ZORG BIOGAS

01

version

Proposal

Biomethane plant 20 million m3/year
using 75 000 tonnes straw/year
and 20 000 tonnes manure/year

Date:27/10/2025
Validity: 3 months

CONTENT

OVERVIEW

We offer a solution to process straw to biogas in high-load reactors (HLR). As the straw pre-treatment a press-extruder (pelleting machine) is used. The proposed HLR technology is superior to the conventional CSTR. HLR is the only techology that is able to work with 100% straw. Other technologies like CSTR can use max 30% straw.
The organic load 8,92 kg of ODM per m^3 of reactor per day.
Competitors offer 3-5 kg of ODM/m^3 per day at best. Due to the high load, the number of reactors is just 3840 m^3 x 4 pcs. Competitors will have 8-10 reactors.
Due to special technology, the CapEx s 2-2.5 times less. The plant consumes only 609 kW of electric power. This is 30-50% lower than any competitor. Low consumption for own needs is due to a number of factors:
1) Lower cooling costs due to the thermophilic mode,
2) lower consumption by the biogas enrichment system to biomethane,
3) fewer pumps and other equipment.

In the offer, we took into account the characteristics of the different raw material (straw and manure), namely:
-these raw materials have different fermentation periods;
-every time when manure is added to the reactor with straw, the straw will grow unfermented;
-raw materials have different temperature regimes.
Therefore, it is better to separate and ferment the manure with the fermented mass from the main reactors and we offer to process manure and fermented straw to biogas in the Post-digester.

We offer amine scrubbers for biogas enrichment. This technology provides the lowest energy consumption and the highest quality of biomethane with a methane content above 99%. In addition, amine scrubbers are also 1,5 - 2 times cheaper than membranes or VPSA. and this is made in EU.

Raw material potential

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	DM content (%)	oDM content (%)	DM quantity (tonnes/day)	oDM quantity (tonnes/day)	Biogas yirld (m^3/tonnesODM)	Biogas (m^3/day)	Methane content (%)	Biomethane (m^3/day)	Biomethane (m^3/year)
Straw	207	75 555	80	96	165,60	152,35	640	97 505	53	52 000	18 980 000
Cattle manure with straw (crushed)	55	20 075	40	85	21,92	18,63	294	5 477	60	3 300	1 204 500
Total	262	95 630			187,5	170,98		102 982	53	55 300	20 184 500

****-DM-** dry matters
*****-oDM-** organic dry matters

Biogas plant characteristics

Characteristics	Values	Figures
Reactor1, 2, 3, 4	units	4
Volume:		
Work	m^3	3617
Overall		3840
Temperature	^0C	48
Overall dimensions of the digester:		
diameter	m	24,0
height		8,5
Organic load	kgODM/m3	8,92
Hydraulic retention time (gross/net)	days	35/33
Post-Digester	units	1
Volume:		
Work	m^3	4431
Overall		4924
Temperature	^0C	39
Overall dimensions of the digester:		
diameter	m	28,0
height		8,0
Organic load	kgODM/m3	3,47
Hydraulic retention time (gross/net)	days	13/12
Number of gasholders	units	1
Volume:	m^3	1377
Dimensions of the gasholder:		
diameter	m	28
Height		5,6

Number of personnel

	Shift 1	Shift 2	Shift 3
Chief engineer	1	-	-
Manager	1	-	-
Accountant	1	-	-
Operator	1	1	1
Driver	1	1	-
Electrician	1	-	-
Mechanic	1	-	-
Total	10		

Biogas plant working principle

The technology is based on the biochemical conversion of organic materials from high molecular weight compounds to low molecular weight compounds. The first stage of this process is hydrolysis. Hydrolysis produces organic acids and alcohols.
Organic compounds + H2O→ C5H7NO2+HCO3.
Further conversion of obtained dissolved compounds like organic acids and alcohols (C5H7NO2,HCO3) into gases - CH4, CO2. C5H7NO2 + HCO3 + H2O → CH4+CO2+NH4.
Biological process of consecutive (phasic) conversion of organic compounds take place in anaerobic environment i.e. in oxygen-free tank (biological reactor). At the first stage of fermentation, substrate hydrolysis take place under acidogenic bacteria influence. At the second stage, elementary organic compounds come through hydrolysis oxidation by means of hetero-acidogenic bacteria with production of acetate, carbon dioxide, and free hydrogen. The other part of the organic compound including acetate forms C1 compounds (elementary organic acids). Produced substances are the feedstock for methanogenic bacteria of the third type. This stage flows in two processes of A and B type the character which depends on caused by different bacteria type. These two types of bacteria convert the compound obtained during the first and second stages into methane CH4, water H20 and carbon dioxide CO2. Methanogenic bacteria are more sensitive to the living environment compared to acidogenic bacteria. They require a complete anaerobic environment and a longer reproduction period. The speed and scale of anaerobic fermentation depends on bacteria metabolic activity. That is why the biogas plant chemical process includes hydrolysis stage, oxidation, and methanization stage. For that kind of substrate, these processes take place in the same reactor

Technological process of biogas production

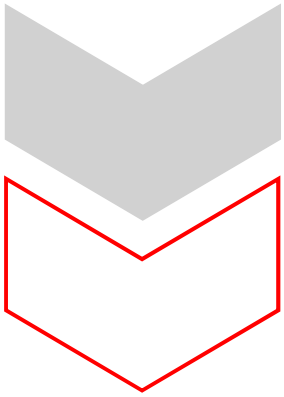
Straw (pellets), manure are directed into the loaders. The loaders input substrates by portion to the reactors using augers. In the reactors the substrate is brought up to a temperature of +48°C (Reactors 1-4) and up to 39°C (Post-Digester). Constant temperature is sustained for the entire digesting period. To prevent a rise in temperature (for example, in summer), the biogas station is equipped with a coolers (dry cooling). The reactors operating regime is thermophilic (reactors 1-4) and mesophilic (Post-Digester). The heated substrate in the digesters is blended periodically. Mixing is performed by vertical agitators (reactor 1-4) and inclined agitators (Post-Digester). The average time of processing in the reactors 1-4 is 35 days. The average time of processing in the Post-Digester is 13 days.

After the reactors, the substrate is fed by pumps to a separator area where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged from the separation area and transported for storage; liquid filtrate is directed to the reactors 1-4.

The post-digester is equipped by a gasholder. Biogas goes up under overlap and delivered into a gasholder through pipeline. The gas holder's weather protective film protects the gasholder from precipitation and damage by foreign objects. The weather protective film is fixed firmly by a special system. To protect the gasholder from overpressure, digesters are equipped with safety valves, which start working at a pressure of 5 mbars and bleeds biogas to the atmosphere. Then accumulated in gasholders biogas goes through a gas pipeline to a biogas cooler with a condensate discharge unit and then to a compressor, where the pressure is raised up to 80-150 mbar to meet engine requirements. After the compressor, biogas is fed to activated coal filters to remove hydrogen sulfide (H2S). After filters, biogas goes to biogas upgrading plant where raw biogas treats through the removal of CO2 and other soluble gases to produce primarily methane gas (~99%) which is clean and dry.

All technological processes are controlled and operated by an automatic system. Biogas plant work is monitored at the central control room monitor. The control room is equipped with a central control unit, which allows the switching of any biogas plant module into automatic or manual mode with local or remote control.

MAIN EQUIPMENT



Straw preparation unit (SPU-01)

The straw preparation plant offers a systems solution for actual managing and feeding bales of straw into the bioreactors. The plant consists of a straw feeding line including conveyor band for bales, shredder, stone and sand trap and briquetting machine before the actual briquetting and direct feeding into the biogas reactor. The harvesting process leaves straws mixed with dusts and other alien materials like stones, metals and plastics. These foreign components have the potential to damage briquetting machine and also lower the quality of the pellets. That is why full automatic straw feeding line for straw based biogas plants is a main key factors for a successful provision of biogas from straw. Straw should be cut and chopped for the appropriate dimensions usable in pelleting machines.
The line includes following units like bale receiving conveyor (from crane system or forklift), string cutter and remover, guillotine for the separation of the bale wads prior to the shredding process, shredder, pneumatic operated stone trap. The crushed and dried powder is channelled to the pelleting machine where great pressure is generated to form great density pellets. Then pellets are cooled to room temperature. The straw feeding line offers a systems solution for actual managing and feeding bales of straw into the bioreactors.

Specifications

Quantity:	**1 pcs.**

Solid feeder1 (SF-01...SF-04)

Solid feeder machines have been proven in various situations. Solid feeder has the solid design, which guarantees a maximum functionality and less maintenance, combined to a low energy consumption. Because of the vertically oriented walls, there is no change for the material to get stuck or build bridges. The conveyor chains and the milling-unit allow continuous dosing by various types of materials. Furthermore, the material is loosened by this dosing process. The user is able to control the material flow up to 25m³/h or more, regarding to the own consumption of electrical power by the machine. In addition, the corrosion protection, wear resistance and high quality allow customers to use our product for a long period of time.

Specifications

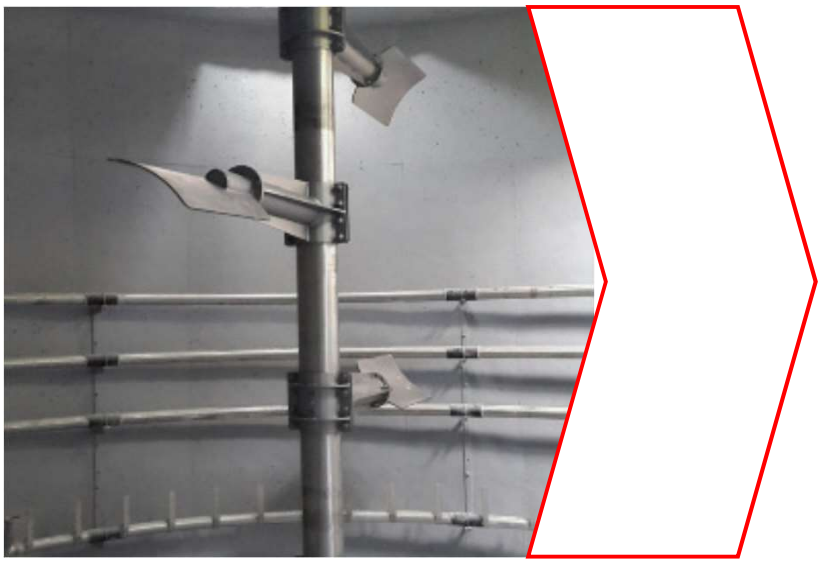
Height:	**2,0 m**
Length:	**4,5 m**
Width:	**2,3 m**
Volume:	**15 m³**
Quantity:	**4 pcs.**

Reactor (R-01...04)

Reactor is a tank of cylindrical form (for better mixing during the fermentation). It is built of cast-in-situ reinforced concrete based on sulphate-resistant cement with thickness of walls and bottom - 0,25m. Overlap of reactor is reinforce concrete plate. On the tank's wall and in the bottom there is to be installed pipelines for heating, intended for assurance and maintenance of the optimal fermentation process temperature at thermophilic conditions. For heat conservation and reduction of heat energy consumption, the reactor walls, overlap and bottom are insulated outside with 100 mm slabs of extruded polystyrene foam. Over the heater, the substructure walls and bottom are insulated with roll damp proofing. Superstructure and substructure heat insulation is protected by shaped sheet from the outside mechanical damages and rodents. The reactor`s bottom has a slope 1%.

Specifications

Height:	**8,5m**
Diameter:	**24,0 m**
Total volume:	**3840 m^3**
Substrate volume	**3617 m^3**
Quantity:	**4 pcs.**



Reactors` vertical agitator (AG-01 ... AG-20)

Vertical agitators are designed and engineered to guarantee high energy efficiency. We use gear units and motors from respected European manufacturers. This guarantees the long life of our mixers. All motors and gear units are available with ATEX certifications.
Agitators are designed for mixing substrates with a high solids content of 13-18%. The blades of the mixers are set at an optimum angle, and the external motor of the mixer is mounted on a special support.

Specifications

Engine power:	**15 kW**
Quantity per reactor:	**5 pcs**
Total quantity:	**20 pcs**

Solid feeder2 (SF-05)

Solid feeder machines have been proven in various situations. Solid feeder has the solid
design, which guarantees a maximum functionality and less maintenance. In addition,
the corrosion protection, wear resistance and high quality allow customers to use our
product for a long period of time.
The main components

- buffer bunker 20 m^3
- Mixing auger
- Hummer mill
- Square-bar frame incl. load cell casings Adding weighing system
- Set of augers
- Control cabinet

Specifications

Height:	**1,56m**
Length:	**5,83 m**
Width:	**2,79 m**
Volume:	**20 m^3**
Quantity:	**1 pcs.**

Post-Digester (R-05)

It is a tank of cylindrical form. It is built of cast-in-situ reinforced concrete based on sulphate-resistant cement with thickness of walls and bottom - 0,25m. In the center of the reactor there is a column with chapiter. From the walls of the reactor to the central column, are fixed support belts for the biogas membrane of the gas holder. Gasholder is a half-spheric tank of membrane PELD. Biogas is collected to it during the process of anaerobic fermentation of raw materials. For heat conservation and reduction of heat energy consumption, the filtrate tank`s walls and bottom are insulated outside with 100 mm slabs of extruded polystyrene foam. Over the heater, the substructure walls and bottom are insulated with roll damp proofing. Superstructure and substructure heat insulation is protected by shaped sheet from the outside mechanical damages and rodents.

Specifications

Height:	**8,0 m**
Diameter:	**28,0 m**
Total volume:	**4924 m^3**
Substrate volume	**4431 m^3**
Quantity:	**1 pcs.**

Reactor`s mixer Paddle-giant (AG-21..24)

The inclined paddle high-power mixer Paddle-giant is designed and engineered for high efficiency with all types of raw materials (including highly viscous media). The operating mode is designed to maximize the preservation of bacterial populations (to achieve optimal gas output).
The mixer bearing is made of special, extremely wear-resistant and rust-proof plastic. All components can be replaced without the need to drain the reactor or replace the mixer shaft. The operating principle is ideal for breaking up floating layers and supports the mixing of solidification layers. Degassing of the substrate is simplified.
This type of mixer is suitable for minor fluctuations in filling levels. In the production of mixers, gearboxes and motors from well-known European manufacturers are used. This guarantees a long service life of our mixers. All motors and gearboxes are available with ATEX certificates.

Specifications

Engine power:	**11 kW**
Quantity per reactor:	**4 pcs**
Total quantity:	**4 pcs**

Window with spotlight (SG-01, SG-02)

Inspection windows are designed for visual control of processes inside the fermenter. Spotlights were made in explosion-proof with automatic disconnection. Inspection windows are equipped with a cleaning washing system.

Specifications

Inspection windows:	**Ø300**
Spotligh: **VISULUX UL50 -G -H**	**230V, 50W, IP65**

Pump equipment (PU-01...PU-09)

Pumps are used to transport substrate to the equipment and facilities in the biogas plant and away. Biogas plant design allows to access easily to all pumps. Pumps are driven by helical geared motor. Stator has hopper inlet for optimum filling of the pumping chamber, wear-protected, robust universal joint with feeding screw, robust bearing pedestal with close-coupled drive and self-centering of the drive shaft. Pumps have modular design for high flexibility, low life-cycle-costs.

Specifications

Substrate pump1 (PU-01..04)

Engine power:	9,2 kW
Flow rate:	30 m3/hour
Pressure:	4 bar
Quantity:	4 pcs

Substrate pump (PU-05..PU-08)

Engine power:	11 kW
Flow rate:	8-25 m3/hour
Pressure:	4 bar
Quantity:	4 pcs

Filtrate pump (PU-09)

Engine power:	11 kW
Flow rate:	50 m3/hour
Pressure:	4 bar
Quantity:	1 pcs

Separator (SR-01... SR-04)

The Press Screw Separator covers a broad spectrum of applications, from agriculture to biogas and bioethanol plants. The innovative technology separates substrates in its solid and liquid elements. The secret of the versatility of the press screw separator is that it can adjust to different dry matter contents and Thick liquids (20% dry matter content). Slotted screens have different assortment and width of table cells and give possibility work with small solids and fiber contents. In the slotted screen, the solids are screened out from the liquid. The solids build up a layer which also acts as a filter to separate finer particles from the liquid. The auger flights convey this layer to the solids outlet. The screen surface is cleaned and a new filter layer is formed. The design of the screens is not conducive to plugging. The pressure in the first part of the screen is low but increases with the solid consistency to the solid output. The consistence of the gained solid can be varied with the help of a output regulator by the amount and position of counter weights. This way the required consistency of the final product for either further storage, use as fertilizer or the basis for compost can be reached. The liquid phase can easily be drained through a pipe or hose system.

Specifications

Engine power:	**7,5 kW**
Flow rate:	**8-25 m3/hour**
Quantity:	**4 pcs**

Equipment
Frame
Screw
Sieve for the filtration
Counterweights
The design of the protective room

Filtrate tank (FT-01)

Reinforced concrete reservoir for reception of liquid kinds of raw materials. The reservoirs are equipped with level sensors and submersible agitators for mixing substrate.

Specifications

Filtrate tank (FT-01)

Diameter:	**9,0 m**
Height:	**3,0 m**
Total volume:	**191 m^3**
Quantity:	**1 pcs**

Submersible mixer (AG-25)

The submersible motor agitator serves for mixing renewable raw materials (RRM), liquid substrate as manure and similar substrates. The electro-motor driven submersible agitator is designed for submersion operations in potentially explosive environments of Ex zone 2 and complies with Directive 94/9 EC. The submersible agitator can be attached to most sliding masts by means of the motor support. A mounting option for a hauling cable is provided on the motor support for height adjustment purposes.
Due to the 4-roller guidance of the motor support, the agitator can be lifted and lowered without friction and the square mast, even if the pull of the hauling cable is slightly angular. The motor support is designed for a 100 x 100 mm square sliding mast as standard, but can also be used for an 80 x 80 mm sliding mast by changing the rollers. The strain relief of the connecting cable can be positioned in the extension of the motor or towards the top on the motor support, depending on the requirements. This enables universal utilization with the most various installation kits.
The geared motor is made of spheroidal graphite iron(GGG40) and painted, the propeller is galvanized and the motor support is made of stainless steel. The submersible motor agitator is designed as a water pressure-tight monoblock unit for driving the three-vane propeller. The submersible agitator is of modular design, submersible electro-motor with flange-mounted planetary gear and bearing flange for holding the propeller. The conical shaft in the bearing flange is mounted in the oil bath by two angular roller bearings and sealed off from the agitating substrate with a mechanical seal.

Specifications

Submersible mixer for the filtrate tank FT-01	**(AG-25)**
Nominal power:	**5,0 kW**
Quantity:	**1 pcs**

Gasholder (GH-01)

The gasholder provides for biogas storage and for equalizing pressure and biogas composition. The gasholder system has a two-layer construction. The external material consists of a weather-proof film of PVC-coated polyester fabrics with UV protection. Both sides are finished with an external N/5cm, internal membrane PELD (gasholder) membrane.
The gasholder has a methane permeation maximum of 260 cm3/m2 * 1 bar biogas resistance. The gasholder film temperature range allows operation from -30°C to +60°C.
The internal film is stretched under normal biogas pressure. Air is blown into the space between the external and internal membranes to pressurize the internal membrane and form the shape of the external membrane.
The biogas pressure in the gasholder is 2-5 mbar. The membranes are designed and cut out on NC machines. Welding is executed by high frequency currents. These steps yield substantial improvements for quality and service life compared to handmade membranes welded by standard welding equipment.
To prevent damage to the gasholder as a result of overpressure conditions, a safety valve is installed. To survey the internal membrane, an inspection window is installed on the external membrane.

Specifications

Height:	**5,6 m**
Diameter:	**28,0 m**
The total volume :	**1377 m^3**
Quantity:	**1 pcs**

Biogas dryer and cooling (CHL-01..02)

Biogas dryer and cooling are provided with special equipment as GAS COOLER and AIR-COOLED LIQUID CHILLER. Biogas plants thanks to an extensive range of dedicated Biogas solutions, low pressure heat exchangers, a comprehensive range of water chillers and RWD Dry Coolers. Designed as one-way shell-and-tube heat exchanger. Process gas inside of the tubes; cooling water in the shell. All parts in contact with the process gas made of stainless steel 316Ti or 316L; heat exchanger shell made of stainless steel/ Designed with gas outlet chamber outlet connection radial; inspection opening axial Official acceptance according to PED 2014/68/EU in accordance with ADMerkblätter and factory pressure test.

Specifications

Gas volume flow:	**2150 m^3/hour**
Gas inlet temperature:	**+48°C**
Gas outlet temperature:	**+10°C**
Electric power:	**71,4 кВт**
Quantity:	**2 pcs**

Biogas compressor (BC-01, BC-02)

Biogas blower is a device used to move gas and increase pressure thanks to a rotating impeller within a toroidal channel, so there is a progressive increase of energy.
Blower is used to transporting biogas from gasholder storage to consumer (biogas upgrading plant in our case).

Specifications

Flow rate:	**5300 m3/hour**
Pressure:	**150 mbar**
Engine power:	**47 kW**
Quantity:	**2 pcs**

Desulphurization system

The desulphurization system is a 3-step system. Stage 1 is adding Ferrum Hydrooxide. Stage 2 - biological. Adding a certain portion of air to the fermenter. Air by special bacteria, converting H2S into S. After 1 and 2 steps the sulphur contcentration is 80 ppm. Stage 3 - activated charcoal filtration, as activated charcoal has the capability to absorb sulfur. After passing through activated charcoal filters, the sulfur concentration is reduced to 0 ppm.

Specifications

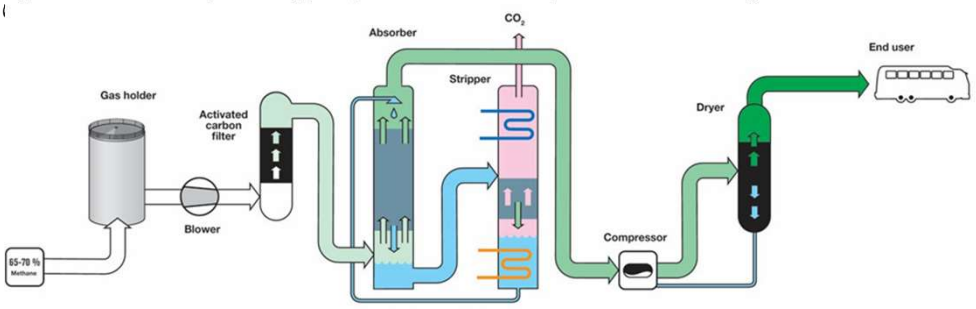
Charcoal filter	**(CF-01, CF-02)**
The volume of charcoal:	**500 kg**
Quantity:	**2 pcs**

Enrichment- Amine scrubber

The biogas upgrading plant is used to purify biogas, landfill gas or sewage gas. Amine scrubber technology, also known as amine gas treatment, is a widely used process for purifying biogas and converting it into biomethane.

The amine scrubber technology utilizes a liquid solvent, usually an amine compound, to selectively remove impurities, particularly CO2, from the biogas stream. The process involves several stages, including absorption, desorption, and regeneration. Here's an overview of the amine scrubbing process for biogas purification:

1. Absorption: The biogas is introduced into an absorption column where it comes into contact with the amine solvent. CO2, being more soluble in the solvent than methane, is selectively absorbed from the gas stream. The purified methane exits the column and is collected as biomethane
2. Desorption: Once the amine solvent becomes saturated with CO2, it needs to be regenerated. This is achieved by heating the solvent in a separate desorption column, which releases the absorbed CO2, resulting in a concentrated CO2 stream. The regenerated solvent is then cooled and recirculated for reuse in the absorption column.
3. CO2 Capture: The concentrated CO2 stream produced during desorption can be further processed for capture or utilization. Depending on the specific requirements and goals, the captured CO2 can be compressed and stored for various applications, including enhanced



Biogas upgrading plant nominal conditions

	Biogas	Biomethane	CO2 reach tail gas
Flow (Nm³/h)	4291	2304	1987
CH4 (Vol %)	53	99.5	1,67
CO2 (Vol %)	43	1,6	96
H2O (Vol %)	0,8	Dew-point < -65°C	1,82
N2 (Vol %)	0,8	1,26	0,26
O2 (Vol %)	0,2	0,11	0,3
H2S (ppm)	<3	-	-
Temperature (°C)	20	25	40
Pressure (bar)	0,09	3,1	0,05

* Sulfur removal is three-stage:
-by iron hydroxide -the first stage of purification (in the digesters);
-by oxygen (in the digesters);
-be coal column - the third stage.

Amine scrubber technology offers several advantages for biogas upgrading to biomethane:

High Purity: The process can achieve high purity levels of methane, typically above 95%, making it suitable for biomethane injection into natural gas grids or direct use as a transportation fuel.

Selectivity: Amine solvents have a high affinity for CO2, allowing for selective removal of this greenhouse gas from the biogas stream while preserving methane.

Scalability: Amine scrubbing technology is well-established and can be scaled up to handle large volumes of biogas, making it suitable for industrial-scale biogas upgrading facilities.

Flexibility: The process can be adapted to different biogas compositions and can handle variations in gas flow rates and impurity levels..

Electric power consumption	
Biogas upgrading plant	0,1 kW/Nm³of biogas

Biomethane compressor station 50 bar(CS-01)

The compressor station has compact dimensions, making it easy to install.
It is designed to operate with biomethane at inlet pressures ranging from 50 to 0 bar. The installation ensures reliable performance, with a capacity of 3,000 to 54,600 Nm^3/day.

Main components:

-Piston compressor with oil-free cylinders
-1- or 2-stage configuration (delivery pressure: 4 to 50 bar)
-State-of-the-art plungers and seals exceeding industry standards
-Direct motor-to-compressor coupling
-PLC with displayRemote control of the integrated system
-Inlet scrubber with automatic discharge

Specifications

Flow rate (biomethane):	**2310 m3/hour**
Electric power :	**183 kW**
Quantity:	**1 pcs**

Flare (BF-01..02)

Flare is designed for the temporary or periodical complete combustion of the biogas produced by biogas plants without the possibility of its use as an energy source. The burn system consists of a burner and additional equipment. The burner is designed on the principle of injection and consists of a combustion nozzle with an injector with an air supply control system, flame protection tube, fitting and burner control system. The biogas combustion system is made of stainless steel.
The supporting structure holds the burner and vertically mounted socket. The burn control system is installed in a case, which is mounted on the supporting structure of the combustion system and contains all the elements for monitoring and controlling ignition and flame.

Specifications

Flow rate:	**4400 m^3/hour**
Pressure:	**min 10 mbar-max 60 mbar**
Quantity:	**2 pcs**

Water supplying and sewerage system

Water supplying system provides biogas plant feed water, water for network circuits, the domestic water and fire safety systems. As used centrifugal single stage pumps as main pumping elements. These pumps are designed for pumping waste water, household / domestic water and sewage. Pressure Boosting Systems are designed for pure water pressure boosting in industrial plants. The booster comprises 2 to 3 (connected in parallel pumps) installed on a common base frame, and provided with all the necessary fittings.

Specifications

Drain pump
Pressure 4m
Flow 2-3 m3 / h
Engine 0,24 kW

Equipment
Pump case control
Stove-base
gauges
Check valves
Float switches
Brackets
Valves

Heating system

Heating equipment is using for biogas plant heating and for sustaining constant temperature in the fermenter. Heating equipment includes circulation pumps, heat exchanger, heating manifold and pipes. The heat from the boiler is transferred to the biogas plant by using heat exchanger, and then is pumped through of biogas plant by circulation pumps. A heat carrier prepares water with an additive of ethylene glycol. Inlet temperature in the fermenter is 60C, the outlet is 40C.

Specifications

Circulating pump feeding heat carrier

Engine power:	3,5 kW
Flow:	28 m^3/hour
Pressure:	1 bar

Circulating pump feeding heat carrier

Engine power:	2,0 kW
Flow:	12m^3/hour
Pressure:	1 bar

The pumping station feeding propylene glycol

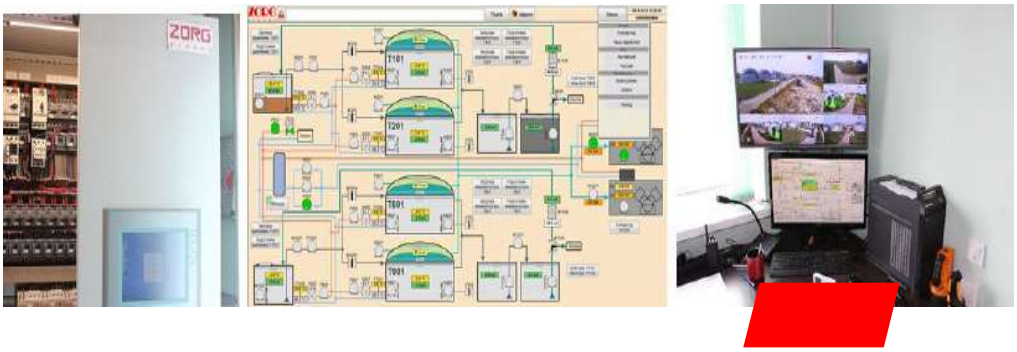
Engine power:	0,7 kW
Flow:	1 m^3/hour
Pressure:	4 bar

Dry cooler (cooling substrate system)

Device is designed to cool the substrate to working temperature according to technological regime. When use high temperature substrate, there is a chance of uncontrolled heating. The cooler is connected to the heating pipes, heat exchangers and it will be activated if it is need.

Specifications

Heat power:	100 kW
Electric power:	4 kW
Quantity:	5 pcs



Automation and electrical equipment

Process control equipment is used for supervision and regulation operation of the plant and for the limitation of damage. In case of emergency (for example, breakdown of the electrical power supply) the biogas plant is automatically transferred to safe operating conditions by the process instrumentation. Critical electrically driven devices are supplied with emergency power. An automatic system allows the supervision of the plant in real time and to recognize and correct aberrations immediately; to run the plant at its optimum saving resources and costs; and to record for the electronic database operation parameters. The automatic system consists of a control cabinet and sensors for parameter control of technological processes and execution devices.

The control cabinet is designed based on the industrial controller Siemens CPU315-DP2, using periphery distributing system Simatic ET200S, and operator panel OP277 Touch with touch-sensitive controls. Communications is executed by PROFIBUS and MPI with physical interface RS-485. The control program is designed based on the Simatic Step7. The control cabinet is a modular design. The upper part has a power box with central and front-end processor. The periphery distributing system, Simatic ET2005, is installed with input - output units. The lower part with interface relay and clips is installed for connecting execution devices. The entire plant is controlled by a single operator.

Specifications

Incoming control case with automatic set ASE-1, 2, 3
Base Siemens CPU315-DP2 controller
Peripherals Simatic ET200S
Control panel OP277 touchscreen
Communication PROFIBUS and MPI
Interface RS-485
Control system Simatic Step7

Sensors set

Sensors are used to measure physical quantities (temperature, pressure, level of moisture) data collection.
installation kits

Specifications

Conductometric sensor
Pressure Sensor / level
Ultrasonic sensor
Gas Pressure Sensor
Temperature converters with protective sleeves
The moisture sensor and the gas temperature

Laboratory

Monitoring and control of parameters of raw materials and fermentation processes is important for the efficient operation of a biogas plant. The laboratory allows you to assess the content of dry matter in the input raw materials, fermented mass, determine the ratio of volatile organic acids to total inorganic carbon (FOS/TAC parameter), determine the degree of substrate fermentation in fermenters, the level of biogas output, and evaluate the efficiency of separator.

-

Equipment

Analytical scales
Moisture analyzer
Automatic titrator
Laboratory pH meter
Centrifuge
A set of flasks

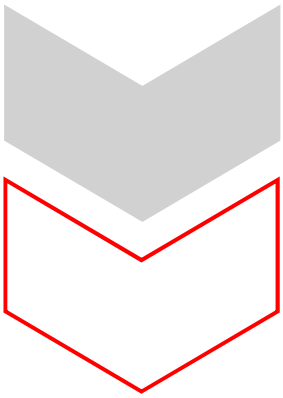
Diesel generator

Diesel generator is used as a backup or main power source. The generator is equipped with a powerful engine that meets the highest international quality standards, as well as environmental standards. A feature of this model is, in addition to power, the presence of both mechanical and electronic engine speed controllers. The generator is equipped with an extremely durable alternator that can withstand 300% of short-circuit current for 20 seconds without interrupting operation. This gives it stability in emergency situations.
In addition, the generator is equipped with a soundproof all-weather casing, as well as a temperature regulator (which allows it to be started in any weather).
Generator advantages:
-reliability;
-low noise level;
-additional options: LiveLink, which performs remote monitoring of the generator status, more effective noise absorption, additional mobility, changing the volume of the fuel tank, etc.;
-increased level of safety;
-three-stage fuel purification;
-operation in any weather. Has a pre-start heating option, which allows you to quickly start the generator in frosty weather;
-AVR: automatic voltage regulator guarantees generator operation without overloads and prevents voltage surges

Specifications

Capacity:	**144 kW**
Rated voltage:	**230/400 kW**
Engine displacement:	**7,15 l**
Fuel consumption (75% load)):	**29,6 l/hour**
Overall dimensions (H x L x W)	**1140x3800x2000 mm**
Quantity :	**1 pcs**

Equipment specification list



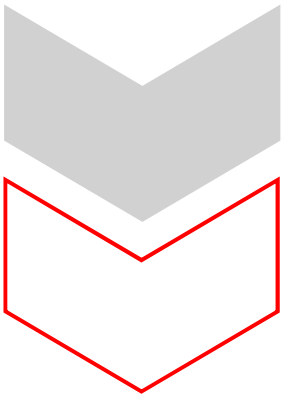
№	Equipment	Characteristic	Quantity
1	**Loader1**	**V=15m3**	**4**
1.1	Container bunker		4
1.2	Feeding screws	set.	4
2	**Loader2**	**V=20m3**	**1**
1.1	Container bunker		1
1.2	Feeding screws	set.	1
3	**Submersible mixer**	**N=5,0 kW**	**1**
3.1	Airtight motor gearbox		1
3.2	Hydraulic screw (wear-resistant steel)		1
3.3	Mixer control mechanism		1
3.4	Electric motor mount		1
3.5	Set of fasteners		1
4	**Reactor`s vertical agitator (Reactor 1,2,3,4)**	**N=15 kW**	**20**
4.1	Airtight motor gearbox		20
4.2	Hydraulic screw (wear-resistant steel)		20
4.3	Shaft (adapted to the height of the fermenter)		20
4.4	Blade		20
4.5	Frequency converter		20
4.6	Mounting bracket to bottom of the mixer		20
5	**Reactor`s inclined agitator (Post-Digester)**	**N=15 kW**	**4**
6	**Safety valve of digesters**		**5**
7	**Window with a searchlight**	**set**	**5**
7.1	Inspection window RD300 (mounts and sealant included)	Ø300	10
7.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	5
8	**Substrate digested pump**	**30 m3/hour N=11.0 kW**	**4**

№	Equipment	Characteristic	Quantity
9	**Separator**	**N=7.5kW, 8-25m3/h**	**4**
9.1	Body		4
9.2	Substrate Supply Pipe 4 ’’		4
9.3	Engine - Gearbox	N=7,5 kW	4
9.4	Frame		4
9.5	Screw		4
9.6	Sieve for filtration		4
10	**Substrate pump**	**8-25 m3/hour N=11,0 kW**	**4**
11	**Filtrate pump**	**50 m3/hour N=11 kW**	**1**
12	**PVC gas holder H/D =1/5**	**1377 m3**	1
12.1	Weather protection film	Ø28m	1
12.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm biogas resistant		1
12.3	Air blower	16A, 0,5kW	
12.4	Excess and minimum pressure valve		1
12.5	Dome level sensor		1
12.6	Mounting system		1
12.7	Accessories		1
12.8	Safety valve		1
13	**Biogas Cooling System**	**2150 m3/h**	**2**
13.1	Chiller		2
13.2	Heat exchanger		2
13.3	Polypropylene glycol tank		2
14	**Desulphurization system**		**1**
14.1	Numbers of charcoal columns	500kg	2

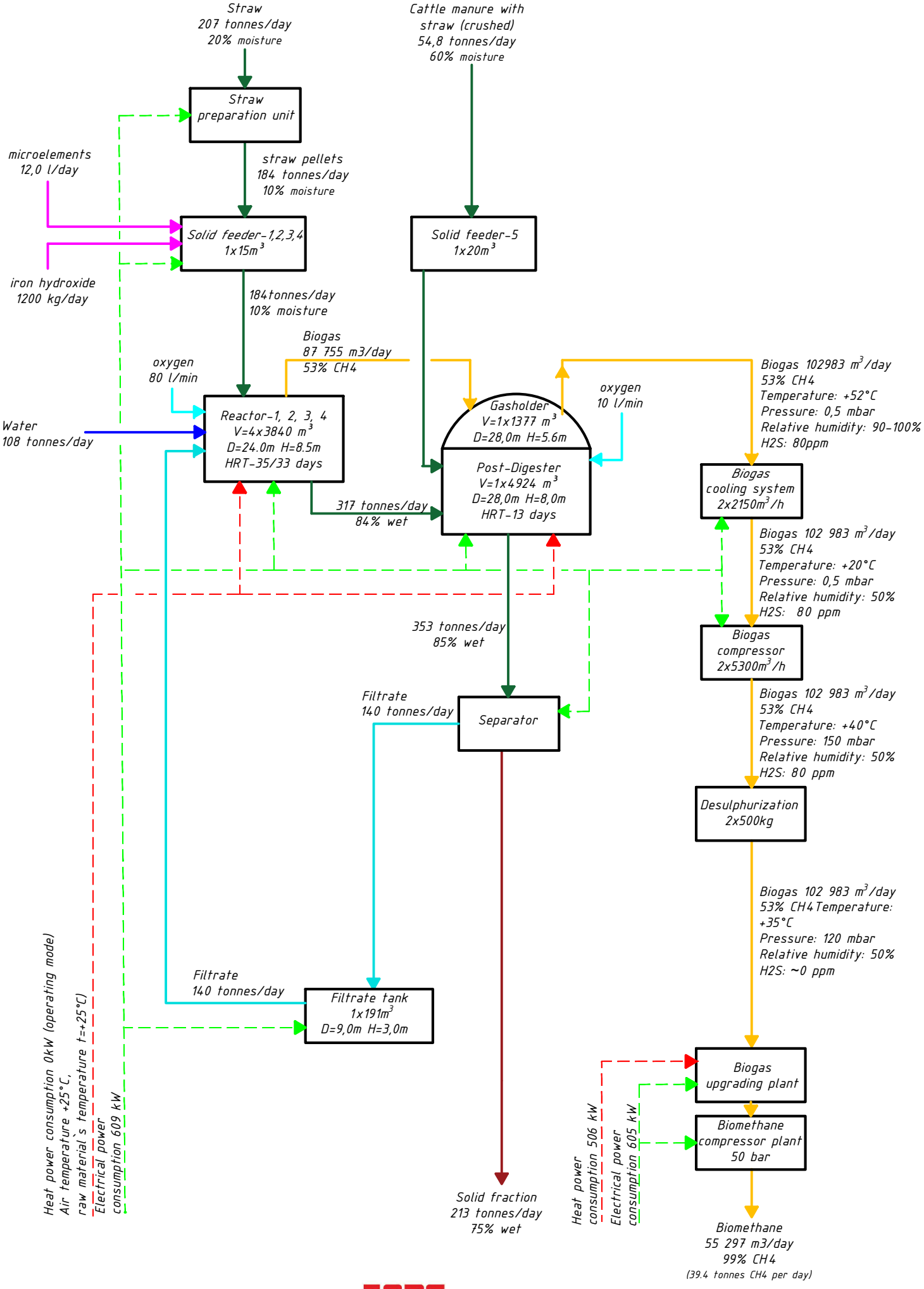
№	Equipment	Characteristic	Quantity
15	**Biogas compressor**	**Q=5300m3/h, H=150mBar, N=47kW**	**2**
15	**Electromagnetic flow meter**		**61**
17	**Flare**	**4300m3/h**	**1**
18	**Gas equipment included**	**set**	**1**
18.1	Drainage pump with float	DN=50, Q=1m3/h, H=13 m	2
19	**The heat supply system**	**set**	**1**
19.1	Diaphragm expansion tank	V=1000 l,P=6Bar T=120°C	1
19.2	Circulating pump for supplying heat carrier	Q=30 m3/h,H=1bar	1
19.3	Propylene glycol feed pump station heating systems	Q=1,0 m3/h, H=4 bar	1
19.4	Circulation pump for supplying heat carrier to the digester	Q=18 m3/h, H=1.1 bar	1
20	**Water supply and sewerage system, complete, disassembled**	**set**	**1**
21	**Automation with electrical equipment**	**set**	**1**
21.1	Incoming distribution cabinet with a set of automation DB-1		1
21.2	Incoming distribution cabinet with a set of automation DB-2		1
22	**Sensors, set**		**1**
22.1	Gas pressure sensor 0,025Bar		5
22.2	Gas pressure sensor 0,4Bar		5
22.3	Pressure sensor(substrate level) 1,0Bar		6
22.4	Pressure sensor (substrate pressure) 2,5bar		6

№	Equipment	Characteristic	Quantity
22.5	Resistive thermometer (gas temperature)		6
22.6	Resistive thermometer with thermo well (fermenter substrate temperature)		6
22.7	Resistive thermometer with thermo-well (digester tank substrate temperature)		6
22.8	Resistive thermometer (heat conductor temperature)		6
22.9	Conductometric sensor of maximum level		6
22.10	Conductometric sensor of water level		6
22.11	Dome position sensor		1
22.12	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	5
22.13	Humidity and gas temperature sensor	ESFTF-I	5
23	**Dry cooler 100kW heat pow.**		**5**
24	**Biogas upgrating plant**	**set**	**1**
25	**Biomethane compressor station**	**set**	**1**
26	**Laboratory**	**set**	**1**
27	**Diesel generator (reserve)**	**set**	**1**

APPENDICES



Material flow diagram



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Structure

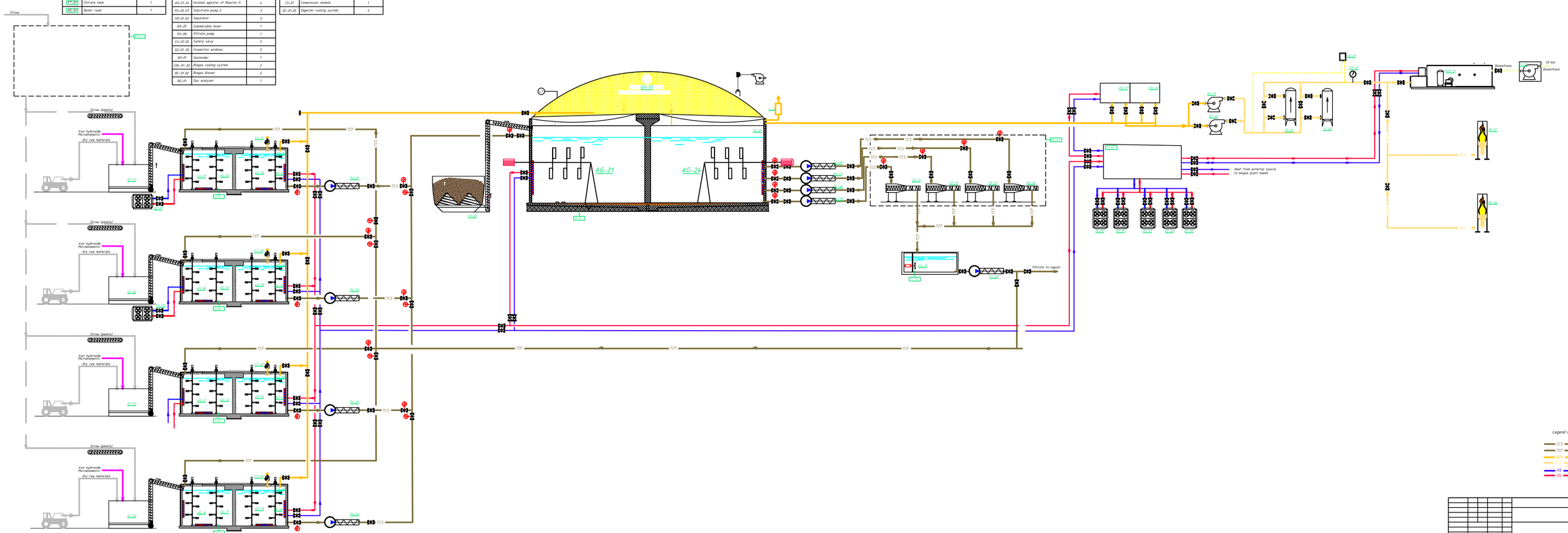
N/№	Name	Q-ty
WPC-01	Straw preparation unit	1
R-01..04	Reactor 1, 2, 3, 4	4
P-05	Post-Digester	1
SE-01	Separator area	1
FT-01	Filtrate tank	1
BR-01	Boiler room	1

Specification

N/№	Name	Q-ty
SF-01.04	Loader machine	4
SF-05	Loader machine	1
AG-01.20	Vertical paddle agitator of Reactor-1,2,3,4	4x5
PU-01.04	Substrate pump 1	4
AG-21.24	Inclined agitator of Reactor-5	4
PU-05.07	Substrate pump 2	3
SR-01.03	Separator	3
AG-25	Submersible mixer	1
PU-08	Filtrate pump	1
SV-01.05	Safety valve	5
SG-01.05	Inspection windows	5
GH-01	Gazholder	1
CHL-01.02	Biogas cooling system	2
BC-01.02	Biogas blower	2
BG-01	Gas analyzer	1

N/№	Name	Q-ty
FM-01	Biogas flow meter	1
DF-01.02	Desulphurisation system	2
BF-01.02	Biogas flare	2
BUP-01	Biogas upgrading plant	1
CS-01	Compressor module	1
DC-01.05	Digester cooling system	5

Basic diagram

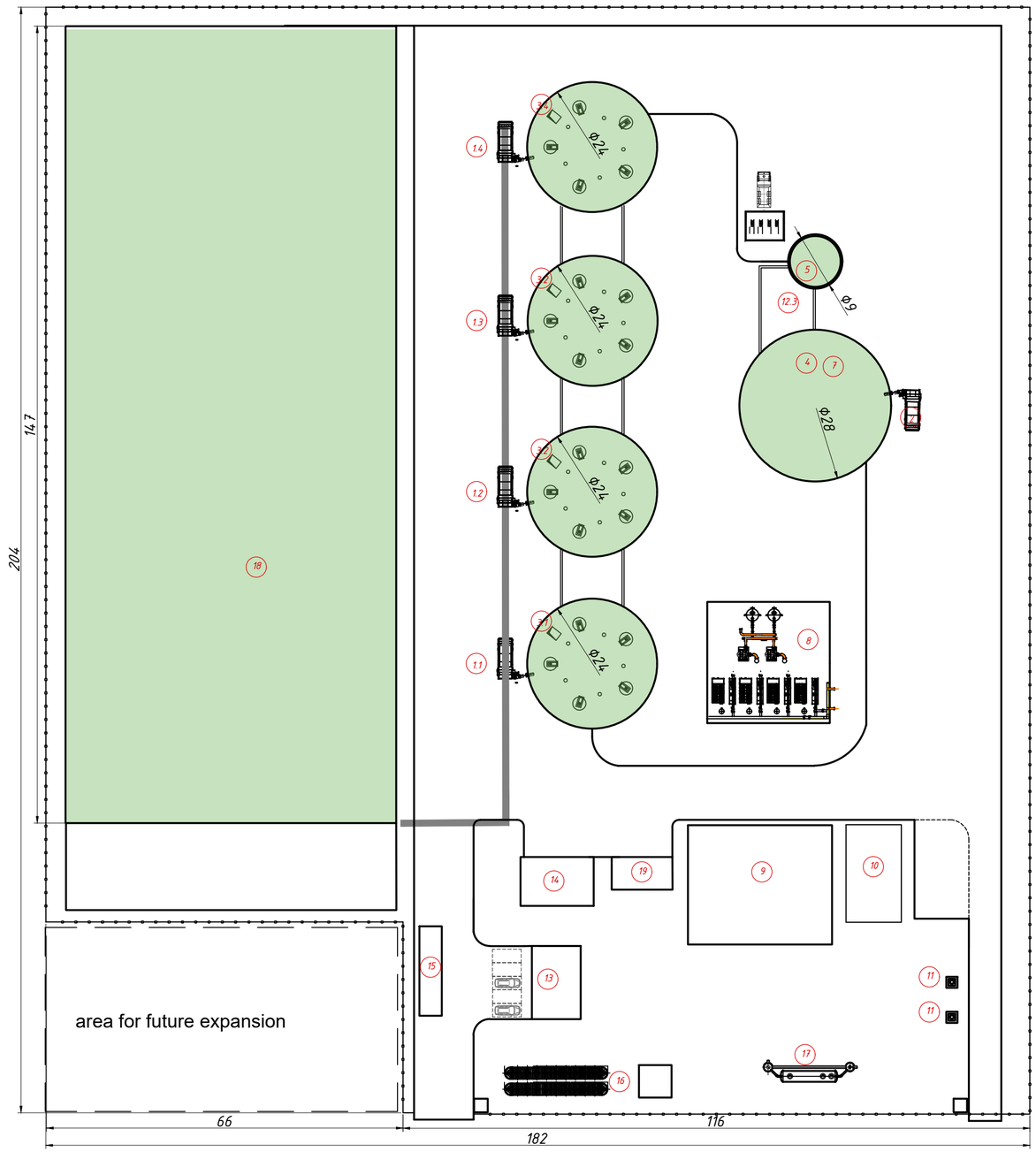


Legend main pipelines

- TCS — Substrate
- TCF — Filtrate
- BGT — Biogas
- BGC — Biogas
- HS — Heat system pipeline
- HS — Heat system pipeline

Basic diagram	Zorg Biogas

Biogas plant layout



Explication

N/№	Name	Note
1	Solid loader1	
2	Solid loader2	
3	Reactor	
4	Post-digester	
5	Filtrate tank	
6	Separator platform	
7	Gasholder	
8	Gas treatment site	
9	Biogas upgrading plant	
10	Compressor station	
11	Biogas flare	
12	Equipment room	
13	Spare parts warehouse	
14	Technical room	
15	Truck Scale (Weighbridge)	
16	Water storage tanks and pumping station	
17	Rainwater treatment facilities	
18	Straw storage	
19	Transformer substation	

Total area of the territory- 3.7 ha

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Appendix 4

Biogas plant					
Name equipment	**Instal. Pow. (kW)**	**Q-y (pcs)**	**Total installed power (kW)**	**Working hours per day**	**Consumption kWh per day**
Conveyor (transportation line)	44,0	1	44,0	4,0	176,0
Loader 1 V=15 m^3	12,0	4	48,0	4,0	192,0
Screw set. 1	23,0	4	92,0	4,0	368,0
Loader 2 V=20 m^3	44,0	1	44,0	11,0	484,0
Screw set. 2	26,0	1	26,0	11,0	286,0
Digester 1,2,3,4 Vertical agitator	15,0	20	300,0	20,0	6000,0
Post-Digester Inclined agitator	15,0	4	60,0	18,0	1080,0
Submersible mixer in filtrate tank	5,0	1	5,0	12,0	60,0
Biogas cooling system	71,4	2	142,8	24,0	3427,2
Biogas compressor	47,0	2	94,0	12,0	1128,0
Digested substrate pump	9,2	4	36,8	2,6	95,7
Separator	7,5	4	30,0	5,9	177,0
Substrate pump to separator	11,0	4	44,0	5,9	259,6
Filtrate pump	11,0	1	11,0	2,8	30,8
Air compressor for gasholder lock	1,5	1	1,5	1,0	1,5
Air blower for double membrane	1,0	1	1,0	24,0	24,0
Digester cooling system	4,0	5	20,0	24,0	480,0
Circulation pump for supplying heat carrier to the digester	0,8	5	3,8	24,0	90,0
Circulation pump for supplying heat carrier to the digester cooling system	2,0	5	10,0	24,0	240,0
Circulating pump feeding hot water at technical building	0,1	1	0,1	24,0	1,9
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Drinage pump	1,0	2	2,0	0,5	1,0
Lighting of the biogas plant territory	1,0	1	1,0	8,0	8,0
Spot light for digesters inspection windows	0,1	5	0,4	0,5	0,2
Working lighting of switchboard	0,1	1	0,1	0,5	0,1
Total installed power, kW			**974**		
Total consumed electric energy, kWh per day					**14611**
Total consumed power, kW					**609**

Biogas upgrading plant					
Name equipment	**Instal. Pow. (kW)**	**Q-y (pcs)**	**Total installed power (kW)**	**Working hours per day**	**Consumption kWh per day**
Biogas upgrading plant	422,0	1	422,0	24,0	10128,0
Biomethane compressor plant up to 50 bar	183,0	1	183,0	24,0	4392,0
Total installed power, kW			**422,0**		
Total consumed electric energy, kWh per day					**14520**
Average consumed electric power, kW					**605**

Total average consumed electric power, kW					**1214**

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es for a biomethane plant 20 million m3/year using straw 75 000 tonnes and 20 000 tonnes manure /

Pos	Name	Number of units	Unit price, EUR	Discounted price sub-total, EUR	
1	Project documentation	1	137 000	137 000	
2	Supervision	1	60 000	60 000	
3	Startup and training	1	60 000	60 000	
4	Living and travel expences	1	20 000	20 000	
5	Permits and aprovals	1	50 000	50 000	
6	Delivery of the equipment (trucks)	25	5 000	125 000	
7	Tape conveyor	1	280 000	280 000	
8	Solid feeder1 (dosing buffer machine) 9 m3	4	94 000	376 000	
9	Screw conveyor	4	125 000	500 000	
10	Solid feeder2 (dosing buffer machine) 20 m3	1	134 000	134 000	
11	Screw conveyor2	1	125 000	125 000	
12	Digester (1,2,3,4) vertical agitator 15 kW	20	89 000	1 780 000	
13	Frame for Digester vertical agitator pos 10	20	6 000	120 000	
14	Digester (5) ihorizontal agitator 15 kW	4	84 000	336 000	
15	Substrate pump 9,2 kW	4	27 000	108 000	
16	Digested substrate pump 11 kW	3	29 000	87 000	
17	Substrate separation unit 7.5 kW	3	58 000	174 000	
18	Over- and under pressure safeguard	5	8 000	40 000	
19	Sight glasses/viewing windows with projector	5	6 500	32 500	
20	Water supply and canalization system	1	61 300	61 300	
21	Heat supply station	1	119 000	119 000	
22	Dry-cooler cooling system for reactors	5	35 000	175 000	
23	Automation and electric cabinet	1	470 000	470 000	
24	Motorized valves (set)	22	9 000	198 000	
25	Sensors (set)	7	25 000	175 000	
26	Gasholder	1	148 000	148 000	
27	Gas conditioning unit	1	95 000	95 000	
28	Biogas chiller (Biogas cooling system)	2	225 000	450 000	
29	Biogas blower	2	75 000	150 000	
30	Desulphurization column with active coal 500 kg	2	35 000	70 000	
31	Biogas burner	2	228 000	456 000	
32	Gas analyzer	1	27 000	27 000	
33	Biogas upgrading plant	1	6 300 000	6 300 000	
34	Biomethane compressor plant 50 bar	1	500 000	500 000	
35	Laboratory	1	28 000	28 000	
36	Reserve diesel generator	1	400 000	400 000	
37	Gas measuring station with automation	1	145 000	145 000	
38	Gas odorization	1	95 000	95 000	
39	Gas chromatograph	1	138 000	138 000	
40	Construction	1	5 000 000	5 000 000	local
		TOTAL by ZORG, EUR		**14 744 800**	
			Total by client, EUR	5 000 000	
			Total ZORG +Client, EUR	19 744 800	

Implementation terms and payment

Months	11.25	12.25	01.26	02.26	03.26	03.26	04.26	05.26	06.26	07.26	08.26	09.26	10.26	11.26
Data collection														
Project documentation		50%			50%									
Obtaining permits														
Equipment						30%	20%	20%		30%				
Equipment supply														
BUP unit			30%							70%				
BU Psupply														
Construction														
Supervision					50%					50%				
Plant start-up												50%		50%

Contracts

Project implementation is executed simultaneously under several contracts

- Engineering contract
- Equipment supply contract
- Supervision contract
- Start-up and training contract

List of exclusions for biogas plant:

1) Project report, civil permits and authorizations, adaptation of the project documentation by a licensed local engineering organisation for the permit purposes. Namely the organisation puts their stamp and acts act the face of the project. The design documentation is not changed in fact. 10 000 – 15 000 EUR
2) Topographic and geological surveys 3000-7000 EUR
3) Electric transformer and the external electric line 130 kW for start-up
4) External roads
5) Temporary water supply during the construction and the hydraulic test of reactors at least 400 m3 water per day. It can be a technical quality water from a river, lake, well. Not salty.
6) Bacterial seed for the start-up. It can be biomass from another biogas plant. Possibley also cow manure, any kind of manure, sludge from city sewage treatment plant. Customer needs to bring the seed one-time during a 1-2 weeks period and to fill with it at least 15-20% of the reactor volume 400-500 m3. The rest is filled with the water item 7 above.
7) Machinery to transport manure and straw to and from storage to the solid feeders (a truck, a frontal loader, a tractor)
8) Machinery to transport filtrate and the digested mass from the biogas plant to the agricultural fields (a truck, a frontal loader, a tractor)
9) Activated carbon 1,0 tonne per two years x 4800 EUR/tonne = 4800 EUR
10) FeO (OH)– 438 t per year x 80 EUR/t= 35 040 EUR
11) Microelements 4 380 l per year total x 25 EUR/l= 109 500 EUR
12) Demineralized water to the heating system 1.5 tonnes
13) Spare parts for two years 180 000 EURO

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