



Technology Description (TD) for Biogas Upgrading Technologies

Contact Information:

TECHNOLOGY/ EQUIPMENT SUPPLIER	<i>Name of institution:</i>	GICON - Großmann Ingenieur Consult GmbH		
	<i>Name of contact Person:</i>	Michael Tietze		
	<i>Street:</i>	Tiergartenstraße 48		
	<i>Town:</i>	Dresden	<i>Zip code:</i>	01219
	<i>Country:</i>	Germany		
	<i>Phone:</i>	+49 351 47878 7737		
	<i>e-mail:</i>	m.tietze@gicon.de		
	<i>www:</i>	www.gicon.de		
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Technology Description:

NAME OF TECHNOLOGY	trickle-bed reactor for methanation
ASSIGNMENT OF TECHNOLOGY	Biogas Upgrading, Power to Gas
TECHNICAL READINESS LEVEL	<p>1 2 3 4 5 6 7 8 9</p>
<p>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)</p>	
What is the core innovation? (Please explain here what is innovative on this technology and which problem does the	<ul style="list-style-type: none"> The biologic methanation of exclusively gases like hydrogen and carbon dioxide is feasible. Electrical energy can be stored in the



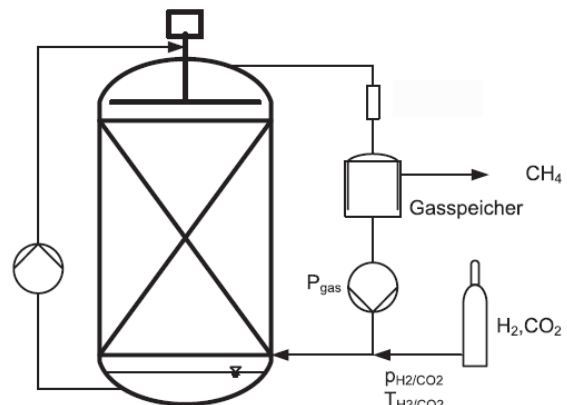
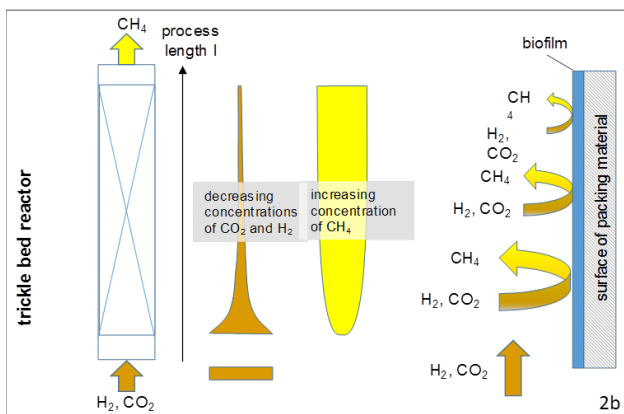
technology solve.)		<p>established gas grid by conversion to methane.</p> <ul style="list-style-type: none"> The quality of produced biogas is very high (cCH₄ = 98 vol%). The energy consumption is very low.
<p>Vision of the innovation (Please describe here what impact you see for the future)</p>		<p>This kind of technology is very easy to integrate into biogas plants, which already exist.</p> <p>It is a well technology to store energy and enhance the methane productivity of biogas plants without to enhance the mass of input.</p>
<p>What are the R&D needs for your technology? (Are there any barriers or challenges which still need to be overcome?)</p>		
TECHNOLOGY/EQUIPMENT AVAILABILITY		
PATENT RIGHTS		YES
METHOD OF MAKING THE TECHNOLOGY AVAILABLE	<i>Licence selling</i>	YES
	<i>Licence granting</i>	YES
POSSIBLE END USERS OF TECHNOLOGY	<i>Please name end users/ contacts that should be invited to project workshops</i>	Operator of biogas plants and wind parks, sources of waste – CO ₂

Description of the technology/equipment:

The trickle-bed reactor contains packing material which is the carrier for the biofilm. The immobilization of microorganisms was performed using digested sludge from a sewage treatment plant. The level of process liquid is below the fixed-bed. Therefore, a gas phase is formed in the trickled-bed-reactor. The microbiological metabolism takes place only in the aqueous phase. The wetting of the packing material respective to the biofilm is required. Consequently, a continuous trickle flow in the fixed-bed is needed and is realized by the recirculation of process liquid.



GICON-Technikum – large scale trickle-bed reactor for methanation



schematic diagram material transfer process



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?)
<i>Current technology</i>	Upgrading capacity of technology at current TRL-level (Nm ³ raw gas/h)	1 Nm ³ BG/h	
<i>Data basis for following data list</i>	1.: market ready stage of technology (based on test runs of current techn.) Please only use 2. or 3. if 1. not at all possible. 2.: market ready stage of technology (based on estimate) 3.: current level (TRL) of technology	1 <input type="checkbox"/> (preferably) 2 <input type="checkbox"/> 3 <input checked="" type="checkbox"/>	
<i>Technical efficiency</i>	Methane content in raw gas (%)	50	
	Methane content in product gas (%)	95	
<i>Capacity</i>	Flow rate (range) /upgrading capacity (Nm ³ raw gas/ h)	500	
	Flow rate biomethane (Nm ³ /h)	450	
	Possible range for upscaling		
<i>Data for assessment of economical added value, possible contribution to GHG-reduction</i>	Electricity demand (kWhel/Nm ³ raw gas)	0,12	
	Heat demand (kWhth/Nm ³ raw gas)	0,12	
	Chemical/additives demand (kg/h or kg/Nm ³ raw gas)	no	
	Demand of other substances (kg/h or kg/Nm ³ raw gas)	no	



<i>and availability</i>	Biomethane slip (range in % of biomethane production)	-	
	Delivery pressure at exit of upgrading plant (bar _{abs})	1	Processing at higher pressure is possible too
	Full load hours (h/a)	8600	
	Exhaust gas treatment		not necessary
	Usable heat (external) through heat extraction (kWh _{th} /Nm ³ raw gas)	-	No significant waste head
	Space requirement (m ²)	600	
	Staff requirement (excluding maintenance) (h/a)	1.000	
	Specific capital costs (excluding project development, planning, permission and additional building costs) (€/Nm ³ /h raw gas)	<p>Please give exact specific cost if possible, if not please specify range.</p> <p><input checked="" type="checkbox"/> < 4.000 €/Nm³/h</p> <p><input type="checkbox"/> 4.000 - 6.000 €/Nm³/h</p> <p><input type="checkbox"/> 6.000 € - 8.000 €/Nm³/h</p> <p><input type="checkbox"/> > 8.000 €/Nm³/h</p>	Without H2 - generation
	Maintenance costs (including spare parts such as new membranes, staff) (€/a or €/operating hour)	-	
	Production costs (€/Nm ³ biomethane)	-	depending on the cost of H2
Expected lifetime of unit (years)	20		
<i>Flexibility</i>	Start-stop-flexibility		



	Part-load possibility	<input checked="" type="checkbox"/> Yes, 100 % of full capacity <input type="checkbox"/> No	
	Is self-maintenance of technology possible?	<input checked="" type="checkbox"/> Yes, 50 % of total maintenance hours per year that can be done by operator himself <input type="checkbox"/> No	
	Does the upgrading technology remove also H ₂ S or is this necessary in a separate unit?	<input type="checkbox"/> Yes, ...% of total H ₂ S-content of rawgas <input checked="" type="checkbox"/> No	
	Necessity for adaptations of other parts of the plant		
	Advantages/disadvantages of technology	<ul style="list-style-type: none">• The quality of produced biogas is very high (cCH₄ = 95- 98 vol%).• The energy consumption is very low.• Cost effections strongly dependend for H₂	
	Special application area of technology	Biogas plants or sources of waste-CO ₂	