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

Anaerobic Digestion Technologies

Contact Information:

TECHNOLOGY/ EQUIPMENT SUPPLIER	*Name of institution:*	University of Warmia and Mazury in Olsztyn Faculty of Environmental Engineering		
	Name of contact Person:	Marcin Zieliński		
	Street:	Warszawska 117		
	Town:	Olsztyn	*Zip code:*	10-720
	Country:	Poland		
	Phone:	+48 89 523 41 24		
	e-mail:	marcin.zielinski@uwm.edu.pl		
	www:	uwm.edu.pl/wnos		
	Date (of filling the TD):	08.09.2017		

Technology Description:

NAME OF TECHNOLOGY	Reactor for biomass digestion
ASSIGNMENT OF TECHNOLOGY	small scale biomass plant
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? (Please explain here what is innovative on this	It is very useful and well adopted to

technology and which problem does the technology solve.)		fermentation of lignocellulosic biomass. Biogas discharge is integrated with the pressure in the fermentation reactors.
Vision of the innovation (Please describe here what impact you see for the future)		Installation can be competitive for small installations where biogas is use for heat.
What are the R&D needs for your technology? (Are there any barriers or challenges which still need to be overcome?)		High operating costs which should be reduced.
TECHNOLOGY/EQUIPMENT AVAILABILITY		technology licence sellers Technology supplier has a prototype functioning in technical scale. It is possible to test the technology for potential customers. The technology supplier is not a producing company.
PATENT RIGHTS		~~YES~~/NO
METHOD OF MAKING THE TECHNOLOGY AVAILABLE	*Licence selling*	~~YES~~/NO
	Licence granting	~~YES~~/NO
POSSIBLE END USERS OF TECHNOLOGY	*Please name end users/ contacts that should be invited to project workshops*	Small biogas plant for livestock farmers

Description of the technology/equipment:

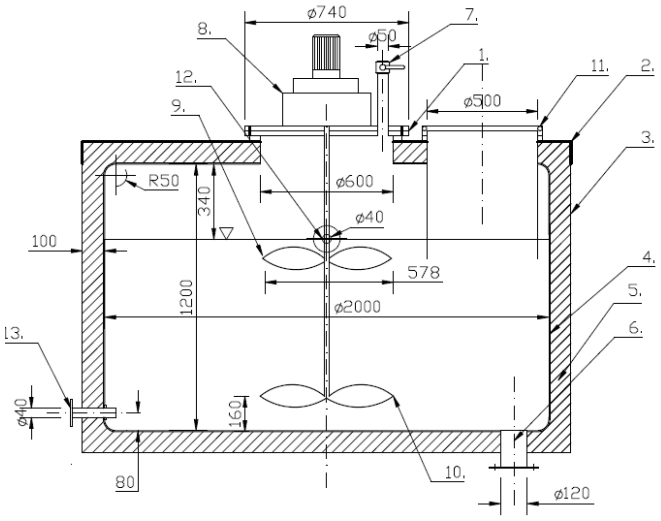
The solid substrates (i.e. manure) are collected at a disposal field in the direct vicinity of the biogas power plant facilities. With the use of a self-propelled feeder, the substrates are exported from the disposal field to a substrate pretreatment tank (SPT) once a day. Cattle slurry is also discharged to the SPT. In the SPT, which simultaneously plays the role of a hydrolyzer, hydration needs to reach ca. 90%. In the SPT, the substrate is mixed and homogenized with a mechanical agitator mounted on the tank's axis. Because of the SPT's volume and retention time, the tank simultaneously plays the role of a hydrolyzer. The SPT is the site where the first or acidic phase of methane fermentation proceeds. Appropriate

temperature conditions are maintained in the tank with a heating system (thin-walled PCV pipes mounted along the walls inside the tank). The increase in biogas production efficiency is achieved through the use of the ultrasound conditioning process. To this end, a mixture of substrates from the SPT is pumped by the existing pumping system so that it passes through a set of disintegrators. The processed substrate is then returned to the SPT. Afterwards, from the SPT reactor the substrates are fed to a fermentation tank (FT) with a rotary pump and flow through a milling disintegrator. The FT is the site where the actual process of biogas production proceeds. Methane fermentation is carried out in mesophilic conditions at ca. 35 ^{o} C. A fermenter is heated with hot water circulating in a closed system between a heat exchange system in a technical room and a system of pipes in the fermentation tank (FT) and post-fermentation tank (PFT). Heat used for heating tanks in the biogas power plant is produced from biogas combustion in a gas boiler. The fermentation tank FT is the site where the exact processes of organic matter degradation and biogas production proceed. The bulk of fermenting microbiota and substrates are kept suspended with the use of a mechanical agitator. The agitator is mounted in the vertical axis of the tank with a reducer and a drive on the tank's dome. The mixture of digested sludge flows gravitationally from the fermentation tank FT to the post-fermentation tank PFT, where complete fermentation and process extinguishing occur. The post-fermentation tank PFT is also equipped in an agitating system, but it is not heated. From the PFT, the digested sludge passes to the retention tank RT. The volume of this tank ensures ca. ten-day retention of digested sludge. From this tank, the digested sludge is discharged via gully emptiers to a sludge tank located outside the biogas works, from where it is exported as fertilizer.

Biogas produced during methane fermentation is collected from fermentation tank FT and post-fermentation tank PFT. Through a filter with a bog iron ore, biogas reaches the gas boiler, where it is combusted, which results in heat generation. Biogas is accumulated only in the gas zone of the FT and PFT tanks. The boiler is switched on automatically when pressure rises above 10 mbar. Biogas accumulated in the gas zone of the FT and PFT tanks is combusted. When the pressure of biogas drops to 5 mbar, the unit is switched off automatically and remains in stand-by mode until the pressure in the gas installation again increases to the appropriate level.

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

Zbiornik przygotowania substratu



1. Króciec górny do mocowania kopuły. (kopuła - wylot gazu, zamocowanie mieszadłaz motoreduktorem oraz właz rewizyjny,
2. Obręcz maskująca L 100 x 100 SKO,
3. Płaszcz zewnętrzny - blacha powlekana drony trapez,
4. Płaszcz wewnętrzny - laminat poliestro - szklany chemoodporny grubość 10 mm
5. Izolacja 100 mm wełna mineralna
6. Króciec (przelotka) DN 100 - 2 szt.
7. Króciec ujęcia biogazu
8. Silnik z motoreduktorem
9. Mieszadło górne o regulowanej wysokości poożenia
10. Mieszadło dolne
11. Śluza zasypowa kiszonki
12.. Króciec wpustowy
13. króciec odprowadzający

Substrate preparation tank:

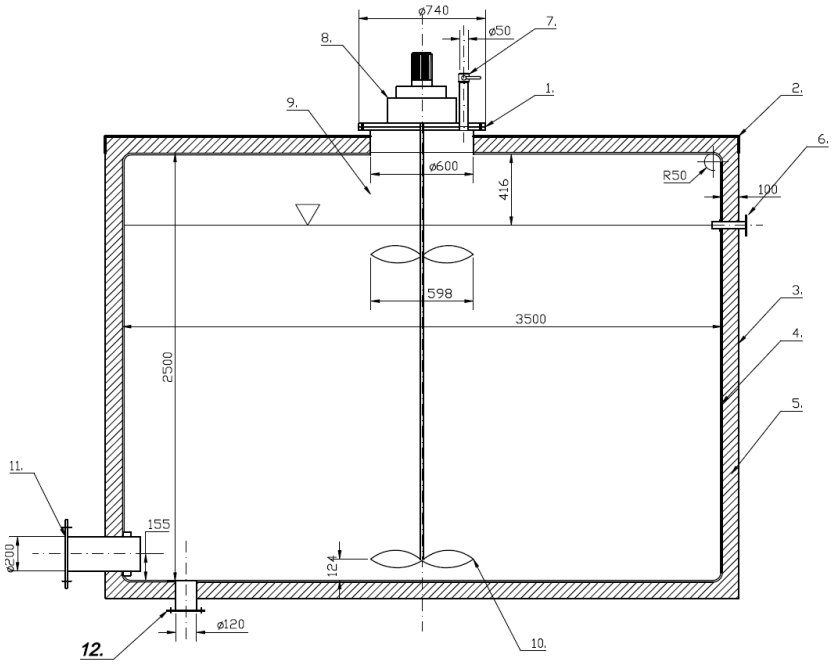
1-the upper connector, 2 – masking ring, 3 – External cover, 4- internal cover, 5- isolation, 6 – grommet, 7 – holder connector biogas , 8 – engine with a motoreductor, 9 – top mixer with regulation, 10 – lower mixer , 11 – lock hopper, 12 – connector inlet, 13 – connector outlet

Reactor for digestion 1 and Reactor for digestion 2

1-the upper connector, 2 – masking ring, 3 – External cover, 4- internal cover, 5- isolation, 6 – grommet, 7 – holder connector biogas , 8 – engine with a motoreductor, 9 – top mixer with regulation, 10 – lower mixer , 11 – connector outlet, 12 – emergency chute

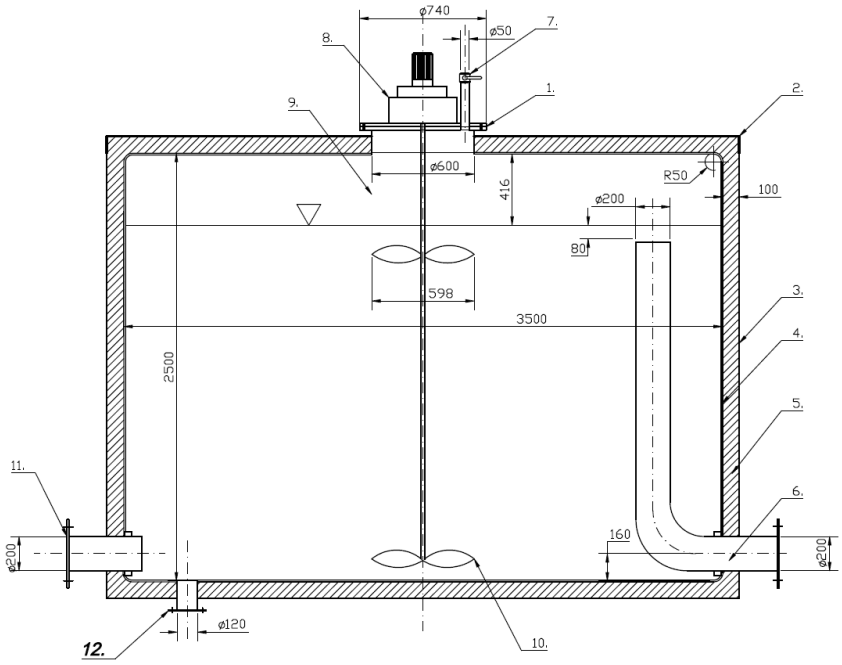
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691911

Fermentor 1



1. Króciec górny do mocowania kopuły. (kopuła - wylot gazu, zamocowanie mieszadłaz motoreduktorem oraz właz rewizyjny,
2. Obręcz maskująca L 100 x 100 SKO,
3. Płaszcz zewnętrzny - blacha powlekana drony trapez,
4. Płaszcz wewnętrzny - laminat poliestro - szklany chemoodporny grubość 10 mm
5. Izolacja 100 mm wełna mineralna
6. Króciec wpustowy
7. Króciec ujęcia biogazu
8. Silnik z motoreduktorem
9. Mieszadło górne o regulowanej wysokości poożenia
10. Mieszadło dolne
11. Króciec odprowadzający
12. Spust awaryjny

Fermentor 2



1. Króciec górny do mocowania kopuły. (kopuła - wylot gazu, zamocowanie mieszadłaz motoreduktorem oraz właz rewizyjny,
2. Obręcz maskująca L 100 x 100 SKO,
3. Płaszcz zewnętrzny - blacha powlekana drony trapez,
4. Płaszcz wewnętrzny - laminat poliestro - szklany chemoodporny grubość 10 mm
5. Izolacja 100 mm wełna mineralna
6. Króciec wpustowy
7. Króciec ujęcia biogazu
8. Silnik z motoreduktorem
9. Mieszadło górne o regulowanej wysokości poożenia
10. Mieszadło dolne
11. Króciec odprowadzający
12. Spust awaryjny

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

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	Biogas production rate of technology at current TRL-level (Nm^3/h)	1 – 1.2	
Data basis for following data list	**1.: market ready stage of technology (based on test runs of current techn.)** <u>Please only use 2. or 3. if 1. not at all possible.</u> **2.: market ready stage of technology (based on estimate)** **3.: current level (TRL) of technology**	1 ☒ (preferably) 2 ☐ 3 ☐	
Technical efficiency	Methane content in biogas (%)	50-70%	Depending on the substrate
Capacity	Flow rate and type per substrate (Mg/h)	0.05-0.08	
	Biogas production rate (range) (Nm^3/h)	1 – 1.2	Depending on the substrate
	Possible range for upscaling	up to 2000 Nm3/day	Technology for little and middle biogas plant
Data for assessment of economical added value, possible contribution to GHG-reduction and flexibility	Fermenter and biogas process technology (e.g. continuously stirred reactor, plug flow digester, box or garage type)	CSTR	
	Electricity demand (kWh_{el}/Nm^3 biogas)	1,2	
	Heat demand (kWh_{th}/Nm^3 biogas)	2,4	
	Chemical/additives demand (kg/h or kg/Nm^3 biogas)	not necessary	
	Demand of other substances (kg/h or kg/Nm^3 biogas)	not necessary	

	Temperature in fermenter (°C)	35	
	Pressure of biogas at exit of fermenter (bar $_{abs}$)	0,01	
	m³ fermenter volume used	40	
	Full load hours (h/a)	8000	
	Hydraulic retention time (days)	45-60	
	Max. dry matter content (%)	85	
	Organic loading rate (kg VS/m³d)	2 - 4	
	Space requirement (m^2)	100	
	Staff requirement (excluding maintenance) (h/a)	500	
	Specific capital costs (excluding project development, planning, permission and additional building costs) (€/Nm³/h)	Please give exact specific cost if possible, if not please specify range. ☐ < 5.000 €/Nm³/h ☐ 5.000 - 10.000 €/Nm³/h ☐ 10.000 € - 15.000 €/Nm³/h ☒ > 15.000 €/Nm³/h 50 000	
	Maintenance costs (including spare parts, staff) (€/a or €/operating hour)	3000	
	Production costs (€/Nm³ biogas)	0,3 – 0,5	
	Expected lifetime of unit (years)	10	
Flexibility	Types of substrate (solid and liquid)	Solid and liquid	Cage mixing system improving efficiencies of solid substrate fermentation
	Start-stop-flexibility	not necessary	

	Part-load possibility	☒Yes, 50 % - 100 % of full capacity ☐ No	
	Is self-maintenance of technology possible?	☒Yes, 80 % of total maintenance hours per year that can be done by operator himself ☐ No	
	Necessity for adaptions of other parts of the plant	not necessary	
	Advantages/disadvantages of technology	Fits small scale farms	
	Special application area of technology	Fits small scale farms	