Upgrading of manure as monosubstrate for biogas production
Final report

Project No.:	10030 / EUDP J.nr. 64009-0051
Made by:	EBRU
Issued:	09 June 2011

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Summary

The objective of the project *Upgrading of dairy cattle manure as a monosubstrate for biogas production* was to improve the efficiency of biogas processes digesting dairy cattle manure.

The project was a collaboration between Xergi, Novozymes and Novozymes Biologicals. The project studied the effect of thermo-chemical treatment NiX, of biological treatment and of combination of the two treatments on recalcitrant fibers from anaerobically digested cattle manure.

The original development plan consisted of three parts, starting from lab-scale screening (part 1), followed by pilot-scale tests (part 2) and full-scale tests (part 3).
The tests were made at lab-scale (part 1, batch tests, biological treatment) and pilot-scale (part 2, CSTR tests, thermo-chemical treatment NiX and combined thermo-chemical followed by biological treatment).
This report describes and concludes on the first two parts of the original development plan and is divided in two parts.

Part 1: lab-scale batch tests

Part 1 of the project was a screening (batch tests) of biological treatments on fibers from anaerobically digested cattle manure.
The best results in the lab-scale trials were obtained with fungal strain Coprinus (NN055974) on autoclaved fibers and resulted in methane potential increases of 30-40 mL-CH_4 / g-VS.

The success criterion for moving from lab-scale (part 1) to pilot-scale (part 2) was that 25% of the theoretical methane potential of fibers from anaerobically digested dairy cattle manure was converted to methane in batch tests, compared to batch testing of water-treated fibers. In lab-scale batch testing, this corresponded to an increase of 100 – 113 mL-CH_4 / g-VS in methane production compared with water control, assuming a theoretical methane potential of cow manure of 400 – 450 mL-CH_4 / g-VS.

Although the results did not meet the original criterion for moving to pilot-scale testing (part 2), the possibility of a synergistic effect between the thermo-chemical treatment NiX and a microbial treatment was apparent. Therefore, it was decided to move to pilot-scale testing (part 2).

Part 2: pilot-scale CSTR tests

Part 2 of the project studied the effect of treatments to improve the efficiency of a 2-step CSTR biogas process digesting cattle manure.
Thermo-chemical treatment (based on patented NiX) improved by 48% the methane yield of the second step of the 2-step CSTR biogas process (from 65 ± 7 to 96 ± 7 L-CH_4 / kg-VS) and by 16% the total methane yield of the overall 2-step biogas process (from 180 ± 13 to 209 ± 15 L-CH_4 / kg-

VS, where VS is the organic matter content of the raw substrate cattle manure). The results from CSTR experiments were confirmed by batch tests.
Combined treatment NiX followed by biological treatment did not increase the methane yield.

Thermo-chemical treatment NiX proved to be suitable to increase the methane yield of cattle manure for long-term operation (steady state) or to temporarily boost the biogas production. The low catalyst dosage makes thermo-chemical NiX treatment attractive for commercial-scale applications.

1 Introduction

Biogas digesters cannot achieve the total methane potential of cattle manure because this substrate contains recalcitrant components.

Solid fraction from cattle manure (fibres) is recalcitrant to anaerobic digestion. Undigested fibres that leave the biogas plant together with the effluent decrease the overall efficiency of the plant.

Fibres are recalcitrant to anaerobic digestion because of their composition and structure. The composition and structure of the fibres protect against the enzymes produced by the microorganisms involved in the biogas process. The enzymes cannot reach the internal parts of the fibres and as a consequence only a small fraction of the fibres is converted into biogas.

Treatments are needed to make the fibres more accessible to microbial conversion and to achieve high efficiency of the biogas process.

Thermochemical treatment (based on patented NiX treatment), biological treatment with fungal strain Coprinus and combination of them were tested during this project at lab-scale and at pilot-scale.