Enhanced Methane Productivity from Lignocellulosic Fibers Using Aqueous Ammonia Soaking (AAS) Treatment. Abstract in the proceedings of the 21st European Biomass Conference and Exhibition

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Enhanced methane productivity from lignocellulosic fibers using Aqueous Ammonia Soaking (AAS) treatment

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Project background

Denmark is one of the largest producers of pig meat in Europe. However, only a small fraction of the manure, less than 10%, is used today for biogas production. Biogas plants digesting liquid manure alone are not economically viable due to the relatively low organic content of the manure, usually 3-5%. Current biogas production in Denmark is based on at least 75% animal manure and up to 25% additional biomasses, like waste from slaughterhouses, glycerine, crops, etc. These biomasses are added mainly to increase the concentration of organic material. However, it has become increasingly difficult to get hold of these biomasses because they are produced in limited amounts and they are used for other production purposes as well. Additionally, the prices of this additional biomass have increased significantly in the last years, which make the biomass addition for increasing biogas production less economically attractive.

Another possibility for solving this problem is to separate the solid and liquid manure fractions and transport only the solid fraction to the biogas plants, while the liquid fraction is used as fertilizer and is spread on the farm land. Even though the solid fraction has a great biogas potential, its conversion process presents difficulties due to its lignocellulosic structure of manure fibers. Therefore a treatment of the material before its anaerobic digestion is necessary.

Project description

In this project aqueous ammonia soaking (AAS) has been used as pretreatment prior anaerobic digestion. Aqueous ammonia soaking is a cheap, easy, non-polluting and safe handling method to pretreat the solid fraction of swine manure and other lignocellulosic materials.

As it is explained in the figure 1, two kinds of manure fibers were used in this study; A) those collected directly in the farm after manure centrifugation in a decanter - called raw manure fibers - and B) those which were collected at a biogas plant after decanting the effluent of the anaerobic digester – called digested manure fibers.

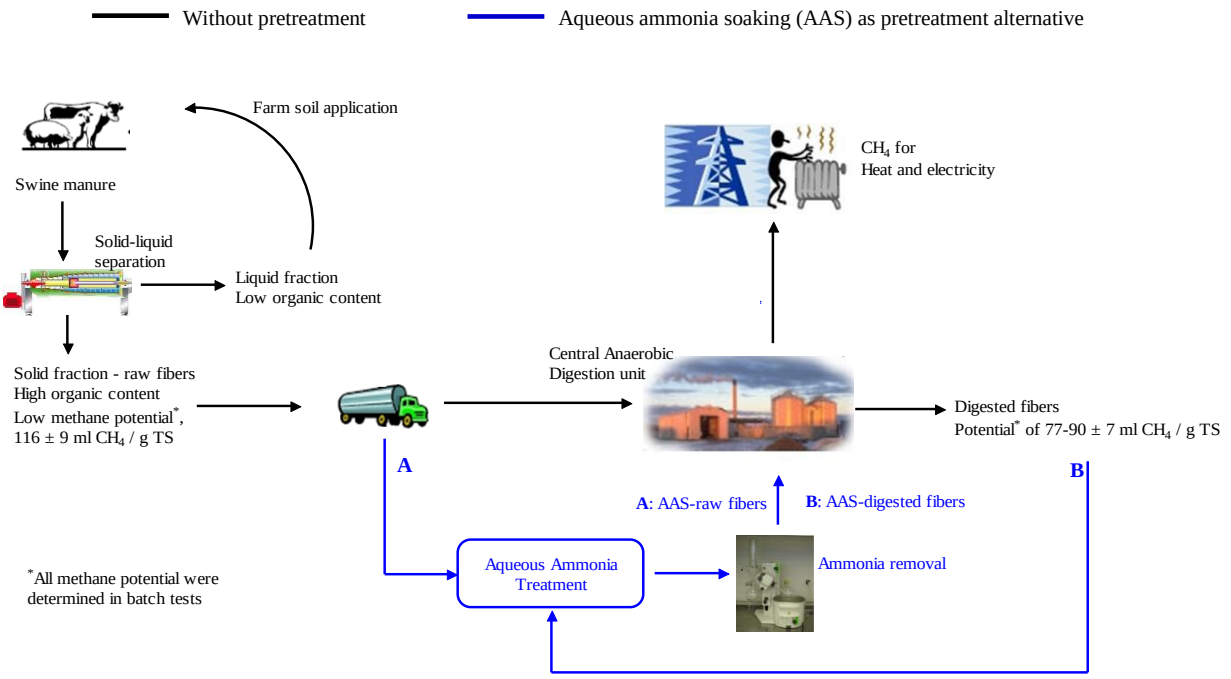

Fig.1. New process proposed in this project.

Results and significance

- Pretreatment

AAS was investigated as a pretreatment method for enhancement of the methane production rate and potential from digested manure fibers. The efficiency of AAS has been tested at different durations (1, 3 and 5 days) and temperatures (22 and 55°C) and AAS for 3 days at 22°C was found to be the most efficient one.

- Batch tests

Methane production rate and yield were evaluated in batch experiments at different organic loading ratios in order to assess any inhibitory effects due to the pretreatment. In all cases an increment over the fibers which had not gone through AAS was observed.

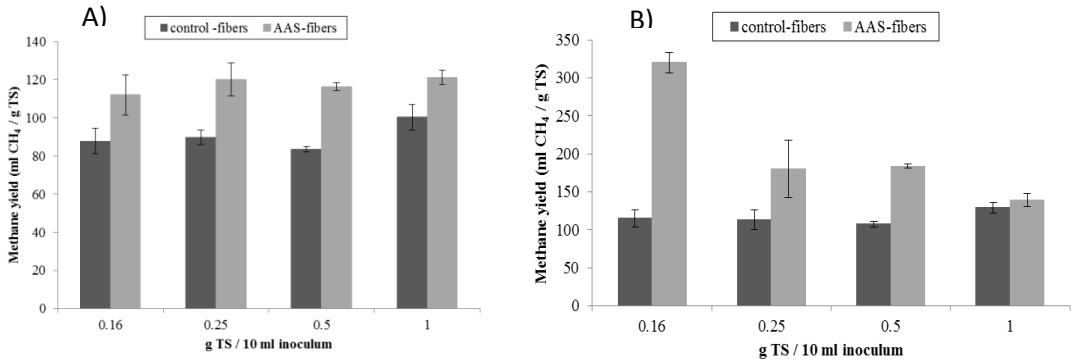

Fig. 2. Methane yield after 40 days of anaerobic digestion of control-fibers (no AAS treatment) and AAS-fibers at different loading ratios (g TS added per 10 ml of inoculum) for (a) digested fibers and (b) raw fibers. AAS was applied for 3 days at 22°C

- Continuous experiments

Three mesophilic (38°C) CSTR-type digesters of 3 L useful volume were operated in parallel. Initially they were fed with swine manure and after they reached steady state the first was fed with a mixture of swine manure and AAS treated raw manure fibers, the second was fed with a mixture of swine manure and AAS treated digested fibers and the third was kept as control for comparison purposes. An increase of 90% and 200% in methane yield (ml CH4 / gTS) was obtained for raw and digested fibers respectively fibers

- Simulation

Anaerobic Digestion Model No1 (ADM1) was fitted on the data from the continuous anaerobic digestion of manure. Subsequently, the model was able to satisfactorily simulate the behaviour of the digesters (even when they were fed with a mixture of manure and fibers) both under steady state and during disturbances.

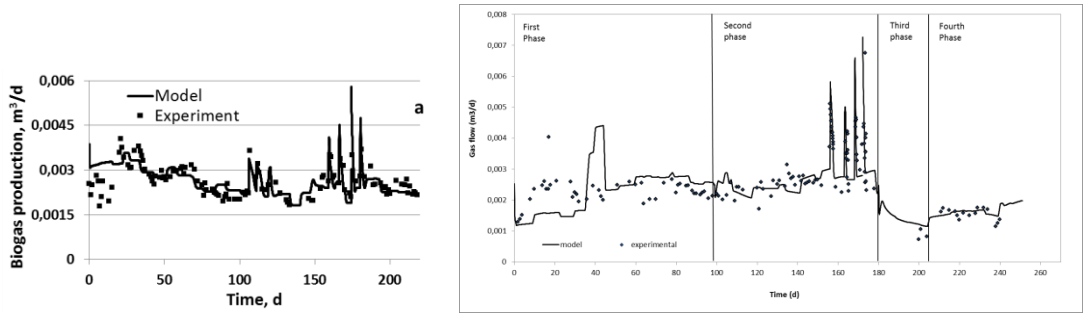

Fig. 3. Experimental (■) and model simulated (▬) biogas production throughout the duration of the continuous experiment in (a) manure-fed reactor and in (b) fed with mixture of manure and AAS pretreated digested fibers.

Future work

Profitable production of biogas using this pretreatment without any subsidy is our final target. An extensive techno economical study is crucial to validate this process. Different options of ammonia extraction in a full scale plant will be considered.

The last step is the scale up the process to a pilot plant before a full size operational biogas plant is developed. This last phase is not an objective in the current project; however a new project to validate this process in a pilot scale is currently under formulation.