ZORG BIOGAS

01

version

Proposal

Biogas plant using 321 tonnes brewery spent grains/day

Date: 13/02/2026
Validity: 10 months

CONTENT

OVERVIEW

Zorg Biogas offers a solution to process brewery spent into the biogas. The produced biogas is used to replace natural gas in the boiler. The proven technology of vertical CSTR reactor with a central agitator is used. The vertical shape provides the optimal mass and heat transfer, as a result the biogas plant consumes very little electric energy.

To compare different concepts of biogas plant it is necessary to pay attention not only to the price, but also to the quality and small but very important details. The temperature is maintained with an accuracy of 0,1ºC. The roof of the reactor and next two rows of rings are made from stainless steel. There is a double filtration of biogas, which save burners life. The biogas plant is equipped with a modern laboratory.

Biogas plants has a lot of features, which are known only to the experienced company. For example, operational temperature, foam safety valves, micro-elements and etc.

Raw material potential

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	DM content: (%)	ODM content (%)	DM quantity (tonne s/ day)	ODM quantity (tonnes / day)	Biogas yield (m^3 / tonneODM)	Biogas (m^3 /day)	Methane content (%)	Biogas (m^3 /year)
Brewery spent grains	321	117 165	20	94	61,2	60,35	630	38 019	60	13 876 935

*-DM- Dry matter
**-ODM- organic dry matter

Biogas plant characteristics

Characteristics	Values	Figures
Number of reactors	units	1
Reactor (vCTR)	units	1
Volume:		
Work	m^3	7920
Overall		8200
Temperature	^0C	55
Overall dimensions of the digester:		
diameter	m	23,05
height		19,87
Organic load	kgODM/m3	7,62
Hydraulic retention time (gross/net)	days	26/24
Number of gasholders	units	1
Volume:	m^3	800
Dimensions of the gasholder:		
diameter	m	12,6
height		9,7

Number of personnel

	Shift 1	Shift 2	Shift 3
Operator	1	1	1
Total	3		

Biogas plant working principle

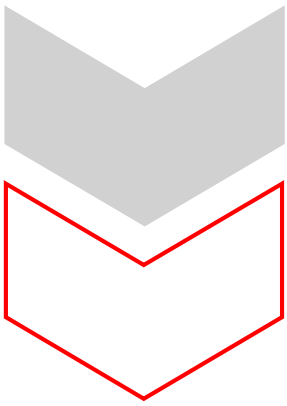
The technology is based on the biochemical conversion of organic materials from high molecular weight compounds to low molecular weight compounds. The first stage of this process is hydrolysis. Hydrolysis produces organic acids and alcohols.
Organic compounds + H2O→ C5H7NO2+HCO3.
Further conversion of 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

Brewery spent grains is directed into a reactor by portion using augers. In the reactor the substrate is brought up to a temperature of +55°C. Constant temperature is sustained for the entire digesting period. To prevent a rise in temperature (for example, in summer), the biogas plant is equipped with a cooler (dry cooling). The reactor operating regime is thermophilic. The heated substrate in the digesters is blended periodically. Mixing is performed by a central vertical agitator. The average time of processing in the reactor is 24 days. After the reactor, the substrate is fed by pump 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 a storage. Biogas goes up under overlap and delivered into a gasholder through pipeline. The gasholder system has a two-layer construction. The gas holder's weather protective film protects the gasholder from precipitation and damage by foreign objects. To protect the gasholder from overpressure, digester is equipped with safety valve, which start working at a pressure of 5 mbar and bleeds biogas to the atmosphere. Then accumulated in the gasholder 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 filter to remove hydrogen sulfide (H2S). After the filter, biogas goes to consumer.

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



Receiving tank (RT-01) and filtrate tank (FT-01)

Reservoir for reception of liquid kinds of raw materials. Tank is equipped with level sensors and side agitators for mixing raw materials. Tanks serve as a buffer for collection substrates and then to supply substrates to points of biogas plant according the technological process.
The receiving tank is used during biogas plant start-up to receive manure or inoculum.

Specifications

Receiving tank

Diameter:	**6,83 m**
Height:	**2,87 m**
Volume:	**105 m³**
Quantity:	**1 pcs.**

Filtrate tank

Diameter:	**6,83 m**
Height:	**2,87 m**
Volume:	**105 m³**
Quantity:	**1 pcs.**

Plates (tank wall enamelled, roof)
Flange, nozzle, lap joint flanges outside
Control glass
Ex light
Manhole
Ladder, stair and walkway
Brackets and clamps for pipe along tank edge (internal/external)

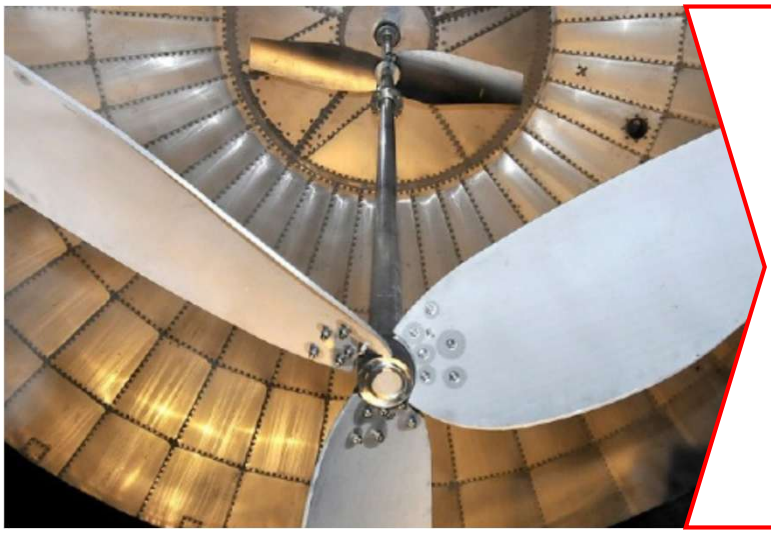
Reactor (RT-01)

Reactor is an important part of a biogas plant made of enameled sheet metal. The steel digester is installed on a concrete basis. A layer of enamel protects the surface of the entire metal structure. The enamel is vitreous and very resistant to aggressive pH and mechanical damage. Enameled digester assembled from steel segments. Such a digester is quickly and safely mounted. Steel panels are joined on bolted joints with a special sealant. The enamel coating is layered according to the PUESTA method. This is a special powder that is laid in layers by electrostatic attraction. Thus, uniformity of coating, density and smooth

Specifications

Height:	**19,87 m**
Diameter:	**23,05 m**
Total volume:	**8200 m^3**
Substrate volume	**7920 m^3**
Quantity:	**1 pcs.**

Plates (tank wall enameled, roof)
Flange, nozzle, lap joint flanges outside
2 off control glass 2 x DN 250 with water flush
Ex light
Manhole
Ladder, stair and walkway
Brackets and clamps for pipe along tank edge (internal/external)



Reactor central vertical agitator (AG-01)

The agitator is fixed to the center of the rigid overlap of the fermenter. Mixer blades are designed in different directions. This design of the blades helps to create a lifting force that lifts the substrate from the bottom of the digester to the top of the tank. The upper blades rotate distributing the substrate along the digester, directing the flow downward. The agitator works constantly, mixing the substrate in the digester all the time

Specifications

Engine power:	**37 kW**
Quantity per reactor:	**1 pcs**
Total quantity:	**1 pcs**

Side agitator (AG-02, AG-03)

Side mixers are used in biogas reactors and receiving tanks for mixing medium and low viscosity substrates. When installed on a metal tank, the stirrer is attached to a support column. The agitator drive is located outside, and a shaft with a screw goes into the reactor through a flange installed in the wall. Installation through a flange prevents the transfer of forces from the agitator to the tank walls. Suitable for use in aggressive environments with a dry matter content of up to 11 %. The special design of the shovel-like blades works good both with mixing different types of substrates and breaking up floating layers and crust.

Specifications

Receiving tank agitator

Engine power:	3,0 kW
Quantity per tank:	1 pcs

Filtrate tank agitator

Engine power:	3,0 kW
Quantity per tank:	1 pcs

Window with spotlight (SG-01)

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:	**230V, 50W, IP65**
VISULUX UL50 -G -H	

Pump equipment (PU-01, PU-02)

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 feed pump (PU-03)

Engine power:	15 kW
Flow rate:	50 m3/hour
Pressure:	4 bar
Quantity:	1 pcs

Substrate digested pump (PU-01)

Engine power:	15 kW
Flow rate:	50 m3/hour
Pressure:	4 bar
Quantity:	1 pcs

Substrate circulation pump (PU-02)

Engine power:	15 kW
Flow rate:	50 m3/hour
Pressure:	4 bar
Quantity:	1 pcs

Filtrate pump (PU-04)

Engine power:	15 kW
Flow rate:	50 m3/hour
Pressure:	4 bar
Quantity:	1 pcs

Decanter (DR-01)

This deep-pond 3-phase decanter centrifuge has been customized for clear clarification, liquid separation and solids dewatering. The solid-wall bowl has a cylindrical section for efficient clarification of the liquids and a conical section for drying the solids. Due to the centrifugal forces, the solids are flung onto the inner bowl shell and are transported by the scroll to the solids discharge. On decanter the heavy or light liquid phase is discharged under pressure by use of a centripetal pump while the other liquid phase is discharged by drain tubes. The housing consists of a frame with supporting feet, protective plates and catchers for the discharged phases

Specifications

Engine power:	**55 kW**
Flow rate:	**40 m3/hour**
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:	**9,7 m**
Diameter:	**12,6 m**
The total volume :	**800 m^3**
Quantity:	**1 pcs**

Biogas dryer and cooling (CHL-01)

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:	**1600 m^3/hour**
Gas inlet temperature:	**+55°C**
Gas outlet temperature:	**+10°C**
Electric power:	**52 kW**
Quantity:	**1 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:	**1600 m3/hour**
Pressure:	**150 mbar**
Engine power:	**22,0 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)**
The volume of charcoal:	**300 kg**
Quantity:	**1 pcs**

Gas analyzer (CH4, CO2, H2S) (GA-01)

Gas analyzer - a measuring device to determine the qualitative and quantitative composition of the gas mixture. In a biogas plant's installed absorption gas analyzers, biogas mixture components are absorbed sequentially with various reagents. Automatic gas analyzers continuously measure any physical or physicochemical characteristics of the gas mixture or its individual components. Operation is based on physical methods of analysis, including auxiliary chemical reactions.

Specifications

Set includes
Device for wall mounting
LCD display menu
Flow meter / control valve
Sensors

Quantity: **1 pcs**

Defined gases methane % (CH4), carbon dioxide % (CO2), hydrogen sulfide ppm (H2S)

Flare (BF-01)

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:	**1800 m^3/hour**
Pressure:	**min 10 mbar-max 60 mbar**
Quantity:	**1 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:	**2,0 kW**
Flow:	**20 m^3/hour**
Pressure:	**1 bar**

Circulating pump feeding heat carrier

Engine power:	**0,8 kW**
Flow:	**3 m^3/hour**
Pressure:	**1 bar**

The pumping station feeding propylene glycol

Engine power:	**0,8 kW**
Flow:	**1 m^3/hour**
Pressure:	**4 bar**

Plate Heat Exchanger (HE-01)

As of today, the design of dismountable plate heat exchangers is the most advanced in the field of solving heat exchange problems. Dismountable plate heat exchangers with thermal capacities ranging from 5 kW to 30 MW can be implemented for various technological processes.

The collapsible plate heat exchanger consists of a frame and a set of heat transfer plates. The frame of the heat exchanger consists of movable and fixed plates, upper and lower guides and a rear stand. All heat exchanger plates in the package are identical in size, but are rotated 180 degrees relative to each other. This arrangement ensures alternating hot and cold channels. During the heat exchange process, the working fluids move towards each other (counter currently). The hot medium transfers heat through the plate wall. There are dozens of plate sizes available for the collapsible heat exchanger. And for each plate size, there are several corrugations. The combination of plates with different reliefs (corrugations) increases the number of possible combinations of heat exchange channels. All of this makes it possible to model a plate heat exchanger that is as close as possible to the specified power and losses.

Specifications

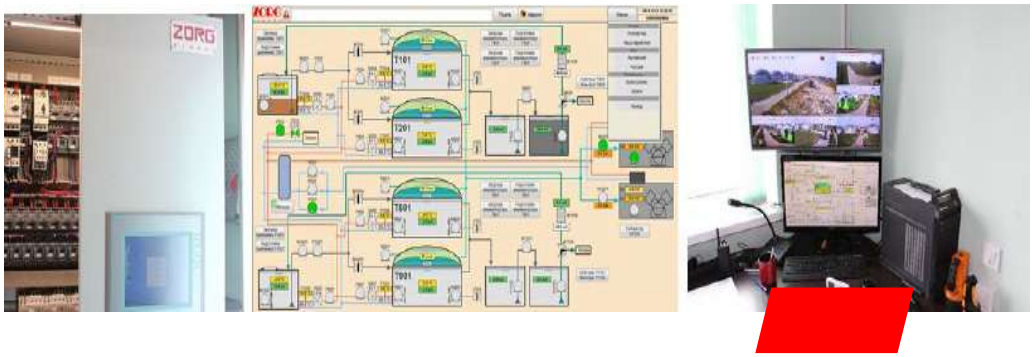
Volumetric capacity	**5 to 100 m3/h**
Temperature	**up to 90°C**
Working pressure	**at 4 bar**
Capacity of the heat exchanger for substrate	**400 kW**
Quantity:	**2 pcs**

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:	**80 kW**
Electric power:	**3 kW**
Quantity:	**1 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.

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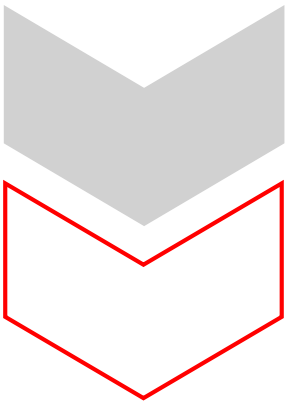
Equipment

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

Equipment specification list



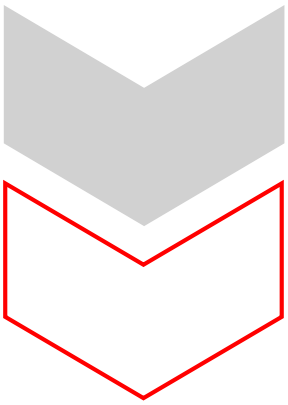
№	Equipment	Characteristic	Quantity
1	**Submersible mixer**	**N=3,0kW**	**2**
1.1	Airtight motor gearbox		2
1.2	Hydraulic screw (wear-resistant steel)		2
1.3	Mixer control mechanism		2
1.4	Electric motor mount		2
1.5	Set of fasteners		2
2	**Reactor central vertical agitator**	**N=37 kW**	**1**
2.1	Airtight motor gearbox		1
2.2	Hydraulic screw (wear-resistant steel)		1
2.3	Shaft (adapted to the height of the fermenter)		1
2.4	Blade		1
2.5	Frequency converter		1
2.6	Mounting bracket to bottom of the mixer		1
3	**Safety valve of digesters**		**1**
4	**Window with a searchlight**	**set**	**1**
4.1	Inspection window RD300 (mounts and sealant included)	Ø300	2
4.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	1
5	**Substrate feed pump**	**50 m3/hour N=15.0 kW**	**1**
6	**Substrate digested pump**	**50 m3/hour N=15.0 kW**	**1**
7	**Substrate circulation pump**	**50 m3/hour N=15.0 kW**	**1**

№	Equipment	Characteristic	Quantity
8	**Decanter**	**N=55 kW**	**1**
9	**Filtrate pump**	**50 m3/hour N=4,0 kW**	**1**
10	**PVC gas holder**	**800 m3**	**1**
10.1	Weather protection film	Ø12,6 m	1
10.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm biogas resistant		1
10.3	Air blower	16A, 0,5kW	
10.4	Excess and minimum pressure valve		1
10.5	Dome level sensor		1
10.6	Mounting system		1
10.7	Accessories		1
10.8	Safety valve		1
11	**Biogas Cooling System**	**1600 m3/h**	**1**
11.1	Chiller		1
11.2	Heat exchanger		1
11.3	Polypropylene glycol tank		1
12	**Desulphurization system**		**1**
12.1	Numbers of charcoal columns	300 kg	1
13	**Biogas compressor**	**Q=1600m3/h, H=150mBar, N=22 kW**	**2**
14	**Electromagnetic flow meter**		**1**
15	**Flare**	**1800 m3/h**	**1**
16	**Gas analyser**	**set**	**1**
17	**Gas equipment included**	**set**	**1**
17.1	Drainage pump with float	DN=50, Q=1m3/h, H=13 m	2

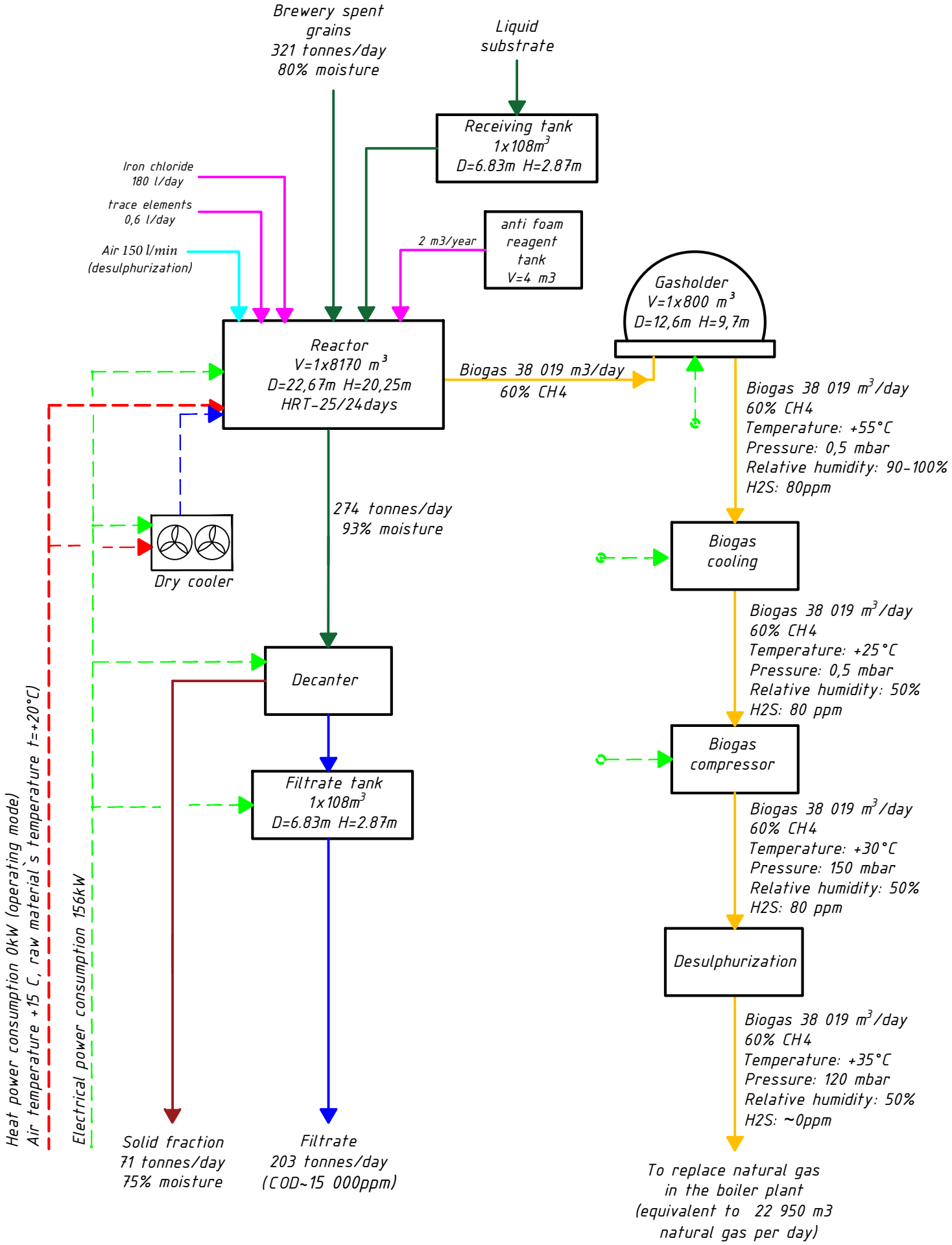
№	Equipment	Characteristic	Quantity
18	**The heat supply system**	**set**	**1**
18.1	Diaphragm expansion tank	V=1000 l,P=6Bar T=120°C	1
18.2	Circulating pump for supplying heat carrier	Q=30 m3/h,H=1bar	1
18.3	Propylene glycol feed pump station heating systems	Q=1,0 m3/h, H=4 bar	1
18.4	Circulation pump for supplying heat carrier to the digester	Q=18 m3/h, H=1.1 bar	1
19	**Water supply and sewerage system, complete, disassembled**	**set**	**1**
20	**Automation with electrical equipment**	**set**	**1**
20.1	Incoming distribution cabinet with a set of automation DB-1		1
20.2	Incoming distribution cabinet with a set of automation DB-2		1
21	**Sensors, set**		**1**
21.1	Gas pressure sensor 0,025Bar		2
21.2	Gas pressure sensor 0,4Bar		2
21.3	Pressure sensor(substrate level) 1,0Bar		4
21.4	Pressure sensor (substrate pressure) 2,5bar		4
21.5	Resistive thermometer (gas temperature)		3
21.6	Resistive thermometer with thermo well (fermenter substrate temperature)		3
21.7	Resistive thermometer with thermo-well (digester tank substrate temperature)		3
21.8	Resistive thermometer (heat conductor temperature)		3
21.9	Conductometric sensor of maximum level		3

№	Equipment	Characteristic	Quantity
21.10	Conductometric sensor of water level		3
21.11	Dome position sensor		1
21.12	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	2
22	**Dry cooler 80 kW heat pow.**		**1**
23	**Laboratory**	**set**	**1**
24	**Steel enamel tank**	**108 m3**	**2**
25	**Steel enamel tank**	**8200 m3**	**1**

APPENDICES



Material flow diagram

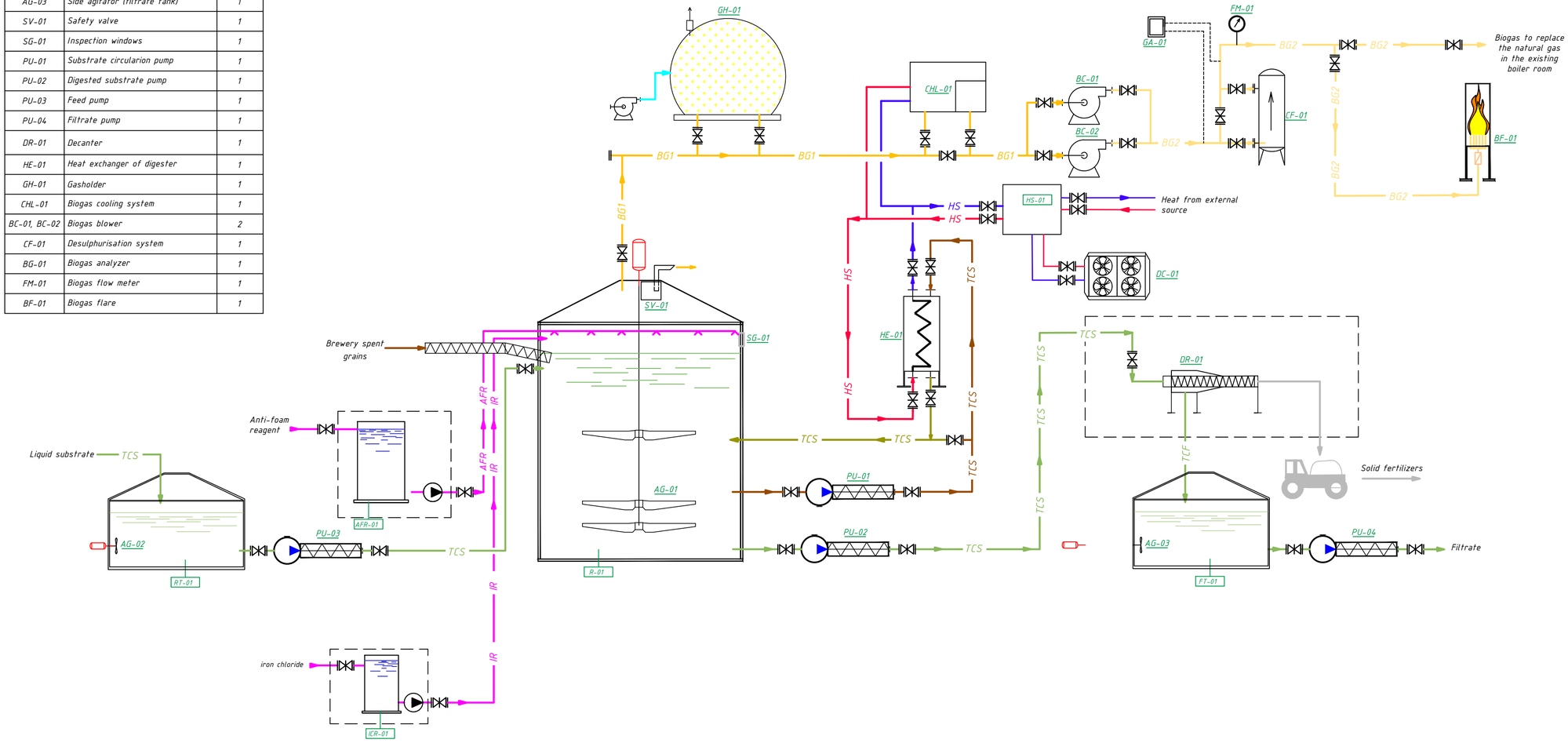


ZORG BIOGAS

Specification

N/№	Name	Quantity
AG-01	Digester central agitator	1
AG-02	Side agitator (receiving tank)	1
AG-03	Side agitator (filtrate tank)	1
SV-01	Safety valve	1
SG-01	Inspection windows	1
PU-01	Substrate circularion pump	1
PU-02	Digested substrate pump	1
PU-03	Feed pump	1
PU-04	Filtrate pump	1
DR-01	Decanter	1
HE-01	Heat exchanger of digester	1
GH-01	Gasholder	1
CHL-01	Biogas cooling system	1
BC-01, BC-02	Biogas blower	2
CF-01	Desulphurisation system	1
BG-01	Biogas analyzer	1
FM-01	Biogas flow meter	1
BF-01	Biogas flare	1

Basic diagram



Structure

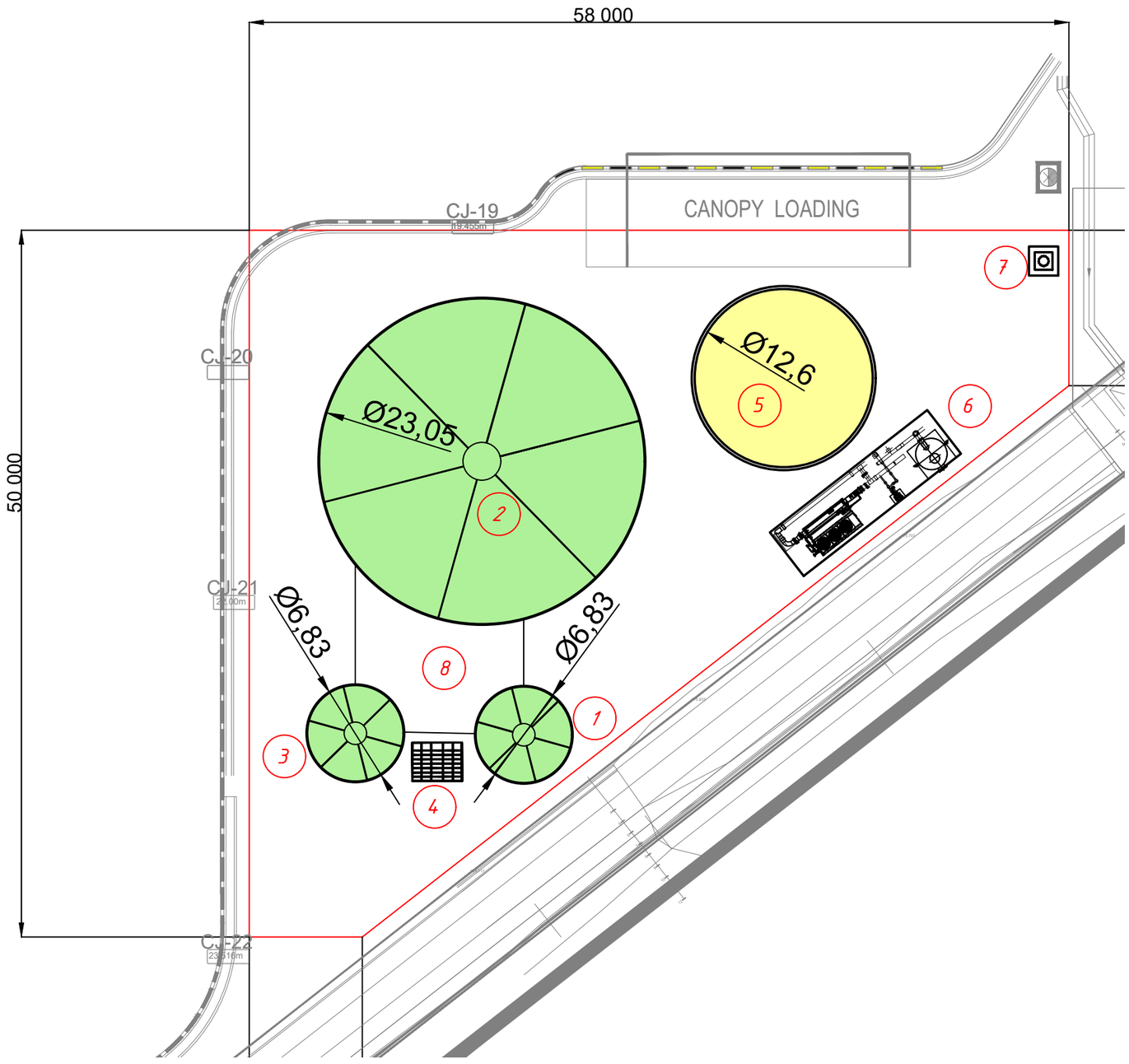
N/№	Name	Quantity
R-01	Reactor	1
FT-01	Filtrate tank	1
HS-01	Heat sub-station	1
AFR-01	Anti-foam reagent tank	1
ICR-01	Iron chloride tank	1

Legend main pipelines

- TCS — Substrate
- TCF — Filtrate
- BG1 — Biogas
- BG2 — Biogas
- HS — Heat system pipeline
- HS — Heat system pipeline
- AFR — Anti-foam reagent
- IR — Iron chloride

ZORG BIOGAS

Plan-scheme of biogas plant



Explication

N/№	Name	Note
1	Receiving tank	
2	Reactor	
3	Filtrate tank	
4	Decanter	
5	External gasholder	
6	Biogas cooling system	
7	Biogas equipment area	
8	Equipment room	

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Appendix 4

Name equipment	Instal. Pow. (kW)	Quantity (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Feeding screw set to reactor	15,0	1	15,0	8,0	120,0
Reactor Central Vertical agitator	37,0	1	37,0	16,0	592,0
Submersible agitator in receiving tank	3,0	1	3,0	8,0	24,0
Submersible agitator in filtrate tank	3,0	1	3,0	8,0	24,0
Feed pump	4,0	1	4,0	1,0	4,0
Substrate pump to separator	15,0	1	15,0	8,0	120,0
Substrate circulation pump	15,0	1	15,0	12,0	180,0
Filtrate pump	15,0	1	15,0	4,0	60,0
Decanter	55,0	1	55,0	8,0	440,0
Anti-foam pump	1,5	1	1,5	1,0	1,5
Iron-chloride pump	0,8	1	0,8	1,5	1,2
Biogas cooling system	52,0	1	52,0	24,0	1248,0
Biogas compressor	22,0	2	44,0	12,0	528,0
Dry cooler (Digester cooling system)	4,0	1	4,0	24,0	96,0
Dry cooler (brewery spent grains cooling system)	4,0	1	4,0	24,0	96,0
Circulating pump feeding heat carrier	3,5	1	3,5	24,0	84,0
Air blower for double membrane	1,0	1	1,0	24,0	24,0
Circulation pump for supplying at carrier to the digester	0,8	1	0,8	24,0	18,0
Circulating pump feeding hot water at technical building	0,1	1	0,1	only ambiant temp +15°C	
Circulation pump for supplying network water to the digester cooling system	2,0	1	2,0	24,0	48,0
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Desulphurization system compressor	1,5	1	1,5	24,0	36,0
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	1	0,1	0,5	0,0
Working lighting of switchboard	0,1	1	0,1	0,5	0,1
Total installed power, kW			**266**		
Total consumed electric energy, kWh per day					**3754**
Total consumed power, kW					**156**

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Appendix 5

Prices a biogas plant 321 tonnes spent grains/day

Pos	Name	Number of units	Unit price, EUR	Price sub-total, EUR	
1	Project documention	1	83 000	83 000	
2	Supervision	1	35 000	35 000	
3	Startup and training	1	50 000	50 000	
4	Living and travel expences	1	40 000	40 000	
5	Delivery of the equipment	15	9 000	135 000	
6	Laboratory	1	27 000	27 000	
7	Digester central vertical agitator 37kW	1	159 000	159 000	
8	Receiving tank side agitator 3,0kW	1	10 000	10 000	
9	Filtrate side agitator 3,0kW	1	12 000	12 000	
10	Substrate feed pump 15kW	1	23 000	23 000	
11	Digested substrate pump 15kW	1	23 000	23 000	
12	Circulation substrate pump 15kW	1	23 000	23 000	
13	Filtrate supply pump 15kW	1	23 000	23 000	
14	Decanter	1	175 000	175 000	
15	Gasholder 800m3	1	65 000	65 000	
16	Biogas chiller (Biogas cooling system) 1600 m3/h	1	115 000	115 000	
17	Biogas blower 1600 m3/h	2	18 000	36 000	
18	Desulphurization column with active coal 300 kg	1	18 000	18 000	
19	Biogas flare 1600 m3/h	1	64 000	64 000	
20	Gas analyzer	1	27 000	27 000	
21	Gas conditioning unit	1	36 000	36 000	
22	Over- and under pressure safeguard	1	8 000	8 000	
23	Water supply and canalization system	1	27 000	27 000	
24	Heat supply station	1	37 000	37 000	
25	External heat exchanger	2	15 000	30 000	
26	Dry-cooler	2	27 000	54 000	
27	Automation and electric cabinet	1	135 000	135 000	
28	Sensors (set)	3	21 000	63 000	
29	Receiving Enameled steel tank V=108 m³	1	75 000	75 000	
30	Filtrate Enameled steel tank V=108 m³	1	75 000	75 000	
31	Digester Enameled steel tank V=8200 m³	1	970 000	970 000	
32	Screw set	1	120 000	120 000	
33	Construction, erection and installation. Includes excavation, concerete foundations, gas pieps, substrate pipes, air pipes, cables, montage of all equipment with labor as well as montage machinery and instrumetns lease. The price is thumb up from our previous experience. Can be confirmed only after teh detailed project design.	1	700 000	700 000	by Client
			ZORG, EUR	2 773 000	
			by Client , EUR	700 000	
			TOTAL Zorg + Client, EUR	**3 473 000**	

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12	13
Project documentation	50%	50%											
Approvals and permits													
Equipment				30%	20%	20%	20%	10%					
Equipment delivery													
Construction													
Supervision				50%			50%						
Biogas 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 organization for the permit purposes. Namely the organization 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 for start-up, for construction period for normal operation.
4) External roads.
5) Temporary water supply during the construction and the hydraulic test of reactors 8200 m3. 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-week period and to fill with it at least 15-20% of the reactor volume 1400-1600 m3. The rest is filled with the water item above.
7) Machinery to transport filtrate and the digested mass from the biogas plant to the agricultural fields (a truck, a frontal loader, a tractor)
8) Impregnated activated carbon 0,3 tonne per year x 2800 EUR/tonne = 840 EUR
9) Fe(CL)3 – 65 tonnes per year x 900 EUR/tonne = 58 900 EUR
10) Anti-foam reagent 1 tonnes annually (all kinds of vegetable oil, for example, palm oil or rapeseed oil)
11) Demineralized water to the heating system 1,0 tonnes,
12) Spare parts for 2 years 120 000 EUR

Business center “Twin Yards”
Walter-Gropius-Straße 23,
DE-80807, München, Germany

Mob. +49 1511 457 29 45 (WhatsApp, Viber, Telegram)

igor.reddikh@zorg-biogas.com
www.zorg-biogas.com