DEMOSOFC

Project n° 671470

"DEMOnstration of large SOFC system fed with biogas from WWTP"

Deliverable number D2.3, *Survey of commercial biogas cleaning systems and creating base for cleaning system investment*

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Abstract:

Keyword list: SOFC, biogas, trace gas removal cost, biogas conditioning

INDEX

1. Background

Biogas contains various impurities in concentrations that usually need to be reduced to increase the durability of the engines. Of all impurities in biogas, siloxanes are most clearly harmful to engines, and especially fuel cells cannot work properly if fuel gas includes siloxanes and/or Sulphur compounds. Impurities from biogas must be removed before utilization in fuel cells. Commercial removal systems are available with variable techniques, thus it was decided to study the cost of those systems at biogas production plants of different capacity. The chosen biogas capacity of about 50 - 300 Nm3/h (appr. 0.3 - 2.8 MW_{e+t}) was requested. This study was done with DEMOSOFC-project using WP2 Energy modelling, design and detailed engineering of the DEMO plant'.

Biogas can be purified using different techniques, but must be noticed that there are no just one technique to remove impurities. Typical removal techniques for siloxanes and hydrogen sulphide are presented in the Table 1. Principles of the following removal techniques are presented according to Arnold (*2009).*

Table 1. Typical removal techniques for siloxanes and hydrogen sulphide

Siloxane removal techniques	- adsorption into solid matter - adsorption into liquid - absorption - cooling
Hydrogen sulphide removal techniques	- biological oxidation - chemical flocculation - adsorption into solid matter - absorption - catalytic removal

Siloxane and hydrogen sulphide adsorption into solid matter like activated carbon or mineral-based materials are the most used removal media due to their easy usage. For siloxanes commonly silicagel and/or its' modifications are used as an adsorption material since it is quite selective for silicon compounds. Advantages are that capacities of each material are quite well known and theoretically they have high purification efficiency. Disadvantages are that the temperature and the humidity of the gas affects negatively to adsorption efficiency, and therefore the gas should be dried to have relative humidity below 50 %. The saturated activated carbon must be replaced or regenerated. The operation expenses of the technique are to a large extent determined according to the replacement interval of the activated carbon. (Arnold 2009)

Adsorption and absorption of siloxanes into liquids is done using scrubbers with liquids like tetradecane, different oils, long-chain organic acids, ethanol and Selexol™-polythyleneglycoldimethylether. Adsorption into liquids is dependent on the temperature, since adsorption/absorption is more efficient within low temperature. With high flow velocity the volatile siloxanes are easily stripped from the liquid back into the gas phase. Typically, the degree of siloxane separation stays at approximately 60 % and the technique is well suited for gas pre-treatment. Thus, usage of scrubbers sometimes needs cooling. At least Selexol – scrubbers have been used widely in USA for landfill gas. (Arnold 2009)

Noshadi et al. (2016) has studied siloxane removal with cyclic amines and they have made adsorbent based on the copolymer of divinylbenzene and a novel methacrylate monomer. The novel cyclic amine based methacrylate monomer was synthesized and polymerized to form a mesoporous adsorbent and tested for D4-siloxane removal. The D4 adsorption capacity of the novel adsorbent is 2220 mg g^{-1}, which was greater than the adsorption capacities of mesoporous poly(divinylbenzene) and commercial activated charcoal. The adsorbent retains 47% regeneration capacity after 10 usage cycles.

Cooling the biogas a part of the siloxanes is removed with the condensation water. The literature gives quite mixed results on how effective cooling is in removing siloxanes from

biogas. The efficiency of this technique is determined by the temperature and pressure used and by the type of siloxanes present in the gas. Arnold (2009) summarized from the literature that cooling down to 2°C and reheating gas to 10°C the removal efficiency of siloxanes was not more than 25 %. By cooling biogas at least down to -30°C and reheating it to 10°C the removal efficiency of siloxanes was not more than 90 %. It was also estimated that deep-cooling is economically profitable only for gas with more than 200 mg/m^3 siloxane concentration.

Hydrogen sulphide can be removed in many ways from the biogas. According to American Biogas Council (2012) iron oxides and iron sponge are often used, and reaction products are iron sulphide and water. Disadvantage is that needed reaction time is longer than e.g. with activated carbon. Iron sponge generally refers to wood chips impregnated with iron oxide, and bed can be regenerated several times before needing replacement. Absorption of hydrogen sulphide into caustic liquids like sodium hydroxide, potassium hydroxide, carbonites are efficient removal methods, and at least sodium hydroxide scrubber is used in landfills and also in many small odour removal processes, due to its' good removal efficiency.

In biofiltration microbes lives on a support matrix to remove sulfides with microbes oxidizing reduced sulfur compounds to sulfate. Sulfides absorb into a liquid film and are then metabolized by the microbial cells. Biotrickling filters work by passing a gas stream through a chemically inert packing material, over which an aqueous phase is continuously trickled. According to Bailon Allegue & Hinge (2014) the main difference between biofilters and biotrickling filters is the nature of the carrier material, organic in biofilters and inert in biotrickling filters. The packing material can be from plastics or from natural media like wood chips or peat moss.

2. Target

The target of this survey was to have report on costs of commercial gas purification application available for SOFC installations. Focus was in removal of hydrogen sulphide (H_2S) and siloxanes, as well as conditioning gas to suitable form to SOFC (solid oxide fuel cell). Biogas capacity about 50 - 300 Nm^3/h (~0.3 - 2.8 MW_{e+t}) was requested. Target was to assess investment and operational costs of commercial purification systems.

3. Limitations

This report excludes assessments of biogas production costs and variability of impurities in different biogas plants. Costs of removal efficiency monitoring are not included.

4 Offer request

Offer requests were sent to ten biogas purification manufacturers, covering widely above mentioned removal methods. Request was sent to following ten manufacturers, Table 2:

Table 2. Called tenders.

Called tenders	Removal technique	Answer
Clean Methane Systems	Adsorption to activated carbons	No
Parker	Adsorption to polymer/silicagel/carbon	No
Siloxa Engineering	Adsorption to activated carbons	Yes, but cannot reach required gas concentrations. No offer
DETES Umwelttechnik GmbH	Adsorption to activated carbons	Yes, partial offer: Carbon prices, pipings, compressors, etc. were not included
Xebec	Pressure-swing absorption (PSA) and/or adsorption	No
DESOTEC	Adsorption to activated carbons	Yes, partial offer: Pipings, compressors, cooling systems etc. were not included
Unison Solutions	Adsorption and/or biological	No
Quadrogen Power Systems Inc.	Cooling, small hydrogen add, hydrodesulphurisation	Yes, total delivery offer
HyGear B.V	Adsorption to activated carbons	Earlier offer to POLITO
BIOKOMP SRL	Adsorption to activated carbons	Earlier offer to POLITO

Sent offer request is shown in following:

VTT Technical Research Centre of Finland Ltd is one partner in the large EU-research project called DEMOSOFC (www.demosofc.eu) which is a new project to the design and installation of an SOFC (Solid Oxide Fuel Cell) plant. SOFC plant will be installed at the Waste Water Treatment Plant (WWTP) in the Turin area and it will generate around 175 kW electric. The DEMOSOFC plant will be the first example in Europe of high efficiency cogeneration plant with a medium size fuel cell fed by biogas.

Use of fuel cells in biogas utilisation is growing field and in the near future we estimate that the number of such plants will increase rapidly due to the need for innovative energy systems with low emissions. Before biogas can be fed to fuel cells, the harmful components for SOFC, such as H_2S and siloxanes, must be removed from it. In this project one aim is to perform survey of commercial biogas cleaning systems and their investment and operational costs to assess the economical feasibility of the whole installation. Therefore, VTT is now asking budget offers for biogas cleaning systems.

The focus is on biogas which is produced from waste water treatment sludge. We are asking offers to three raw biogas capacities which are 50, 100 and 300 Nm^3/h. Pressure of raw biogas is 40 mbar(g).Purified biogas should be compressed to pressure 4 bar(g) and temperature should be between -10 to 40 °C. Purified gas should contain siloxanes < 0.06 $mgSi/m^3$, sulphur (as S) < 0.04 mg/m^3, halogenated compounds < 1 ppm and moisture as non-condensing. Other technical devices, such as blowers, chillers, compressing etc. should be included.

Gas concentrations of raw biogas are as follows:

		Biogas
CH_4	vol-%	62-65
CO_2	vol-%	32-36
H_2O	vol-%	2
Siloxanes L2–L4, as Si	mgSi/m³	3
Siloxanes D3–D5, as Si	mgSi/m³	6
Sulphur compounds, as S	mgS/m³	30
Aliphatic hydrocarbons	mg/m³	120
Aromatic hydrocarbons	mg/m³	8
Aliphatic cyclic hydrocarbons	mg/m³	15
Σ-xylenes	mg/m³	2
Limonene	mg/m³	8
Toluene	mg/m³	8
Halogenated compounds	ppm	1

If you have further questions, do not hesitate to contact us and ask them! Thank you in advance.

Answers to requests

Answers and offers were received from three manufacturers:

1. DETES Umwelttechnik GmbH
2. DESOTEC
3. Quadrogen Power Systems Inc.

5 Results

Received three offers varied a lot from what was included or not included. In the following there are described main points of the offers. Offers are presented in annexes.

1. Quadrogen Power Systems Inc. offered a system which makes biogas purification using following processes according to patent US2013/0209338A1: "Siloxanes, chlorine, oxygen and Sulphur are removed to parts per billion levels as well as removing the majority of water and some volatile organic compounds. The biogas system cools a biogas stream to partially remove contaminants, blends in a small concentration of hydrogen gas and then combusts the remaining oxygen to heat the biogas and leave sufficient hydrogen suitable for a downstream sequence of further contaminant conversion and removal in stages using a hydrodesulphurization bed and adsorbent media beds. Heat exchange arrangements provide efficient recycling of waste heat and compensation for varying levels of oxygen in the incoming biogas waste stream." Schematic of the process is presented in Figure 1.

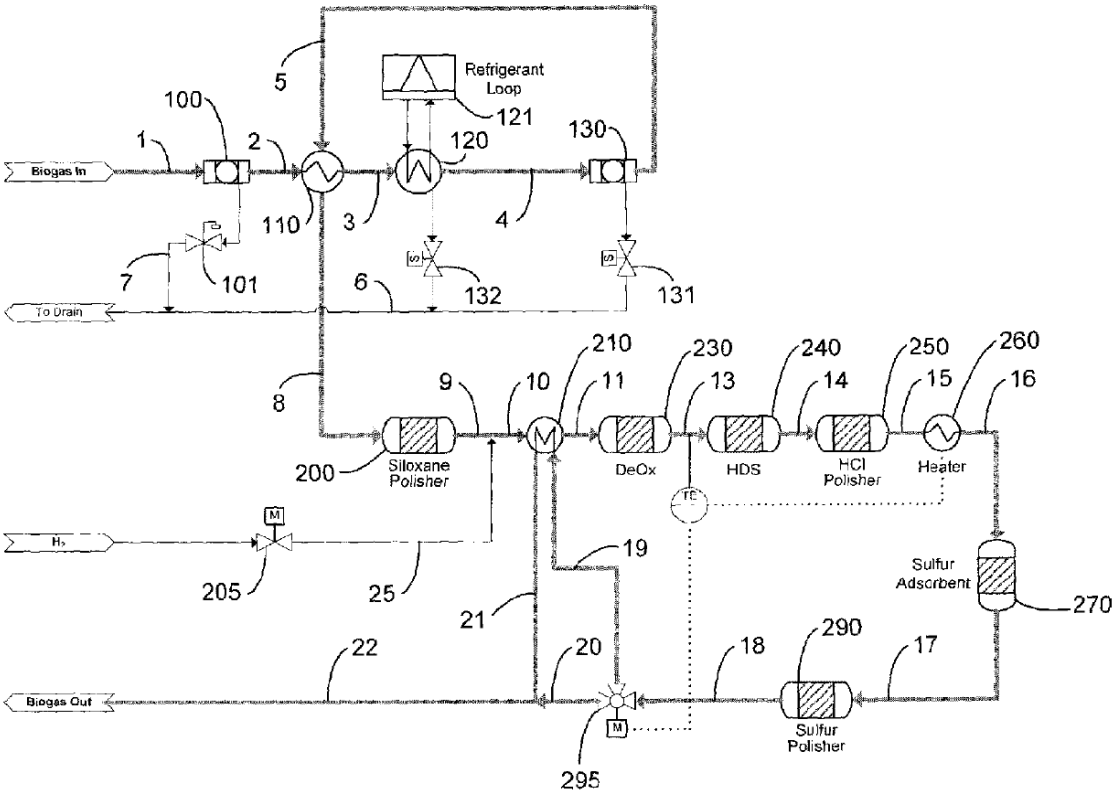

Figure 1. Process schematic of Quadrogen Power Systems Inc. (US2013/0209338A1)

Trace concentrations are removed with hydrodesulphurisation and/or adsorption. During process biogas is also heated up to 400°C. Offer included the whole removal system with pipings etc. Investment and operational costs of two biogas capacities were presented. *The removal efficiencies of siloxanes and sulphur should be measured periodically to ensure needed removal efficiency level.* Brochure of technical details are presented in Annex A.

- Estimated investment cost of removal system called IBCS (300), for capacity 160 Nm^3/h, is about 700000 USD. Price equals to 625 000 €.
- Estimated investment cost of two removal systems called IBCS (300), for capacity 300 Nm^3/h, is about 1300000 - 1400000 USD. Price equals to 1.2 M€.
- Estimated operational costs are from power consumption of 0.10-0.20 kWh/Nm^3 of Feed Biogas. No hydrogen add costs included.

2. DETES Umwelttechnik GmbH sent a partial offer. They offered a system which had removal of Siloxanes and sulphurs with activated carbons. Investment costs of cooling systems were included in the offer. Any other costs were not included in the offer, like carbon prices, pipings, compressors, etc. Only investment costs of adsorption media vessels and blowers for three biogas capacities were presented. Any installation or operational costs were not presented. *The removal efficiencies of siloxanes and sulphur should be measured periodically to ensure needed removal efficiency level.* Brochure and prices are presented in Annex B. Picture of the offered system (blower, cooling and vessel) is presented in Figure 2.

   - Capacity 50 Nm^3/h: Investment cost of filter unit of 200 litres was 22500 €. Blower was 5000 €. Totally 27500 €. Estimated lifetime of activated carbon was 6 months.
   - Capacity 100 Nm^3/h: Investment cost of two filter units of 700 litres was 28500 €. Blower was 8000 €. Cooling system 17000 €. Totally 53500 €. Estimated lifetime of activated carbon was 1 year.
   - Capacity 300 Nm^3/h: Investment cost of filter unit of 3000 litres was 36000 €. Blower was 12000 €. Cooling system 38000 €. Totally 86000 €. Estimated lifetime of activated carbon was 1 year.

Figure 2. Picture of the offered DETES system (blower, cooling and vessel).

3. DESOTEC offered a partial system which had only carbon prices and one vessel. The principle was removal of Siloxane and sulphur with activated carbons. Carbon prices were included in the offer. Pipings, compressors, cooling systems etc. were not included in offer. *The removal efficiencies of siloxanes and sulphur should be measured periodically to ensure needed removal efficiency level.* Brochure of AIRCON 2000 C filter unit and prices are presented in Annex C.
    - Investment cost of Mobile activated carbon filter AIRCON 2000 C was 15000 €. No estimation for expected lifetime of activated carbon.
    - Activated carbon AIRPEL 10-4 for removing VOCs was 2000 €/ton.
    - Activated carbon AIRPEL ULTRA DS-6 M3 for removing sulphur compounds was 3200 €/ton

Since received offers were only three pieces, two offers received from Politecnico di Torino (DEMOSOFC project coordinator) were included into this assessment. At their request the biogas capacity was set to be 60 Nm^3/h. The offers are not presented in this report.

- HyGear B.V offered a system which had removal of ammonia, siloxane and sulphur with adsorption medias. Media prices were included in the offer. Pipings, compressors, cooling systems etc. were all included in offer. Investment costs were presented.

  Operational costs were not presented.
    - Investment cost of removal units were 192000 €.
    - Investment cost of compressor with heat exchanger and enlarged cooling system were 49200 €.
    - System design for ATEX Zone2 (instead of Zone2NE) was 37000 €.

- BIOKOMP SRL offered a system which had removal of siloxane and sulphur with activated carbon medias. Media prices and estimations of operational costs were included in the offer. Dehumification, pipings, compressors, cooling systems etc. were included in an offer. Process chart of the system is shown in Figure 3. Total investment cost was 217050 € according to an offer version 8, dated on 15th April 2016. *The removal efficiencies of siloxanes and sulphur should be measured periodically to ensure needed removal efficiency level.*

  Investment costs were presented. Operational costs were partly presented and therefore electricity consumption was estimated using data given in the offer.
    - Investment cost of the frist part of the system (stazione di recupero) was 36200 € with non ATEX class 2 certified system. This part includes first dehumification, compressing and conditioning of the gas.

- Investment cost of the cleaning system (implianto di trattamento) was 160600 €. This part includes removals of sulphur, siloxanes and particulates. The system includes also compression to 4 bar and second dehumification of the gas.
- Operational costs for activated carbon medias for the first installation were
  - for siloxane removal totally 3500 € (1000 kg*3.5 €/kg)
  - for sulphur removal totally 3750 € (500 kg * 7.5 €/kg)
  - mentioned, that interval of media changes is approximately 6 months, thus annual costs are respectively siloxane 7000 €/a and sulphur 7500 €/a, totally 14500 €/a.
  - media change costs or needed working time were not presented.
  - Electricity consumption can be estimated using power consumption data
- Assistance for installation and operation 10000 €.
- Transportation 3000 €

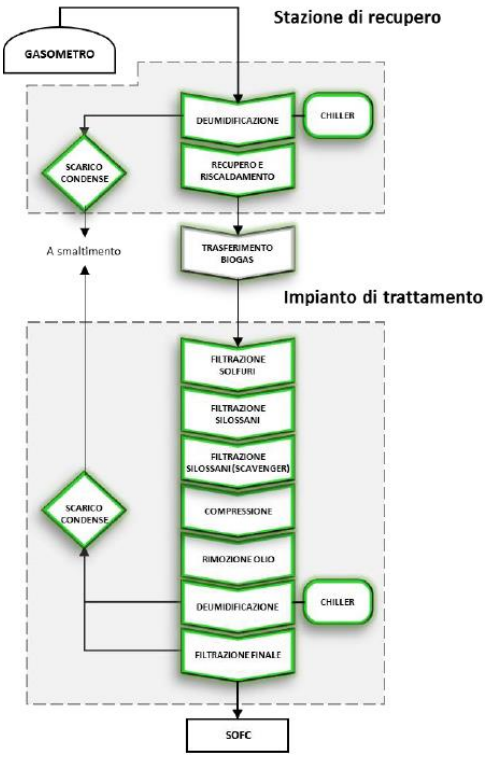

Figure 3. System of BIOKOMP SRL.

6 Summary of costs

Investment costs and annual operational costs are presented in Table 3 and Figures 4 and 5. Annual operation time was estimated to be 8300 hours. Note that offers from DETES and DESOTEC were very incomplete.

Electricity consumption of Quadrogen removal units were calculated by using Italy's electricity price of 0.2 €/kWh (Eurostat 2016), representing annual operational costs of Quadrogen removal unit and presented in Figure 2. Operational costs of activated carbons for DETES and DESOTEC were estimated using following prices:

- According to DESOTEC offer activated carbon for siloxane+VOC removal 2 €/kg and for sulphur removal 3.2 €/kg.
- According to Matsui&Imamura (2010), the removal capacity for siloxane+VOC to activated carbon was estimated to be 17 w-%.
- According to DESOTEC brochure (Annex C, page 4) the removal capacity for sulphur removal of 70 w-% was used.
- Other operational costs were not estimated.

Table 3. Summary of costs. Operational costs were presented only for Quadrogen Power Systems Inc.

	Capacity / m^3/h	50	100	300	50	100	300
	Capacity / kWh_{e+t}	319	637	1911	319	637	1911
Manufacturer	Unit description	Investment costs / k€			Operational costs / k€/year		
Quadrogen	Total delivery, IBCS (300)		625	1 200		33.2	99.6
DETES	Filter unit and cooling system. No pipings etc.	27.5	53.5	86	1.8*	3.5*	10*
DESOTEC	Activated carbon filter unit, AIRCON 2000 C	15			1.8*	3.5*	10*
HyGear B.V	Total delivery	241					
BIOKOMP SRL	Total delivery	217			49		

* = estimated media consumption, media prices according to DESOTEC offer.

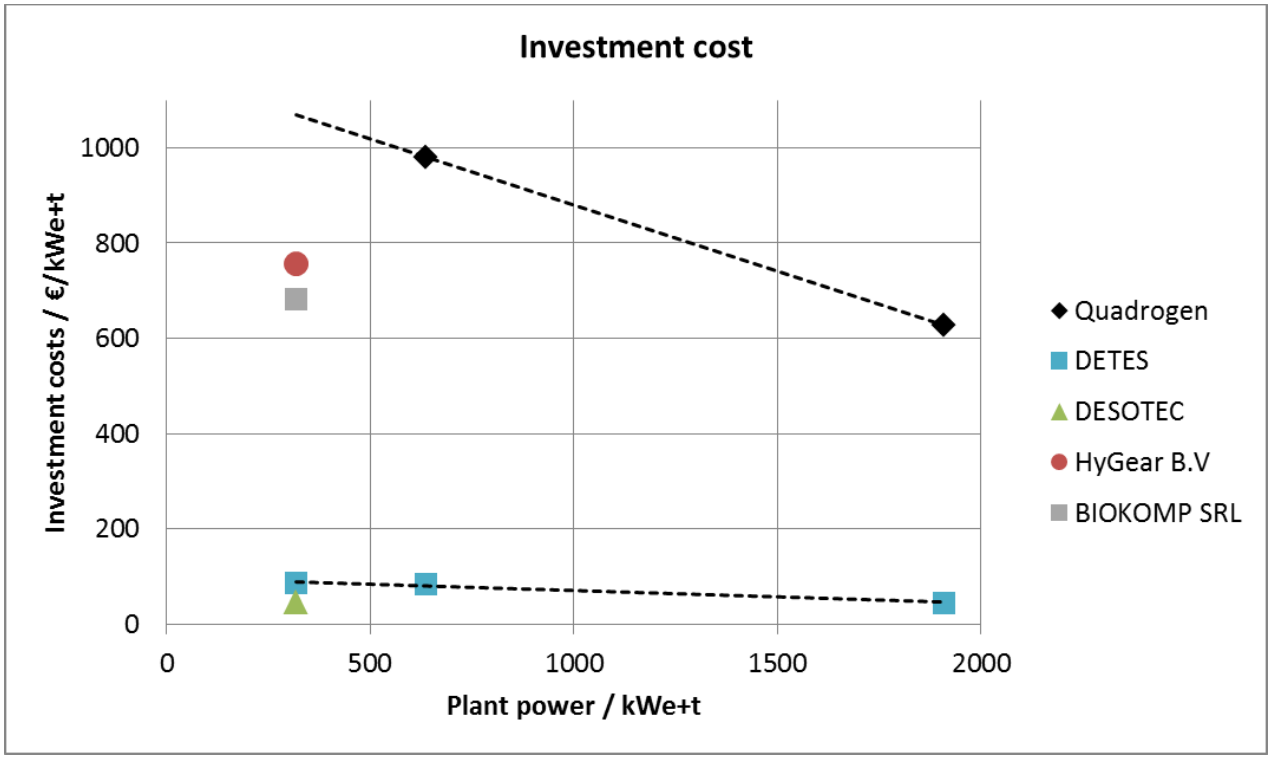

Figure 4. Investment costs related to biogas capacity. Note: only Quadrogen, HyGear and BIOKOMP offered total deliveries, other offers lack components.

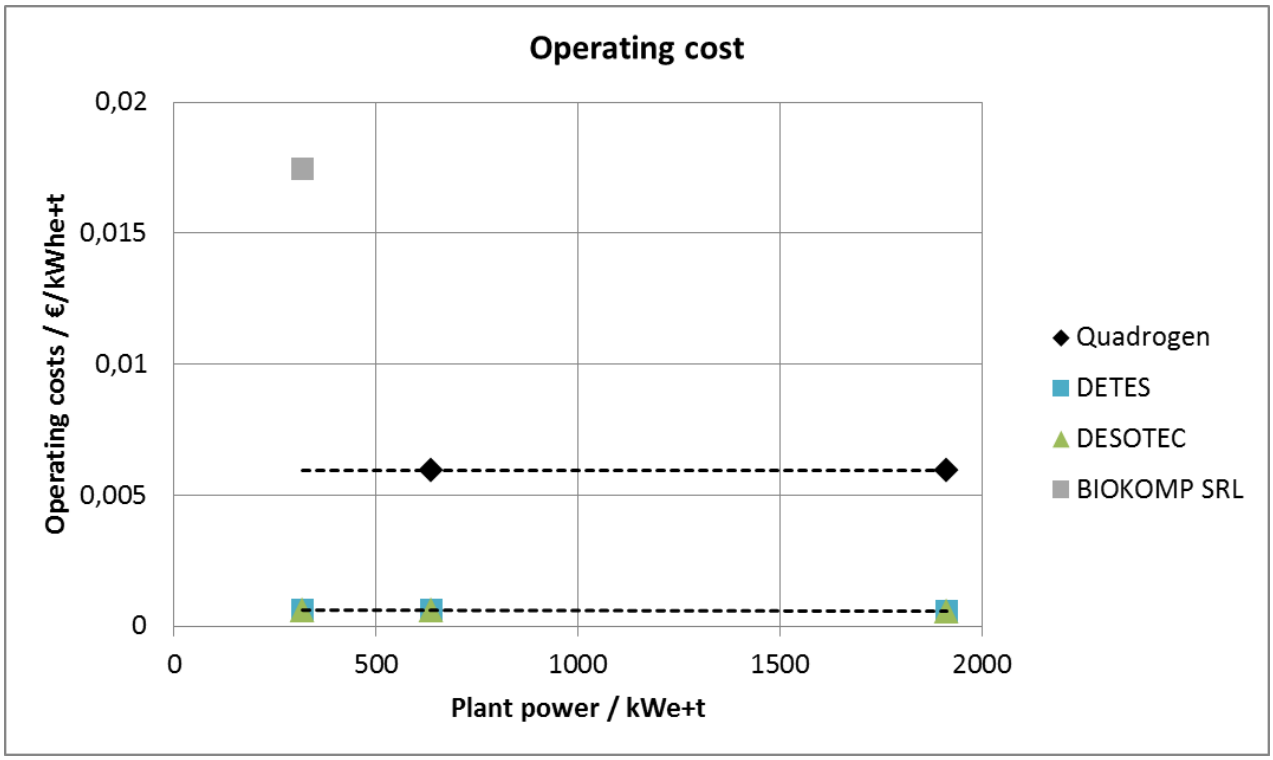

Figure 5. Annual operational costs of Quadrogen removal unit. Note: DETES and DESOTEC include only adsorbents and Quadrogen includes only electricity.

7 References

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Annex A. Quadrogen Power Systems Inc. Brochure of technical details of removal system IBCS 300.

Technical Specifications

	IBCS 300	IBCS 750	IBCS 1500	IBCS 3000
DESCRIPTION				
	Integrated Biogas Clean-Up System			
BIOGAS FEED FLOW RATE				
Nm^3/h (0°C, 101.3 kPa(g)) SCFM (60°F, 14.7 PSIA)	160 Nm^3/h 100 SCFM	765 Nm^3/h 475 SCFM	1530 Nm^3/h 950 SCFM	3060 Nm^3/h 1900 SCFM
COMPATIBILITY WITH FUEL CELL LOAD PRODUCTION*				
	300 kW	1400 kW	2800 kW	5600 kW
POWER CONSUMPTION				
	0.10-0.20 kWh/Nm3 of Feed Biogas			
CLEAN BIOGAS PRODUCT PURITY				
	<50 ppbv siloxanes or undetectable <30 ppbv sulfur species or undetectable <30 ppbv halides or undetectable <50 ppbv oxygen or undetectable <30 ppbv volatile organic compounds or undetectable			
TURNDOWN RANGE				
	25% to 100% of full load			
ENVIRONMENTAL				
Storage Temperature Ambient Temperature Noise dB(A) at 1 Meter	5°C to 60°C (41°F to 140°F) -20°C to 40°C (-4°F to 104°F) <80			
ESTIMATED FOOTPRINT REQUIREMENT				
	12 m x 12 m (40 ft x 40 ft)	23 m x 15 m (75 ft x 50 ft)	23 m x 23 m (75 ft x 75 ft)	30 m x 30 m (100 ft x 100 ft)

**Estimated power output when integrated with a molten carbonate, solid oxide, or phosphoric acid fuel cell.*

Quadrogen offers custom engineered biogas clean-up systems to meet your specific operational requirements. Please contact us to discuss your applications and options available to best fit your needs.

QUADROGEN

Quadrogen Power Systems, Inc.
1160 – 4250 Wesbrook Mall, Vancouver, BC Canada V6T 1W5
T 604 221 7170 F 604 221 3001 www.quadrogen.com

Annex B. DETES Umwelttechnik GmbH.

Estimated costs VTT

[m³/h]	dimension of activated carbon Si [kg] and halogenated	dimension of activated carbon S [kg]	filter unit	Lifetime	price	cooling system	blower	sum
50	200 l	included (2 coals in one filter)	200 l	approx 6 month	22.500,00 €	incl.	5.000,00 €	27.500,00 €
100	700 l	700 l	700 l / 700 l	approx 1 year	28.500,00 €	17.000,00 €	8.000,00 €	53.500,00 €
300	3000 l	included (2 coals in one filter)	3000 l	approx 1 year	36.000,00 €	38.000,00 €	12.000,00 €	86.000,00 €

all prices plus shipping and fittings

DETES Umwelttechnik GmbH, Huellbergstrasse 19, D- 44267 Dortmund

DETES Umwelttechnik Deponie · Bio · Klärgastechnik

detes.com

Compact unit

Kompakt Anlage mit Aktivkohlefilter 75 kW

2 x 700 l

3000 l

1-Kammer-System

Annex C. DESOTEC.

AIRCON® 2000 C

AIRCON® 2000 C

Features

The use of mobile adsorption systems has several advantages:

- Just connect and start
  - Rapid and easy site installation
  - Quick connections
- No on-site carbon handling
  - Combined transport vessel and filter
  - Can be used with other media
- Available on a rental base, without investment cost
  - Daily contracts
  - No maintenance costs
- Possibility to test and evaluate new applications without capital investment
- Efficient design (low pressure drop)
  - Installation in series or parallel is possible

Description

The **AIRCON® 2000 C** is a mobile interchangeable adsorption filter, specially developed for the treatment and purification of air and gases.

The **AIRCON® 2000 C** is a combined transport and adsorption vessel that can be temporarily or semi-permanently installed into the process giving the advantage of no on-site media handling.

The **AIRCON® 2000 C** is prefilled with a selected media and then delivered to the customer's site ready for use and can easily be moved by forklift. The frame of the filter allows it to be placed on a flat and hard surface.

The **AIRCON® 2000 C** comes complete with piping, valves and connections suitable for immediate connection to the stream to be treated. The filter is normally connected with flexible hosing and is used up-flow.

The **AIRCON® 2000 C** is used in a simple and economical way as single filter or in series or in parallel for the treatment and purification of air and gases. The outlet can be provided with a vent cap (anti-rain).

When the **AIRCON® 2000 C** is saturated or the treatment objective is reached, it is taken off-line to exchange the entire filter by another unit, filled with fresh media. This eliminates the need for spent media disposal by the user and minimises manipulation and transport costs. Once the mobile filter is returned to **DESOTEC**, it is discharged of spent media, cleaned, checked and refilled with the required product.

The **AIRCON® 2000 C** can be used on-site for industrial air and gas purification applications such as deodorisation, solvent removal, tank venting, industrial gas and exhaust treatment.

DESOTEC recycling services

DESOTEC ACTIVATED CARBON supplies products, such as activated carbon and other filtration media, that are used to remove a wide range of molecules from liquids and gases by processes such as adsorption, chemisorption,... Once the supplied products are saturated, or the treatment objective is reached at customers' site, it is named 'spent product'. As part of DESOTEC's complete service package, we offer several recycling or treatment options:

1. Recycling of spent activated carbon by thermal reactivation
2. Energy valorisation of spent activated carbon or other carbonaceous media
3. In the rare event that spent material cannot be reactivated or the energy cannot be valorised, DESOTEC assures the proper elimination of the spent material.

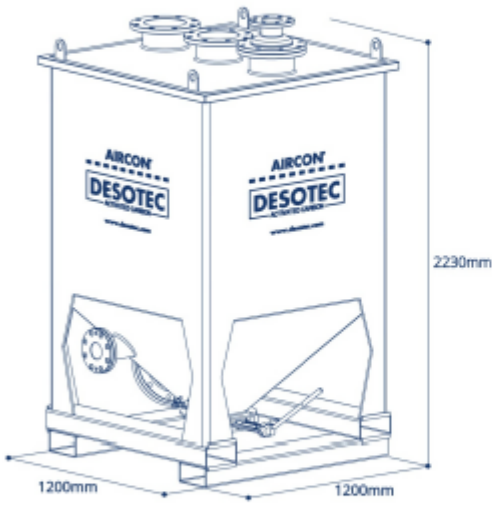
The recycling option depends on the nature of the spent product. Prior to anything, DESOTEC will analyse the process data and the spent product sample supplied by the user, to advise and select the most cost effective and environmentally friendly solution.

www.desotec.com

Pressure drop

For the treatment of air and gases, extruded activated carbon is normally used. For the calculation and the prediction of this pressure drop, use the pressure drop graph (on request). The pressure drop depends on the pellet size, the viscosity of the fluid and the design of the filter itself and is only to be used as a guideline

Typical lay-out



AIRCON® 2000 C

Technical description

Flow rate (Range) (m³/h)	65-650
Temperature* (Max.) (°C)	40
Pressure (Max.) (mbarg)	100
Vacuum (Max.) (mbarg)	50
Useful volume (Max.) (m³)	1.7
Vessel - Total volume (m³)	1.9
Material of construction	SS304
Vessel coating	None
Gaskets	Not applicable
Piping material	Not applicable
Connections - Inlet	DN 100 - PN10 flange
Connections - Outlet	DN 100 - PN10 flange
Connections – Drain valve	2 x ½" Ball valve
Inlet sampling	Not applicable
Outlet sampling	Not applicable
Dimensions (HxWxL) (m)	2.3 x 1.2 x 1.2
Clearance height (Min.) (m)	2.5
Drained weight (Max.) (T)	2.1
Floor weight (Max.) (T)	3.3

(*) The unit should be insulated when operating above 40°C to comply with the CDM regulation.

DESOTEC reserves the right to change specifications without notice.

Safety

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing activated carbon, appropriate sampling and work procedures including local requirements for potentially low-oxygen spaces should be followed.

For certain classes of chemicals, reaction or adsorption on the activated carbon surface can be accompanied by the release of a large amount of heat, which may cause hot spots in the carbon bed. In the unlikely event of a hotspot or bed fire, it is recommended to inert the bed with a gas such as nitrogen.

Description	Packing	Quantity	Unit price	Price
-> For removal of VOC:				
Activated carbon AIRPEL 10-4	BB 500 kg	1.000 kg	2,000	2.000,00 EUR
Take-back of the used product not included.				
Invoice following weight ticket				
OR :				
Activated carbon AIRPEL 10-4	Bag 20 kg	1.000 kg	2,000	2.000,00 EUR
Take-back of the used product not included.				
-> For removal of S:				
Activated carbon AIRPEL ULTRA DS-6 M3	BB 500 kg	1.000 kg	3,200	3.200,00 EUR
Take-back of the used product not included.				
Invoice following weight ticket				
OR :				
Activated carbon AIRPEL ULTRA DS-6 M3	Bag 20 kg	1.000 kg	3,200	3.200,00 EUR
Take-back of the used product not included.				
-> Activated carbon Filter :				
Mobile activated carbon filter AIRCON 2000 C		1 pce(s)	15.000,000	15.000,00 EUR
-> this is a budget price				
Transport organized by the customer		1 tp		

The above mentioned prices are net prices (VAT excluded)
Subject to approval of our credit insurance.
According to our general conditions in attachment.
E-mail address for orders: logistics@desotec.com

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ADSORPTION ON THE MOVE

DESOTEC ACTIVATED CARBON

AIRPEL® ULTRA DS-6

AIRPEL® ULTRA DS-6 is an extruded impregnated activated carbon with enhanced adsorption capacity for H_2S, SO_2, mercaptans and acid compounds especially developed for air and gas purification applications. **AIRPEL® ULTRA DS-6** is produced by steam activation from selected grades of anthracite coal, ensuring a constant quality and high hardness, and is then impregnated with selected specific chemicals for an excellent chemisorption capacity for the targeted application. The product is designed for fast adsorption kinetics and high sulphur loading capacities. Under the correct operating conditions sulphur loadings of over 70% W/W, for H_2S removal, can be achieved.

Applications

AIRPEL® ULTRA DS-6 is used in a wide range of applications. These applications include

- H_2S removal from gases such as
  - Air
  - Biogas
  - Underground stored natural gas

The hydrogen sulphide removal capacity of an activated carbon depends on the operating conditions in which the product is used e.g.:

- Molar ratio of H_2S to O_2;
- Temperature;
- Operating pressure;
- Relative humidity;
- Activated carbon type;
- And other operating parameters.

Please contact one of our specialists to help you select the most cost effective product and operating conditions for your application.

Properties

Specifications		
Particle size (mm)	3	4
Sieve analysis*		
>3.35mm (Min.) (%)		93
>2,36mm (Min.) (%)	93	
Typical values		
Bed density** (kg/m³)	560	
Sulphur loading*** (% W/W)	70	
Hardness* (%)	96	

(*) Base material
(**) Bed density is used for adsorber sizing
(***) H_2S removal under the correct operating conditions
DESOTEC reserves the right to change specifications without notice.

DESOTEC recycling services

DESOTEC ACTIVATED CARBON supplies products, such as activated carbon and other filtration media, that are used to remove a wide range of molecules from liquids and gases by processes such as adsorption, chemisorption,... Once the supplied products are saturated, or the treatment objective is reached at customers' site, it is named 'spent product'. As part of DESOTEC's complete service package, we offer several recycling or treatment options:

1. Recycling of spent activated carbon by thermal reactivation
2. Energy valorisation of spent activated carbon or other carbonaceous media
3. In the rare event that spent material cannot be reactivated or the energy cannot be valorised, DESOTEC assures the proper elimination of the spent material.

The recycling option depends on the nature of the spent product. Prior to anything, DESOTEC will analyse the process data and the spent product sample supplied by the user, to advise and select the most cost effective and environmentally friendly solution.

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ISO 9001 BUREAU VERITAS Certification