This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691911

Technology Description (TD) for

Substrate Pre-Treatment Technologies

Contact Information:

TECHNOLOGY/ EQUIPMENT SUPPLIER	*Name of institution:*	ventury GmbH		
	Name of contact Person:	Henri Wernecke		
	Street:	Hüblerstraße 3		
	Town:	Dresden	*Zip code:*	01309
	Country:	Germany		
	Phone:	+49-351-317762-77		
	e-mail:	wernecke@ventury.org		
	www:	www.ventury.org		
	Date (of filling the TD):	28.09.2017		

Technology Description:

NAME OF TECHNOLOGY	Pressure Swing Conditioning
ASSIGNMENT OF TECHNOLOGY	Fibrous substrates (straw, dung)
TECHNICAL READINESS LEVEL **TRL 1** - basic principles observed **TRL 2** - technology concept formulated **TRL 3** - experimental proof of concept **TRL 4** - technology validated in lab **TRL 5** - technology validated in relevant environment (industrially relevant environment in case of key enabling technologies) **TRL 6** - technology demonstrated in relevant environment (industrially relevant environment in case of key enabling technologies) **TRL 7** - system prototype demonstration in an operational environment **TRL 8** - system completed and qualified **TRL 9** - actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)	1 2 3 4 **5** 6 7 8 9
What is the core innovation?	Now, non-fermentable fiber-containing substrates can be processed. The biogas digester can be much smaller.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691911

Vision of the innovation		A gap will be closed for the recycling of organic residues.
What are the R&D needs for your technology?		The operational stability of system components (valves etc.) must be improved
TECHNOLOGY/EQUIPMENT AVAILABILITY		Investor is needed for continuous plant/prototype
PATENT RIGHTS		NO
METHOD OF MAKING THE TECHNOLOGY AVAILABLE	*Licence selling*	NO
	Licence granting	NO
POSSIBLE END USERS OF TECHNOLOGY	*Please name end users/ contacts that should be invited to project workshops*	Farmer with straw residues and/or straw-rich manure

Description of the technology/equipment: (Pls. describe the technology. You may include pictures or graphics.)

Description of the technology/equipment:

Pressure Swing Conditioning is a thermal pressure hydrolysis method developed by the company ventury GmbH (Dresden, Germany) and conducted in a pilot plant.

In cooperation with DBFZ ventury identified lignin-rich agricultural residues which weren´t used so far. These include barley straw, cattle and chicken manure.
Therefore ventury designed a treatment plant that conditions highly fibroid substrates in a thermo-mechanical process for improved biogas fermentation.

Pilot plant of pressure swing conditioning system

Test execution:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691911

PSC-hydrolysis of barley straw

Manure contains regularly straw. This was the reason why straw should be tested separately. Biogas or methane yield is the main parameter to evaluate the quality of pre-treatment. Thereby heightened yields results can be generated and profitability can be calculated.

Image 1 shows the specific gain of methane of processed barley straw. It was submitted to a PSC hydrolysis at varying temperatures (130°C, 160 °C, 190 °C) and detention time (5 min, 30 min), followed by a batch-fermenting test.

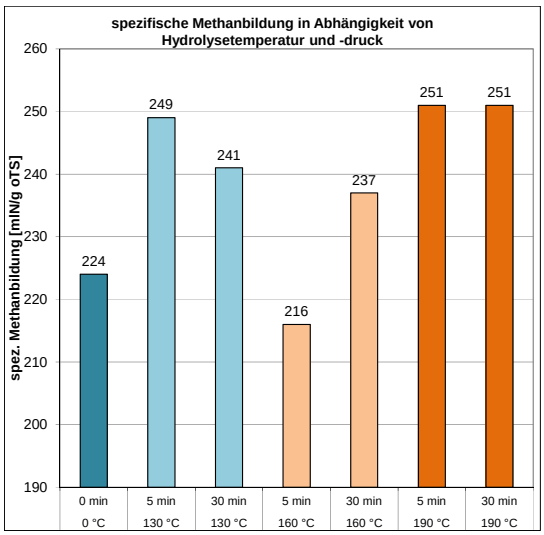

Image 1: barley straw spec. yield of methane

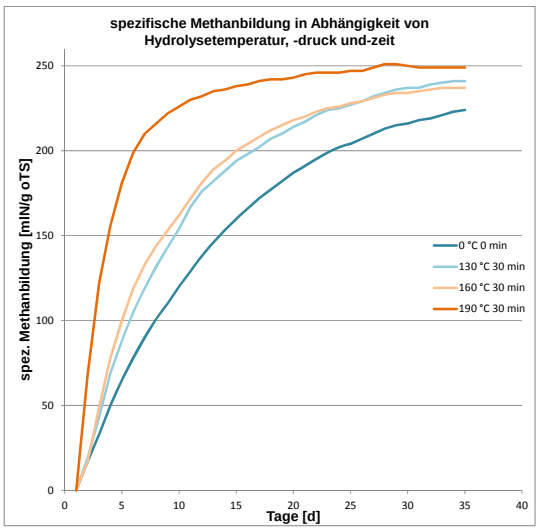

Image 2: barley straw spec. Methane prod., process speed

The highest methane productions were measured at 190 °C and 5 or 30 minutes retention time. There were reached 251 mlN/g VS (increase of 12%).

An essential process advantage of the PSC is to significantly accelerate the gas production. In image 2 is clearly shown that in treated straw were obtained 90% of the gas yield from untreated straw after 5 days instead of 25d. This corresponds to an acceleration of methane formation by a factor of 5.

Straw is an agricultural remnant which is underutilised in biogas production due to a high lignin and fibre content. Images 3 to 6 show the achievement of the PSC -hydrolysis.

The development of mono- and disaccharides by hydrolysis (can also be smelled) increase the methane production

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691911

Image 3: barley straw untreated

Image 4: barley straw (160°C, 30 min)

Image 5: barley straw (160°C, 240 min)

Image 6: barley straw (190°C, 240 min)

Table 1 is an abstract of separate parameters. It shows PSC-hydrolysis as useful method to treat barley straw for an efficient fermentation. Both solubility and gas production increases strikingly.

Tab. 1: Results of the digested barley straw

parameter	PSC-values	efficiency
acids	240 min, 190 °C	+ 633 %
mono- and disaccharides	30 min, 190 °C	+ 440 %
oligosaccharide	30 min, 190 °C	+ 2000 %
methane yield	30 min, 190 °C	+ 12-30 %
process speed	30 min, 190 °C	+ 400%

Especially higher process speed enables modification of plant design. So the hydrolyzed straw requires just ca 25 % of digester volume. During continuous fermentation tests an increased methane production were proven (+30 %).

PSC-hydrolysis of cattle manure:

Samples of cattle manure were treated with PSC (images 7 and 8). The manure were pretreated on two temperature levels (160° C, 190 °C) and three residence times (5 Min., 30 Min., 60 Min.) in the pilot plant.

Image 7: cattle manure: - untreated, crushed, PSC treated (Source: DBFZ)

Image 8: cattle manure PSC treated (Source: DBFZ)

In either way the cattle manure which was pre-treated by pressure swing conditioning the methane yield was even higher than in all versions with untreated substrate. The highest methane yield was reached at 160°C/60 Min (Image 9). The pretreated cattle manure already reached a methane yield of 100 mlN/gVS after two days whereas the untreated ones reached 100 mlN/gVS not until 25 days later.

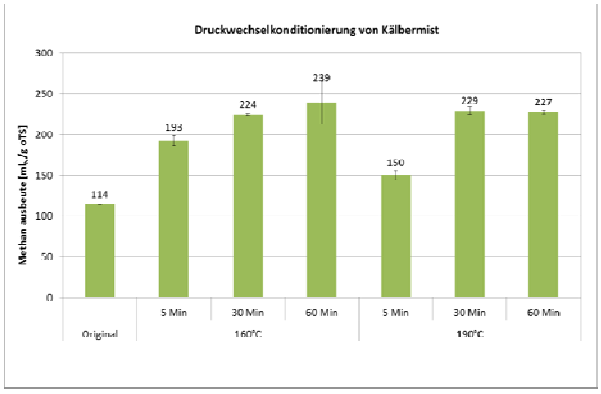

Image 9: methane yield of PSC treated cattle manure (Source: DBFZ)

The PSC hydrolysis is excellent for the digestion of lignocellulosic substrates. In this way, cell structures are disrupted and released gas active substances. So even methane yields of conventional substrates like corn silage can be accomplished and surpassed. A fermentation upstream PSC hydrolysis module is therefore to substitute capable expensive primary and secondary substrates. Ecological and economic advantages here are the use of agricultural residues.

Technical Data:

Parameter		Value (please fill or tick) If value not available, please give estimate (and indicate with *).	**Comments** (e.g. which condition does the entered value correspond to?)
Current technology	Flow rate of technology at current TRL-level (Mg/h)	0,5 Mg/h	
Data basis for following data list	1.: market ready stage of technology (based on test runs of current techn.) 2.: market ready stage of technology (based on estimate) 3.: current level (TRL) of technology	1	
Technical efficiency	Increase in biogas production through pre-treatment technology (%)	up to 30	With straw in continuous digestion tests in laboratory scale
Capacity	Flow rate (range) (Mg/h)	up to 1	
	Possible range for upscaling	modul multiplication	
Data for assessment of economical added value, possible contribution to GHG-reduction and availability	Electricity demand (kWh$_{el}$/Mg Substrate)	25	
	Heat demand (kWh$_{th}$/Mg Substrate)	147	
	Chemical/additives demand (kg/h)	no	
	Demand of other substances (kg/h)	Water for steam generation: 0,132	
	Full load hours (h/a)	8.000	
	Dry matter content (range) (%)	up to 100	
	Space requirement (m^2)	50	(40'-Container)
	Staff requirement (excluding maintenance) (h/a)	-	
	Specific capital costs (excluding project development, planning, permission and additional building costs) (€/Mg nominal capacity/h)	300.000 €/Mg/h	

	Maintenance costs (including spare parts, staff) (€/a or €/operating hour)	40.000	
	Production costs (€/Mg)	25.000	
	Expected lifetime of unit (years)	10	
Flexibility	Types of substrate (solid and liquid)	solid	
	Start-stop-flexibility	Yes	
	Part-load possibility	Yes, full range of capacity	
	Is self-maintenance of technology possible?	Yes, 70% of total maintenance hours per year that can be done by operator himself	
	Necessity for adaptions of other parts of the plant	steam generation from exhaust heat	
	Advantages/disadvantages of technology		Enhancement/acceleration of degradation/biogas formation
	Special application area of technology		Fibrous material

Data Usage:

I agree that the above data can be published on the "Biomethane Map" www.biomethane-map.eu and to the further use for other possible scientific purposes.

Signature: H. Wesneder