptake (e.g. autumn and winter) can result in:

- Nutrient volatilization
- Surface run-off/ nutrient leaching to near by waterways

Mitigation procedures

- Storing the digestate until the optimal time for application
- Limiting or avoiding the application of digestate in the periods of low plant uptake
- Using different methods of spreading (e.g. immediate incorporation in the topsoil)
- minimizing the surface area of digestate that is exposed to air after application

Benefits of Anaerobic Digestion

Economic advantages

- Additional income
- Self sufficiency to farmers by generating electricity

Agronomic advantages

- Using anaerobic digestate as fertilizer or soil supplement
- Increased availability of nutrients to plants

Environmental advantages

- Odour reduction
- Reduction in green-house gas emission
- Reduction in weed seeds
- Reduction in pathogenic micro-organisms

Canadian Provincial Guidelines for AD

- Every province in Canada has regulations for the use of on- farm waste including feedstock for AD
- Ontario has separate regulations for the use of on-farm and off-farm waste as a feedstock for AD
- Ontario and British Columbia also have processing standards for digestate pathogen testing and pre-treatment of the feedstock prior to addition to the digester

International Guidelines for AD

- Most jurisdictions have guidelines and regulations for AD such as Spain, Belgium, Italy, UK, Hungary, Scotland, Germany, Denmark, Austria, Netherlands, etc.

- Belgium, Denmark and UK have specific requirements for the feedstock prior to addition to the digester such as pasteurization of animal by- products at 70°C for 1h or 57°C for 5h

- The anaerobic digestate is commonly used as a fertilizer and soil conditioner for agriculture

Fertilizer Act and *Regulations*

- Fertilizers and supplements when imported into or sold in Canada are regulated under the authority of the federal *Fertilizers Act* and *Regulations* administered by the CFIA.

- Pursuant to *Fertilizers Act* and *Regulations* , all products must be safe with respect to human, animal and plant health and the environment.

- Currently, anaerobic digestate does not meet any of the exemptions, therefore requires registration (including pre-market assessment) prior to importation and sale in Canada

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