ENVIRONMENT

Technological Innovation

ABSTRACT

In response to the growth of hog production in North America, Bio-Terre Systems developed an innovative environmental solution for manure management in collaboration with Agriculture and Agri-Food Canada (AAFC). This technological approach combines low-temperature anaerobic digestion, concentration of solids and production of green energy. It facilitates the transformation of organic matter into value-added by-products, offering a solution that benefits agricultural producers.

The Bio-Terre Systems technology allows users to fertilize their land with the liquid fraction, supply energy for their buildings with the biogas produced and export their excess nutrients with the solid fraction. The technology meets the needs of agricultural operations of all sizes, while solving odour problems and destroying pathogenic microorganisms.

AGRI-ENVIRONMENT

LOW-TEMPERATURE ANAEROBIC TREATMENT OF HOG MANURE AND TRANSFORMATION OF BIOGAS INTO GREEN ENERGY

HIGHLIGHTS

Technology
- Uses robust anaerobic microorganisms that can tolerate low temperatures
- No pre-treatment or solid–liquid separation necessary
- Stable process even in presence of antibiotics and in a variety of operating conditions
- Continuous production of biogas with high energy potential
- Automated system needing minimal monitoring and maintenance

Environment
- Production of biogas, a renewable energy source
- Production of high-value liquid fertilizer that is odourless and free of pathogenic microorganisms
- Reduction by up to 50% of the quantity of phosphorus in the liquid fraction
- Reduction by 90% of greenhouse gas emissions from hog manure

Economy
- Incorporates into existing farm operations and infrastructure
- Profitability of capital investments assured by agronomic benefits and energy-savings

Canada

Bio-Terre Systems Inc.

Ministère de l'Agriculture, des Pêcheries et de l'Alimentation Québec

PROJECT OBJECTIVES / PHASES

The objective of this project was to develop and market an integrated technology to treat hog manure and produce green energy from it. This low-temperature anaerobic treatment technology was intended to facilitate:

- **Treatment of hog manure in compliance with environmental standards**
- **Use of nutrients contained in the manure**
- **Conversion of biogas produced into green energy**
- **Generation of value-added bio-solids**
- **Export of excess phosphorus off the farm**

Phases

1995–2000:
Development and optimization of the technology with laboratory and semi-commercial bioreactors (3 m³, 8 m³ and 12 m³) at the AAFC Research Centre in Lennoxville, Quebec.

2000–2001:
Installation and optimization of 165 m³ commercial bioreactors on the farm of Richard Péloquin in Ste-Edwidge de Clifton, Quebec. This phase included rigorous scientific monitoring.

2001–2003:
Full-scale demonstration of commercial bioreactors on a farm producing 2500 hogs/year and adding value to by-products.

2004:
Doubling of treatment capacity to 5000 hogs/year and commercial demonstration in farms producing 12 000 to 18 000 hogs/year (including adding value to by-products).

BACKGROUND

The Canadian hog industry is expanding rapidly. In Quebec, a moratorium and the adoption of increasingly severe and restrictive environmental standards are motivating producers to seek more effective ways to manage manure. As the agricultural land in a number of regions is saturated with phosphorus, producers must find alternatives to applying untreated hog manure, which is rich in this nutrient.

The start-up and expansion of hog operations have become laborious processes, mainly because of fears of surface and groundwater contamination and odour emissions. In addition, the application of manure to fields releases large amounts of nitrous oxide (N_2O), a greenhouse gas 310 times more harmful than carbon dioxide.

TECHNOLOGY

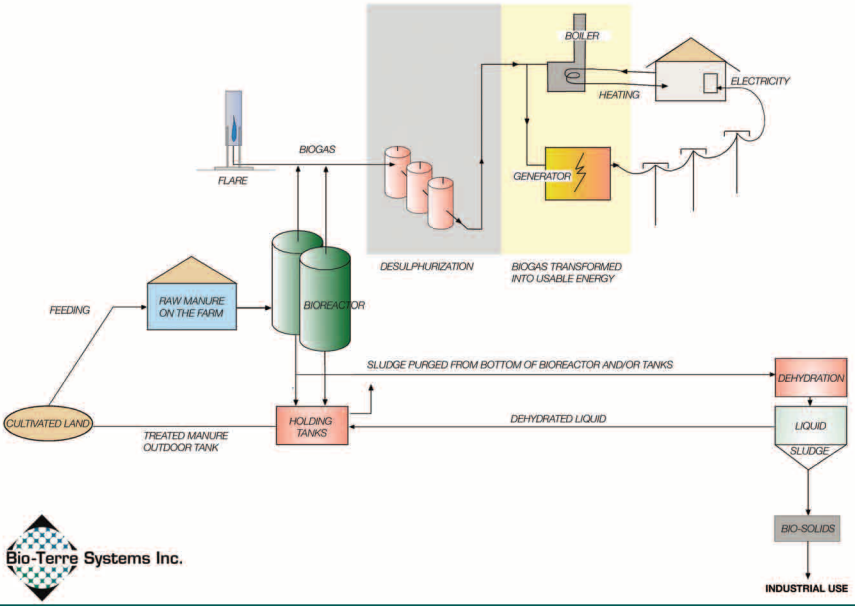
The Bio-Terre technology for anaerobic digestion of hog manure, developed by Agriculture and Agri-Food Canada, is a patented process that uses anaerobic microorganisms adapted to low temperatures (15°C to 25°C). These microorganisms are kept in sequencing batch reactors (silos next to the livestock building) in which the following sequence of processes takes place: filling, reaction, settling and decanting. The liquid fraction of the treated manure is stored in existing tanks before being applied to the fields as fertilizer.

Digestion concentrates the phosphorus in the sludge settled at the bottom of the bioreactors and holding tanks. This sludge is purged to reduce phosphorus concentrations in manure that is to be spread on fields.

The purged sludge can be dehydrated using a coagulation–flocculation process with static filtration that produces bio-solids with a dry solid content of 12% to 20%.

The treatment also produces biogas rich in methane (70%), which can be used as a source of thermal or electrical energy. Less than 10% of the energy produced is consumed by the operation of the bioreactors; the rest can be used on the farm or sent to electrical power grids.

PROCESS FLOW CHART



RESULTS

The data presented are based on measurements taken over a three-year period at a commercial facility installed on the farm of Richard Péloquin in Ste-Edwidge de Clifton, Quebec. Analyses were carried out by Agriculture and Agri-Food Canada and Laboratoires d'environnement S.M. inc.

Agronomic Results

The liquid effluent produced by the bioreactor is a high-quality fertilizer. The proportion of nutrients (nitrogen and phosphorus) in mineralized form (more easily absorbed by plants than organic forms) is higher in treated manure than in raw manure, making it possible to improve crop yields. Recorded performances are similar to those achieved with inorganic fertilization. Anaerobic digestion also allows a 5% reduction in the volume of manure to be managed. In addition, the concentration of manure solids in the sludge allows 50% of the phosphorus to be exported from the farm in just 2% of the initial volume produced. This sludge can be sent to a treatment centre to be transformed or exported for spreading on other fields.

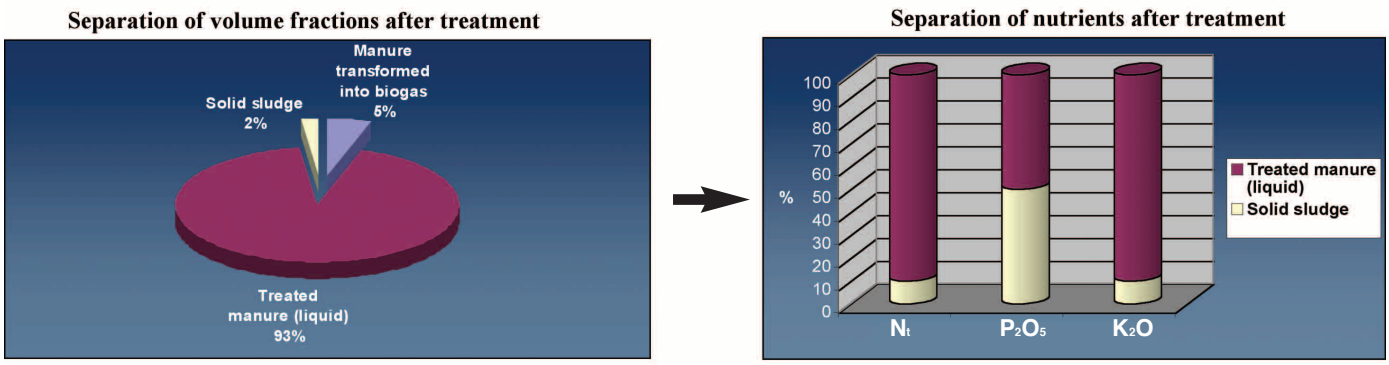
Energy Production Results

Through the work carried out, researchers were able to measure and evaluate the considerable energy potential of the biogas produced through anaerobic digestion. The bioreactors, installed outdoors in Quebec's difficult climatic conditions, produced 37 m^3 of biogas per cubic metre of hog manure. Thus, approximately 200 kWh/m^3 of treated manure can be produced using an electric generator (25% efficiency), with thermal energy recovery (50% efficiency) operating 90% of the time.

Environmental Results

In terms of environmental benefits, the treatment technology can reduce by 90% greenhouse gas emissions associated with energy consumption on the farm, manure storage (CH_4), use of inorganic fertilizers produced using natural gas (CH_4), and land application of manure (N_2O). In addition, treated manure is free of pathogenic microorganisms and is odourless. By exporting phosphorus from the farm, application of bio-liquids can be balanced according to crop needs, and over-fertilization, which could contaminate water, can be avoided.

PERFORMANCE OF THE BIO-TERRE PROCESS



POTENTIAL AND LIMITATIONS

Potential

- Remote monitoring of the process by means of a computerized system connected by telemetry
- Designed to adapt to the standard operations of existing farm
- Making liquid effluent a better alternative to inorganic fertilizers for crops integrated with animal production
- Technology applicable to other types of manure, slaughterhouse waste and livestock carcasses
- Reduction of variations in production costs related to fluctuations in the price of fossil fuels used to heat buildings

Limitations

- Start-up period needed for the anaerobic digestion process
- Biogas production directly related to the concentration of organic matter in the manure to be treated
- For some recovery equipment, biogas filtration may be required
- Volume to be managed is reduced by only 5%
- Cannot be discharged into waterways

INFORMATION

This data sheet is based on the results of three years of monitoring at a full-scale facility using low-temperature anaerobic treatment. In addition to technical and financial support from Agriculture and Agri-Food Canada, the project received technical support from Environment Canada and financial support from Canada Economic Development and the ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec. Activities in the areas of commercial demonstrations and transformation of by-products benefit from partnerships with Hydro-Québec, Quebec's ministère des Ressources naturelles and, ministère du Développement économique et régional (support program for technological showcases, PSVT), and Sustainable Development Technology Canada.

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ENVIRONMENT
Technological Innovation

Technological Innovation data sheets, published by Environment Canada, are intended for all firms, industries, organizations and individuals interested in new environmental technologies.

Their purpose is to disseminate the results of technology development and demonstration projects carried out in the following sectors: wastewater, atmospheric emissions, contaminated soil, waste management, hazardous waste, agri-environment, and innovative tools and processes.

Data sheets may be obtained from: Environment Canada
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