RENEWABLE ENERGY SOLUTIONS

A range of biogas- / Landfill- treatment products manufactured by Parker Hiross Zander Division

The biomass market in Europe is expanding as governments invest in renewable energy generation. The EU Commission has set a target to produce 21 % of electricity from renewable energy by 2010. More than 80 % of this increase will come from biomass.

Bio-energy refers to renewable energy coming from biological material such as trees, plants, manure, waste... Biogas is available from any organic material:

- landfills
- wastewater treatment plants
- agriculture and livestock operations
- organic industrial waste treatment plants
- separated municipal solid wastes
- gasification of biomass residues

Biogas is produced when bacteria decompose biological matter in an anaerobic environment (no oxygen is present).

The decay of biomass produces a gas that can be used as an energy source. The products include gas with 45 to 80 percent methane content.
Biogas is primarily composed of:

- methane (CH_4)
- carbon dioxide (CO_2)
- small amounts of hydrogen sulphide (H_2S) and ammonia (NH_3)

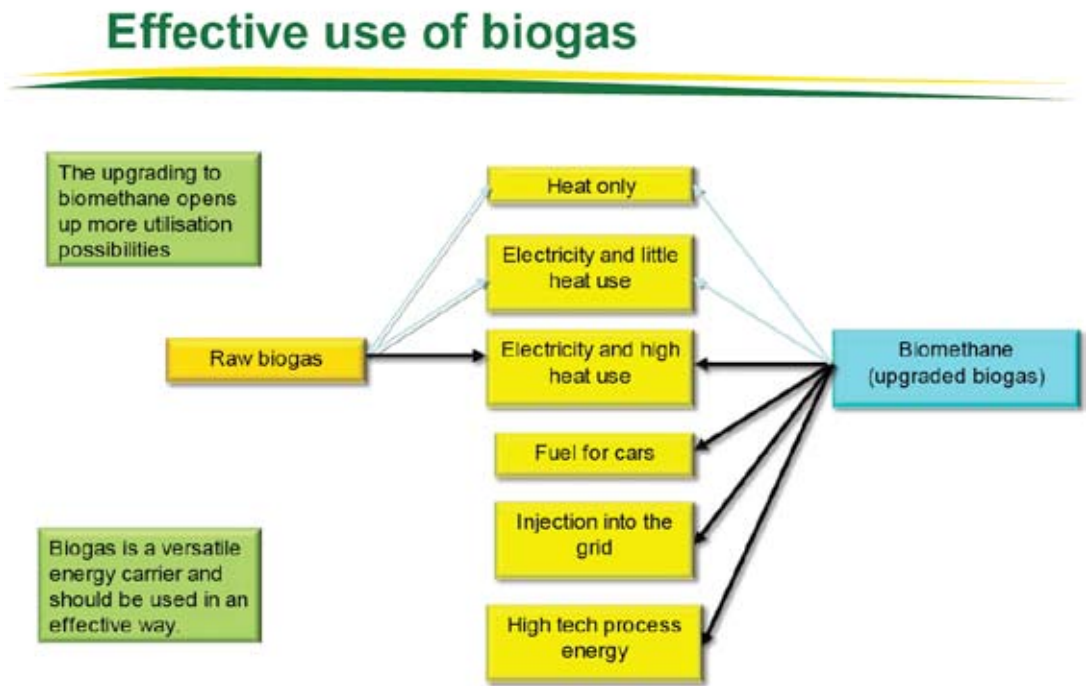
Trace amounts of other gases like hydrogen (H_2), nitrogen (N_2) or carbon monoxide (CO) are also present in the biogas. The mixed gas is saturated with water vapour and may contain dust particles. For biogas as a fuel, most of the impurities have to be removed as they cause corrosion, deposits and damage to equipment.

Substances which need to be removed include:

- hydrogen sulphide
- water
- CO_2
- halogen compounds (chlorides, fluorides)
- siloxanes
- aromatic compounds

APPLICATIONS

Gas Production Flow Process



The above flow diagram shows the effective upgrading of raw biogas taken from production point to the final user.

To satisfy the wide range of requirements for biogas treatment, Parker Hiross Zander supply a complete range of filter housings and high efficiency filter elements in stainless steel and other corrosion resistant materials, as well as a choice of biogas treatment components which enable the gas to be cleaned, dried and upgraded to meet with a wide range of applications, such as cogeneration, gas-network injection and for use as an alternative fuel for vehicles.

Application - Digester Gas

Anaerobic digestion involves converting organic materials such as animal waste and food processing waste into what is known as digester gas, or biogas. The waste material is put into an airtight container, called a digester, where temperature, pH levels and the amount of time spent in the container are closely monitored. The waste is then decomposed and broken down into smaller molecules. The decomposed matter is converted to organic acids.

Finally, the acids are converted to digester gas. The gas can then be used as an energy source for various process components such as engines and turbines, or can be stored for future use.

The Problem
Once the waste material has been placed in the digester, mixed, and converted to gas, the resultant gas will contain impurities generated by and left over from the actual digestion process. These impurities include water, condensed gas liquids, hydrocarbons, and acid gas which must be removed prior to transport, for usage or simply for storage. Unfiltered gas leads to:

- Engine damage
- Fouling in gas scrubbers, valves and other instrumentation equipment

The Solution
The gas coming off the digester should be treated prior to entering a gas receiver to eliminate contaminants generated by digestion. Gas leaving the digester should be treated to remove any particles and moisture carried over from the process. A coalescing filter or separator is recommended prior to the gas-engine. Additionally adsorption dryers may be required for special applications where the gas is to be injected into the national or local network.

Application - Landfill Gas

Landfill waste decomposes and produces what is known as landfill gas. This gas is composed mainly of methane and carbon dioxide, with small amounts of other gases, organic (non-methane) and inorganic compounds. Furthermore it may contain more than 500 different contaminants such as halogenated hydrocarbons and aromatic components. Landfill gas has proven to be a reliable energy source for both industrial and residential use, and its conversion reduces greenhouse gas emissions, pollution and energy costs.

Landfill gas that is otherwise released to the atmosphere is a significant source of greenhouse gas emissions due to its methane content. Collecting the gas and converting the methane to carbon dioxide greatly reduces greenhouse gas emissions.

Landfill gas is collected in underground wells, brought to the surface and compressed before being sent out for resale and delivery.

The Problem
Landfills are naturally dirty and retain particulate and moisture. Temperature changes increase the amount of condensate at both the heat exchanger outlet and gas collection point. Inadequate filtration of the gas produced will lead to:

- System compressor damage
- Heat exchanger fouling
- Unpleasant odours
- Safety hazards and other problems at energy usage sites

The Solution
Treatment of collected landfill gas entering into the compressor will eliminate particles, moisture and aerosols, such as aromatic compounds and halogenated hydrocarbons that could otherwise damage downstream equipment. A coaleser should be placed downstream of the heat exchanger to collect any compressor lube oil and condensed liquids.

RAW BIOGAS TREATMENT

Range of biogas treatment supplied by Parker Hiross Zander

- Filters
- Cooling and chilling packages
- Condensate drains
- Gas drying and dehydration packages, utilising TSA and PSA technology
- Removal systems for siloxanes, H_2S, NH_3, HHC from biogas/ landfillgas
- Fuel, associated gas and natural gas purification systems
- High Pressure compressed gas filters
- Instrument air packages

FILTERS FOR BIOGAS APPLICATIONS

Parker Hiross Zander offer an array of filters sized to handle gas flows up to 50,000 Nm^3/h and several media choices to meet gas application demands for digester -, sewage -, and landfill gas. Systems for the treatment of natural gas and coal-mine gas are also available.

Approval compliant filter housings are constructed from carbon steel or stainless steel.

Particle and Aerosol Removal

- capacity up to 50,000 Nm^3/h, depending on pressure
- operating pressure 100 mbar - 100 bar
- a wide-range of filter element configurations available
- ATEX approved
- PED, GOST, ASME, SQL etc. Pressure vessel codes

Filter Types

- Water separation
  utilising element series S, PL12, PL25, PL12NX, Pl25NX
- Aerosole and solid particle removal
  utilising element series C, CF, CSF

BIOGAS DEHUMIDIFICATION (CONDENSATION)

Biogas from anaerobic digestion is commonly saturated with water, 35 – 100 g/m^3, which is dependent on the saturation point at different temperatures. Inadequate water removal can result in corrosion damage to delivery pipes and components. As an additional effect, removing humidity will also reduce the concentration of sulphur as well as many other dissolved substances. CHPs (Cogeneration Heat Power) require gas-dehumidification which results in lower operating costs and more reliable operation.

Parker Hiross Zander provide the technology for cost effective cooling, incorporating water- or air-cooled heat exchangers, demister separators and refrigerant chillers.

Cooling utilising Parker Hiross-Zander Solutions:
WFS350 cooler SFH390 separator ICE150 Bio-energy Chiller

Land-fill application in Italy

AIR AND WATER COOLED HEAT EXCHANGERS

Cooling utilising Parker Hiross-Zander Solutions:
WFS350 cooler SFH390 separator ICE150 Bio-energy Chiller

WFB shell & tube coolers

- Stainless steel ribbed tubes
- Std 1800 mm length
- High efficiency system
- Low pressure drops design

AIR AND WATER COOLED HEAT EXCHANGERS

refrigerant model	technical data gas flow		refrigerant connections		dimensions (mm)			refrigerant weight
	m^3/h	m^3/min	gas	water	A	B	C	(kg)
WFB120	120	2	DN125	1“	1800	100	133	71
WFB170	170	2,8	DN150	1“	1800	100	168,3	86
WFB220	220	3,7	DN150	1“	1800	100	168,3	92
WFB300	300	5	DN150	1 ¼“	1800	125	193,7	110
WFB500	500	8,3	DN200	1 ¼“	1800	125	273	150
WFB700	700	11,7	DN250	1 ¼“	1800	125	323,9	209
WFB1000	1000	16,7	DN300	1 ½“	1800	125	323,9	259
WFB1300	1300	21,7	DN350	1 ½“	1800	125	355,6	298
WFB1600	1600	26,7	DN350	2“	1800	125	375	333
WFB2000	2000	33,3	DN450	2 ½“	1800	150	457	480
WFB2400	2400	40	DN500	DN100	1800	200	508	600
WFB2800	2800	46,7	DN600	DN100	1800	200	610	890

Performances refer to models operating with clean coolers, gas flow at 20 °C/ 1 bar g. Nominal working conditions: 60 % CH4, 35 % CO2, 5 % other gases, working pressure 0,2 bag g, gas inlet water content 48 g/Nm³, gas inlet temperature 65 °C, water inlet temperature 1 °C, gas outlet temperature 4 °C.

SFB demister separator

- Double stainless steel demister
- High efficiency system separator
- Low pressure drops design
- Easy removable demister

AIR AND WATER COOLED HEAT EXCHANGERS

separator model	technical data gas flow		gas connections		dimensions (mm)			separator weight
	m^3/h	m^3/min	inlet	outlet	A	B	C	(kg)
SFB120	120	2	DN125	DN50	785	191	133	35
SFB220	220	3,7	DN150	DN100	932	212	168,3	42
SFB300	300	5	DN150	DN125	936	214	193,7	58
SFB500	500	8,3	DN200	DN150	1422	285	273	105
SFB700	700	11,7	DN250	DN200	1609	285	323,9	140
SFB1000	1000	16,7	DN300	DN200	1610	285	355,6	180
SFB1600	1600	26,7	DN350	DN250	1880	305	457	240
SFB2000	2000	33,3	DN450	DN300	2130	355	508	310
SFB2400	2400	40	DN500	DN350	2335	390	609,6	400
SFB2800	2800	46,7	DN600	DN400	2155	415	609,6	435

Performances refer to models operating with clean separators, gas flow at 20 °C/ 1 bar g. Nominal working conditions: 60 % CH4, 35 % CO2, 5 % other gases, working pressure 0,2 bag g, gas inlet water content 48 g/Nm³, average pressure drop 2 kPa.

CONDENSATE DRAINS

HDF condensate drain

- Large capacity drain
- No electrical wiring and no gas loss
- Low pressure design
- Corrosion resistant coating

drain model	construction materials			technical data						dimensions (mm)			weight
				gas flow		connections		max pressure	power supply				
	housing	float	lever	m^3/h	m^3/min	inlet	outlet	bar g		A	B	C	(kg)
HDF220	aluminium	plastic	plastic	15.000	250	1"		1	-	266	111	108	1,9

BIOGAS CHILLING SYSTEMS

Cooling with Hyperchill

Model Ref: ICE, water chiller, Bio-energy version

- Hyperchill range and features
- Epoxy coating on all exposed copper parts against aggressive ambient conditions
- Corrosion resistant coating to all external & internal areas against aggressive ambient conditions

Chiller model		ICE007	ICE010	ICE015	ICE022	ICE029	ICE039	ICE046	ICE057	ICE076	ICE090	ICE116	ICE150	ICE183	ICE230	ICE310	ICE360
Cooling capacity [1]	kW	7	9,5	14,3	21,8	28,1	38,2	45,2	56,4	76,2	90,2	115,5	149,2	182,3	225,1	305,1	359,7
Comp. abs. power [1]	kW	2	2,3	3,4	5,2	5,7	7,7	10,1	12,3	15,4	20,3	24,9	30,8	40,1	51,1	64,2	81,5
Cooling capacity [2]	kW	5,2	7	10,6	16,2	20,8	28,4	33,8	42,1	56,5	67,1	86,4	110,9	135,4	163,2	220,8	259,1
Comp. abs.power [2]	kW	1,7	2,2	3,2	4,5	6	8,2	11	13,1	16,4	21,1	25,8	33,5	42,1	54,1	66,2	83,7
Controller		microchiller		pCO xs						pCO small			pCO medium				
Protection class	IP	44		54													
Compressors																	
Type		hermetic, piston		hermetic compliant scroll													
Compressors/circuits		1/1								2/2			4/2				
Max. abs. power - 1 compr.	kW	1,8	3	2,9	6,9	7,8	11,1	13,7	16,8	11,1	13,7	16,8	11,1	13,7	16,8	23,3	28,7
Axial fans																	
Quantity		1					2			3			2		3	4	
Max. abs. power - 1 fan	kW	0,1	0,1	0,61	0,61	0,78	0,61	0,61	0,61	0,78	0,78	0,78	2	2	2	2	2
Air flow	m³/h	4400	4100	7100	6800	9200	12400	12000	17400	25500	25000	26400	47000	46000	66000	88000	88000
Pump P30 (standard on ICE007-230, optional on ICE310-360)																	
Type		peripheral		centrifugal													
Max. abs. power	kW	0,78	0,78	1,04	1,34	1,34	1,34	2,35	2,35	1,85	2,24	2,24	4	4	4	7,5	7,5
Water flow (nom/max) [1]	m³/h	1,3/3	1,5/3	2,3/6	3,5/9,6	4,5/9,6	6,3/9,6	7,6/18	9,3/18	13/18	15/26	19/27	35/50	30/50	38,7/48	52,5/90	61,9/90
Head pressure (nom/max) [1]	mH_2O	35/8	31/8	29/21	28/17	27/17	24/17	28/22	27/22	26/22	28/16	25/16	34/20	32/20	28/21	34/21	31/21
Water flow (nom/max) [2]	m³/h	0,9/3,0	1,0/3	1,6/6	2,4/9,6	3,2/9,6	4,5/9,6	5,5/18	6,7/18	9,0/18	11,0/26	13,4/27	18/50	22,1/50	28,1/48	38/90	44,6/90
Head pressure (nom/max) [2]	mH_2O	42/8	39/8	30/21	29/17	28/17	27/17	28/22	28/22	27/22	32/16	30/16	36/20	35/20	32/21	35/21	35/21
Pump P15																	
Max. abs. power	kW	0,48	0,48	0,3	0,45	0,75	0,75	0,75	0,75	1,1	1,1	1,1	1,5	1.5	2,2		
Water flow (nom/max) [1]	m³/h	1,3/2,4	1,5/2,4	2,3/4,2	3,5/7,2	4,5/18	6,3/18	7,6/18	9,3/18	12/25	15/25	19/44	25/44	30/44	39/48		
Head pressure (nom/max) [1]	mH_2O	23/6,0	20/6,0	18/10	18/7,0	17/10	16/10	16/10	15/10	15/8,0	15,8/0	13/6,0	12/6,0	10/6,0	14/9,0	on request	
Water flow (nom/max) [2]	m³/h	0,9/2,4	1,0/2,4	1,6/4,2	2,4/7,2	3,2/18	4,5/18	5,5/18	6,7/18	9,0/25	11,0/25	13/44	18/44	22/44	28/48		
Head pressure (nom/max) [2]	mH_2O	30/6,0	27/6,0	18/10	20/7,0	17/10	17/10	17/10	16/10	16/8,0	16/8,0	13/6,0	11/6,0	12/6,0	20/9,0		
Dimensions & weights																	
Depth	mm	980	980	1100	1100	1650	1650	1650	2200	2200	2200	2200	3000	3000	3260	4200	4200
Width	mm	540	540	750	750	750	750	750	750	890	890	890	1290	1290	1280	1500	1500
Height	mm	1260	1260	1390	1390	1390	1390	1390	1390	1970	1970	1970	2280	2280	2270	2240	2240
Connection in/out	in	1"	1"	1 1/4"	1 1/4"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	2"	2"	2"	2 1/2"	2 1/2"	2 1/2"	4"	4"
Tank capacity	l	45	45	120	120	180	180	250	300	500	500	500	1000	1000	1000	400	400
Weight [3]	kg	170	180	250	270	380	410	430	520	800	900	1000	1500	1800	2100	2900	3100
Noise level																	
Sound pressure [4]	dB(A)	53	53	50	50	53	52	52	56	58	58	58	62	62	64	65	65

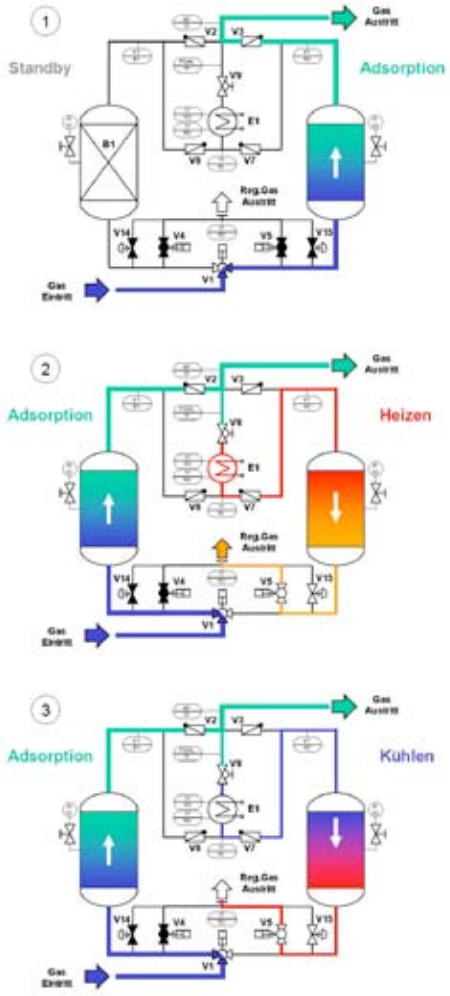
1) Data refers to inlet/ outlet temperature 20/15 °C, glycol 0 %, ambient temperature 25 °C
2) Data refers to inlet/ outlet temperature 12/7 °C, glycol 0 %, ambient temperature 32 °C
3) Weights are inclusive of pallet and refrigerant charge
4) In free field conditions at a distance of 10 m from unit, measured on condenser side.
All models supplied with R407c. Power supply:400 V / 3 ph / 50 Hz.

BIOGAS AS BIOMETHANE

Bio-methane for network injection

Drying, Condensation and partial Purification

Some upgrading processes require relatively dry biogas, e.g. biogas has to dry prior to network grid injection. Parker Hiross Zander offers technical solutions for drying and partial purification.



Desiccant Dehydration

Adsorption drying agents are used to capture moisture

- Regenerative System for normal Pressure Applications
- Twin Tower Design: one tower is actively used for drying whilst the other is regenerated
- No down time during changeover between adsorption and regeneration
- Operation - 24-7
- Maximum gas output
- Fully automatic, electronically controlled regeneration cycles
- Lower energy requirement
- Various adsorbent materials available
- Various flash-gas sources possible

Pressure Swing Adsorption utilizes the properties of the varying affinities of gases for a given solid surface to separate a mixture of gases. Usually very porous materials are selected as adsorbents, providing large enough surfaces to adsorb significant amounts of gas. Adsorbents typically used are silica gels, activated aluminas and activated carbon. Specialty adsorbents, for instance zeolites and molecular sieves adsorb gases based on the size of their molecules.
In general, the greater the pressure, the more gas is adsorbed, reducing the pressure releases or desorbs the gas. When the adsorbent bed is saturated, the pressure is reduced to release the adsorbed moisture, preparing the bed for another cycle.

Regeneration with heated flash-gas

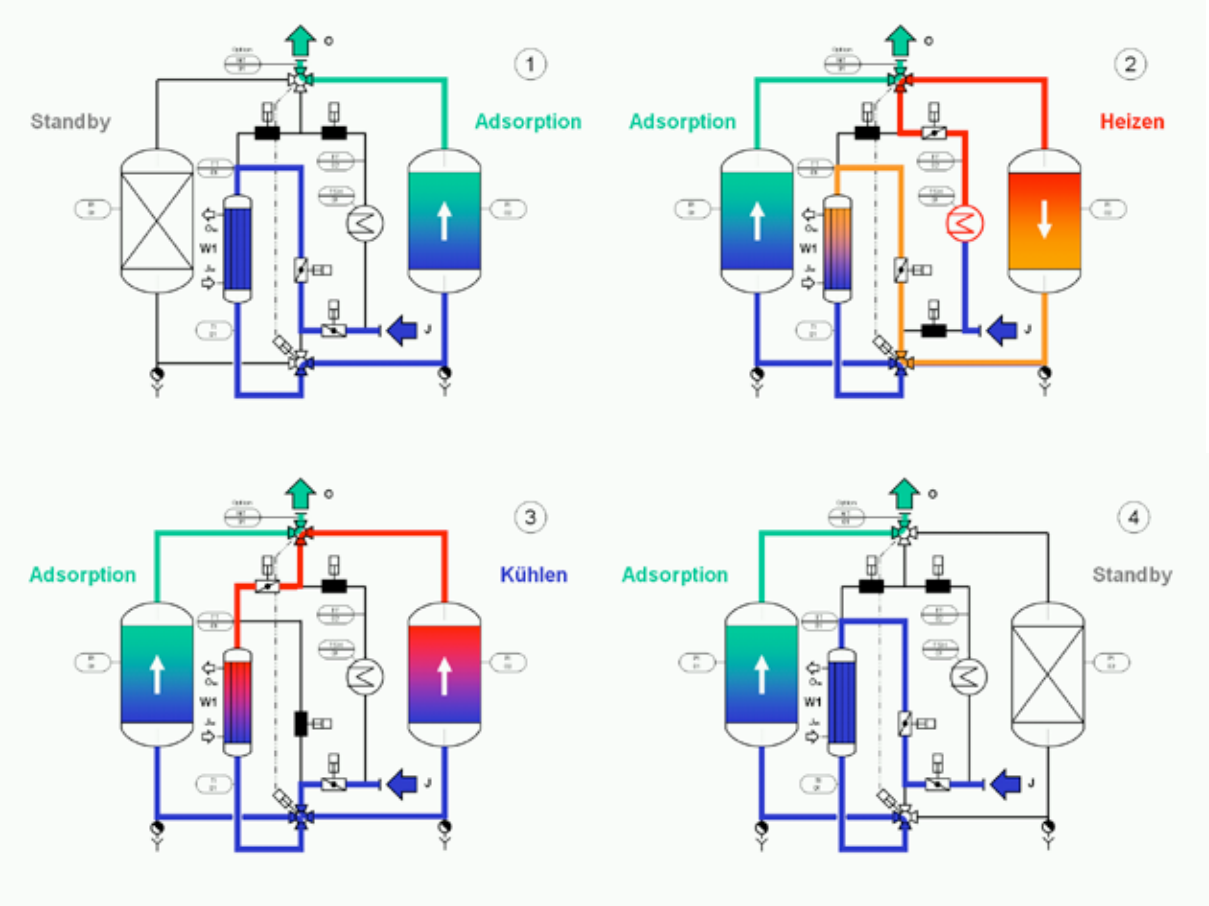
W120ES
Regeneration without gas losses.

The following examples demonstrate how Hiross Zander drying units have been successfully sold into various gas-upgrading applications.

Hiross Zander Model Ref: W920DL

Hiross Zander Model Ref: W920DL

Type “W”-dryer with process gas regeneration. This principle represents a zero loss process, using methane as flash-gas



Modular and turn-key solutions manufactured by Hiross Zander

Parker Hiross Zander is a leading supplier of efficient gas drying components for drying biogas without gass-loss. Using proven techniques developed in house, constant gas quality is guaranteed. Hiross Zander biogas drying plants are modular in design, allowing individual and flexible gas treatment solutions ranging from 500 m³/h up to 18000 m³/h.

TREATMENT OF LANDFILL GAS

Besides different contaminants such as aromatic compounds and halogenated hydrocarbons Land-fill gas or even the digestion of sewage sludge may also contain siloxanes. Siloxanes are volatile silicones bonded by organic radicals. Volatile silicones can be found in products such as cosmetics, deodorant, water-repelling coatings, food additives, soaps, lotions and plastics. When disposed of in a landfill, the siloxanes volatize into the landfill gas contaminating it. This contamination can be observed in problems with downstream systems and equipment.

Why Siloxane Removal?

Sil-ox-ane
sil(icon) – ox(ygen) – (alk)ane

When landfill gas combusts inside a boiler, engine or turbine the siloxanes are converted into Silicon Dioxide (SiO2), which is deposited onto the internal surfaces of the combustion chamber and exhaust.

These SiO2 deposits:

- significantly increase maintenance costs and downtime,
- reduce engine efficiency over time,
- Quickly block and cause failure of downstream catalysts making it
  difficult to meet CO emissions standards

As a result of this, engine, turbine & fuel cell manufacturers are imposing strict limits on allowable levels of siloxanes in fuel gas.

Siloxane Removal Methods

- **Deep Refrigeration** – Energy intensive, complicated process, high initial capital cost, delivers gas at low temperature which is not good for gas engines / does not drop out all siloxanes.
- **Cooling** – High market penetration in Europe./ pre-drying and partial purification of VOCs/ Siloxanes. / Necessary prior to carbon bed adsorption.
- **Carbon bed** – Extremely effective, no energy required, simple process, low initial capital cost. Carbon has limited life and must be changed at intervals depending upon gas quality.
- **Adsorption technology** – Adsorption using Activated Adsorbents
  Highly effective regenerative technology based on the removal of siloxanes utilizing different adsorbents.

Parker Hiross Zander SILOXANE REMOVAL SYSTEM

Based on Adsorption technology:

Removal of organic compounds such as siloxanes

The Parker Hiross Zander Siloxane Removal System consists of three primary treatment stages:

0.01 Micron Coalescing Bio-gas Pre Filters

- Removes virtually all solid, liquid and aerosol contaminants to protect the media beds.

Twin tower regenerative adsorption system

- Removes siloxanes (and water vapour).

1 Micron Dry Particulate After Filter

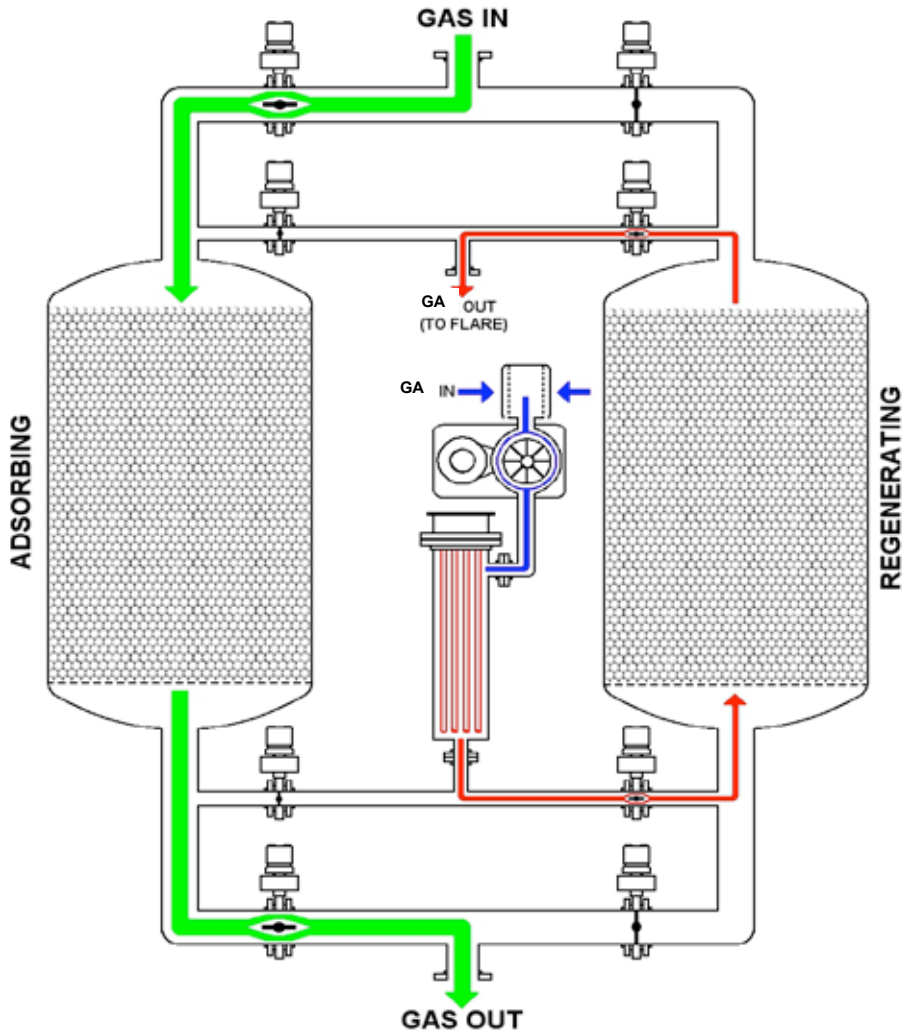
- Removes any solid particles which separate from the adsorbent media.

Principle

Two towers in parallel, filled with a blend of proprietary medias which remove siloxane through adsorption.

While one tower separates siloxane from the gas stream, the other regenerates, purging the collected siloxane to a flare or thermal oxidizer.

The system operates automatically and continuously on an adjustable cycle, with no disruption to the gas flow.



ALTERNATIVE FUELS

COMPRESSED NATURAL GAS

Gas treatment for filling stations places particular demand on dew-point quality as the formation of condensate must be eradicated.

CNG filtration and purification

With over 6 million CNG vehicles and 7,500 filling stations globally, prevention of solid and liquid contamination damaging CNG fuel dispensing systems and CNG vehicles is vital. The installation of Parker Hiross Zander Filters in these processes can provide a positive impact on efficiencies in the CNG market.

Compressed Natural Gas, or CNG, is a leading alternative to traditional fuel for the automotive industry. CNG is used in passenger vehicles, pickup trucks, in transit and on school buses. It can be less expensive than gasoline, and is more environmentally friendly – it reduces the amount of carbon monoxide, carbon dioxide and hydrocarbon vehicle exhaust emissions.

Natural gas is gathered from a pipeline and travels to a connecting compressor station. The gas is elevated to pressures ranging from 2000 psig up to 5000 psig and the resultant CNG is stored in large tanks. The CNG then makes its way to a gas dispenser where it is ready for use in natural gas vehicles.

CNG is prone to the same types of contamination that is present in traditional fuels – solids that collect during handling, water that condenses in tanks and compressor lube oils that carry over into the CNG stream. During its transport to the dispenser, the CNG will also have contaminants that are generated within the delivery system. This leads to:

- Compressor fouling
- Vehicle fuel system repair
- Liquids in storage tanks
- Gas dispenser replacement

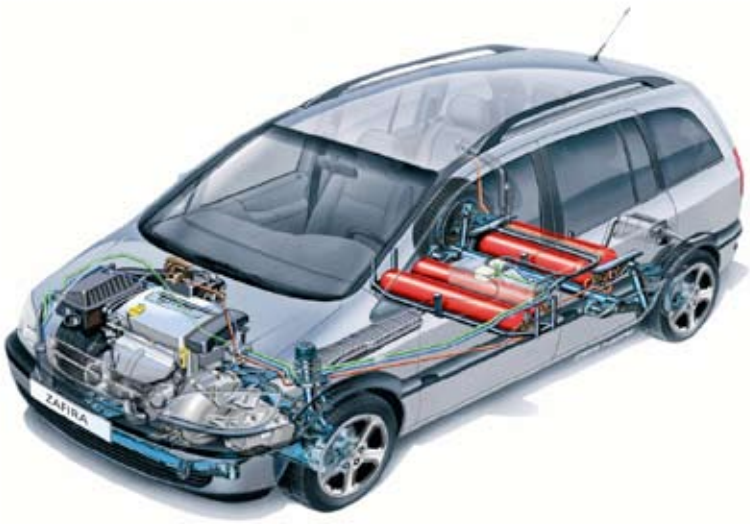
Biogas car

Applications in Fuel Dispensing

Installing a lower pressure particulate filter before the compressor station will remove pipe scale to prevent compressor damage. Before the gas is transported from storage to the dispenser, pre-filtration of the gas with two-stage coalescing will eliminate solids, oil and water generated during underground transit. For extra protection, a high efficiency coaleser should be placed at the gas dispenser to protect sensitive dispenser metering equipment and prevent oil from making its way into the vehicle.

PURGAS FILTER

Please see enclosed Brochure entitled „Purgas“.



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