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

Biogas Upgrading Technologies

Contact Information:

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	Date (of filling the TD):	05/04/2017		

Technology Description:

NAME OF TECHNOLOGY	ALAT upgrading technology
ASSIGNMENT OF TECHNOLOGY	
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**
TECHNOLOGY/EQUIPMENT AVAILABILITY	98%

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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*	- aB&T-Eu (Air Liquide affiliate in charge of operating biogas upgrading units) - FuturBiogas : juergen.kube@futurebiogas.com

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

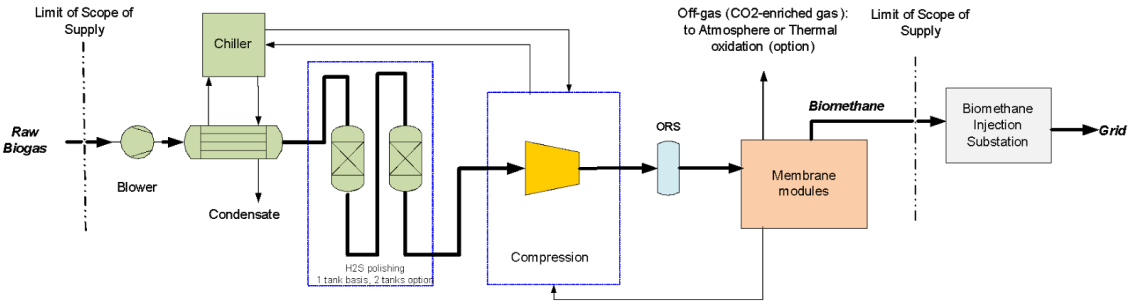
Based upon a simple process, most of our equipments are integrated into a container.

Partial 3D view of the AIR LIQUIDE biogas upgrading solution

The main biogas treatment steps are the following:

- A **pre-treatment** step to dry the inlet biogas and to remove pollutants such as ammonia, hydrogen sulphide (H_2S) , VOCs and dust generated from pollutants removal
- A volumetric lubricated screw **compression** step to ensure the optimum conditions for CH4/CO2 membrane separation.

  This compression step is followed by a second drying step in order to lower the dew point and remove water, in order to avoid water droplets in the membrane fibers. This step is also followed by an oil removal step in order to remove the oil remained in the gas, and by a dust filtration step in order to remove the dust generated from coal.
- A highly selective membrane process for **CO2 removal**



Based upon a **hollow polymeric fiber membrane** system, the ALAT biogas upgrading process removes the main pollutants within the inlet biogas (CO2, H2S, H2O…).

Throughout the membrane step, we obtain two types of gas:

- **A gas rich of CO2**, sent to the vent. This gas can be treated through an additional step of thermal oxidizing before sending it to the vent. This gas can also be used as feed for the CO^2 liquefaction unit.
- **Biomethane CH4**, which will be valued according to client's needs.

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Technical Data:

			Comments (e.g. which condition does the entered value correspond to?)
Technical efficiency	Methane content in raw gas (%)	55%	
	Methane content in product gas (%)	97%	
Capacity	Flow rate (range) /upgrade capacity (Nm^3 raw gas/ h)	200 Nm3/h	
	Flow rate biomethane (Nm^3/h)	115 Nm3/h	
	Possible range for upscaling	Up to 250 Nm3/h	
Data for assessment of economical added value, possible contribution to GHG-reduction and flexibility	Electricity demand (kWh_{el}/Nm^3 raw gas)	0,25 kWh/Nm3 (for the entire unit – only 0,22 kWh/Nm3 for the compressors)	
	Heat demand (kWh_{th}/Nm^3 raw gas)	0	
	Chemical/additives demand (kg/h or kg/Nm^3 raw gas)	0	
	Demand of other substances (kg/h or kg/Nm^3 raw gas)	0	
	Biomethane slip (range in % of biomethane production)	<0,5% (the recovery rate is >99,5%)	
	Delivery pressure (bar_{abs})	< 8 barg (< 10 barg also possible)	
	Full load hours (h/a)	Availability of 98%	
	Exhaust gas treatment	CO2 to the vent. Also possible to valorise the CO2 (liquefaction for example)	
	Usable heat (external) through heat extraction (kWh_{th}/Nm^3 raw gas)	30 kWh/Nm3	At >80°C –back at 65 °C
	Space requirement (m^2)	17,5 x 6	

	Staff requirement (without maintenance) (h/a)	180 h / year	Not more than half an hour per day on average
	Capital costs (€)	~ 900 k€	Including one H2S removal vessel
	Maintenance costs (including spare parts such as new membranes, staff) (€/a or €/operating hour)	25 k€ / year	First two years are less expensive, third year is more expensive. In average, it is 25 k€ /year
	Production costs (€/Nm³ biomethane)		
	Expected lifetime of unit (years)	20 years	
Flexibility	Necessity for adaptions of other parts of the plant	None	
	Advantages/disadvantages of technology	Possibility of heat recovery High availability Easy to operate Easy to maintain Lower Capex Limited footprint	
	Special application area of technology	Adaptable to various biogas applications	Industrial waste, municipal solid waste, Agricultural waste, Sewage treatment plants