ZORG BIOGAS

01

version

Proposal

Biomethane plant 14,5 million m3/year
using 60 000 tonnes straw/year

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CONTENT

Overview 3
Raw material potential 4
Biogas plant characteristics 5
Working principle 6
Technological process of biogas production 7
Main equipment 8

- Straw preparation plant 9
- Solid feeder 10
- Reactor-1,2, 3 (HLR) 11
- Reactor-1,2,3 vertical mixer 12
- Reactor-4 (CSTR) with gasholder 13
- Reactor-4 inclined paddle agitator 14
- Window with spotlight 15
- Pump equipment 16
- Separator 17
- Filtrate tank 18
- Submersible mixer 19
- Biogas cooling system 20
- Biogas compressor 21
- Desulphurization system 22
- Biogas burner 23
- Gas analyzer 24
- Water supplying and sewerage system 25
- Heating system 26
- Dry cooler (cooling substrate system) 27
- Automation and electrical equipment 28
- Sensors set 29
- Laboratory 30

Specification list 31

Appendices: 34
Appendix 1. Material flow diagram 35
Appendix 2. Basic diagram 36
Appendix 3. Plan of biogas plant 37
Appendix 4. Electric power consumption 38
Appendix 5. Equipment price 39
Appendix 6. Prices for equipment and Zorg' services 40

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 total turn-key budget for a biomethane plant 14,5 million m3 is 21 million EUR. In case, if the end-roduct is electric power generation 7MW (58 million kWh per year) then the biomethane upgrader and a compressor may be excluded. The total budget with the power generation is 17,5 million EUR.

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 (%)	Biomethane (m^3 / day)
Straw	164	60 000	80	96	131.5	120.98	640	77 429	53	41 286

Biogas plant characteristics

Characteristics	Values	Figures
Number of digesters	units	4
Digester -1,2,3 (HLR)		
a) volume:		
Work	m^3	3799
Overall	m^3	3898
b) Organic load	kgODM/ m^3	9.55
c) Hydraulic retention time (gross)	days	35/33
d) Overall dimensions of the digester (diameter / height)	m	22.0/10.5
e) Temperature	^0C	+52
Digester -4 (CSTR)		
a) volume:		
Work	m^3	2355
Overall	m^3	2659
b) Organic load	kgODM/ m^3	5.14
c) Hydraulic retention time (gross)	days	10/9
d) Overall dimensions of the digester (diameter / height)	m	22.0/7.0
e) Temperature	^0C	+52
Gasholder on the Filtrate Storage tank		
a) Volume	m^3	674
b) Number of gasholders	units	1
c) Dimensions of the gasholder (diameter / height)	m	22.0/4.4

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 is transported to the biogas plant area and discharged to a straw preparation unit, where the input material gain new technical features which turn it into a light and fibrous product (straw pellets). Then straw pellets are directed into loaders. Straw is transported to a biogas plant area and discharged into loaders. The loaders input substrates by portion to reactors using augers. In the reactors the substrate is brought up to a temperature of +52°C. 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. The heated substrate in the reactors is blended periodically. Mixing is performed by vertical mixers. The average time of processing in the reactors is 35 days. After the reactors, the substrate is fed by pump to a postdigester CSTR reactor. Where all substrate mixed and digest 10 days more in average. After postdigester the substrate is supplied by pump to a separator area where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged to the separation area and transported for storage; liquid filtrate is directed to a technological process. Biogas goes up under overlap and delivered into a postdigester, which equipped with gas holder roof instead of concrete roof. 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 biogs 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 plant (SP-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 pellets 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 straw 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 channeled to the briquetting machine where great pressure is generated to form great density briquettes. 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

Installed power	525 kW
Power consumption:	290 kW
Quantity:	1 pcs.

Solid feeder (SF-01 ... SF-03)

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 20m³/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

Length:	7.6 m
Width:	2.6 m
Height	2.8 m
Volume:	20 m³
Quantity:	3 pcs.

Reactor (R-01, R-02, R-03)

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. In the center of the digester there is a column with chapiter. 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 bottom has a slope 1%.

Specifications

Height :	10.5 m
Diameter :	22.0 m
The total volume :	3989 m^3
The substrate volume :	3799 m^3
Quantity:	3 pcs

Reactor vertical mixer (AG-01 ... AG-15)

Mixers 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:	N=15 kW
Quantity per digester:	5 pcs
Quantity total:	15 pcs

Reactor (R-04)

Raactor CSTR 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. The tank bottom has a slope 1%. The flexible gasholder is mounted above the tank. The tank can be used as a storage for filtrate, manure or water. In the storage tank there are two submersible motor agitators serves for mixing renewable raw materials (RRM), liquid material and similar substrates. The gasholder serves for biogas storage and for making even pressure and biogas composition. The gasholder system has two-layer construction. External - weather rotection film PVC-coated polyester fabrics, UV-protected, both side with finisher, 3.000 N/5cm, internal membrane PELD (gasholder) - methane permeation max. 260 cm3/ m2 * d * 1 bar, 650 N/5cm biogas resistant, Gasholder film cold resistance – 30°C... +60°C. Internal film is stretched under produced biogas pressure. The air is blow into space between external and internal membranes for making pressure for internal membrane and making form for external. Membranes are designed and cut out on NC machines.

Storage Specifications

Height :	7,0 m
Diameter :	22 m
The working volume :	2355 m³
The total volume :	2659 m³
Quantity:	1 pcs

Gasholder Specifications

Height :	4.4 m
Diameter :	22 m
The total volume :	674 m³
Quantity:	1 pcs

Reactor-4 paddle giant agitator (AG-16 ... AG-20)

Inclined paddle agitator with high agitator power is designed and engineered to high effectiveness also with high-viscosity media. Gentle treatment of the bacteria population in order to attain an optimum gas yield. Container bearing consisting of special, extremely wear resistant and matance-free bearing plastics. All relevant components can be replaced without having to drain the container or replacing the agitator shaft. The functional principle is ideal for breaking floating layers. The functional principle supports the agitation of setting layers. Degassing of the substrate is made easier. This agitator type is suitable for slightly fluctuating filling levels. 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

Specifications

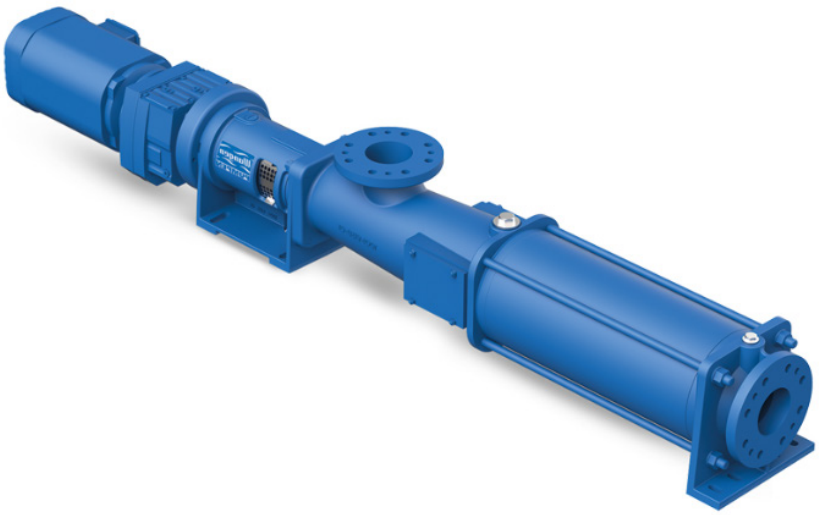
Engine power:	N=15 kW
Quantity per digester:	4 pcs
Quantity total:	4 pcs

Window with spotlight (SG-01 ... SG-04)

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
Spotlight VISULUX UL50 -G -H
230V, 50W, IP65



Pump equipment (PU-01 ... PU-07)

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 pump (PU-01...PU-03)	
Flow rate:	30 m3/hour
Engine power:	7.5 kW
Pressure:	4 bar
Quantity:	3 pcs
Digested substrate pump (PU-04, PU-05)	
Flow rate:	35 m3/hour
Engine power:	11 kW
Pressure:	4 bar
Quantity:	2 pcs
Filtrate pump (PU-06, PU-07)	
Flow rate:	40 m3/hour
Engine power:	7.5 kW
Pressure:	4 bar
Quantity:	2 pcs

Separator (SR-01 ... SR-02)

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

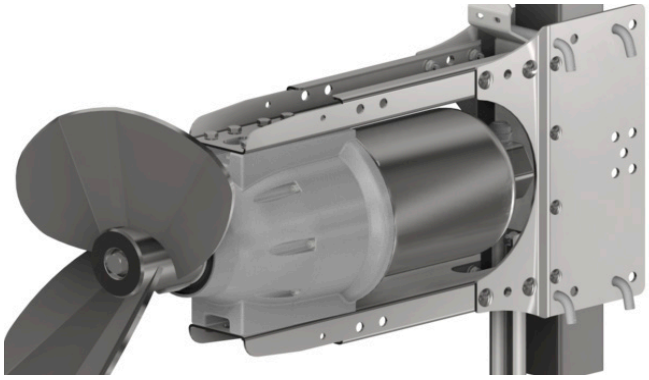
Engine power	**7.5 kW**
Flow rate	**8-15 m³ / h**
Quantity	**2 pcs**
Equipment	
Frame	
Screw	
Sieve for the filtration	
Counterweights	
The design of the protective room	

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

Diameter:	8.0 m
Height	3.0 m
Total volume:	150 m^3
Quantity:	1 pcs



Submersible mixer (AG-21)

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 of the filtrate tank (AG-21)

Nominal power	N= 3.0 kW
Quantity:	1 pcs

Biogas dryer and cooling (CHL-01, CHL-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	1650 m^3/ h
Gas inlet temperature	+50 C
Gas outlet temperature	+20 C
Cooling power	200 kW
Engine power	46 kW

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

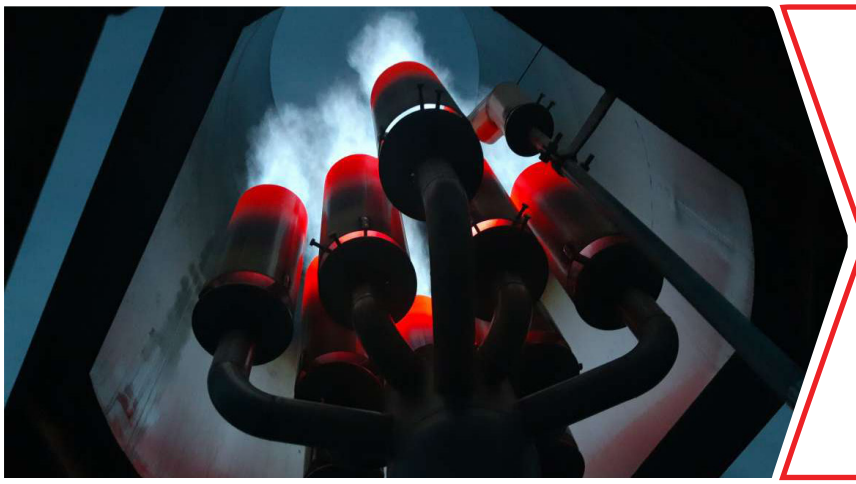
Flow rate:	3300 m^3/h
Pressure:	150 mbar
Engine power:	30 kW
Quantity:	2 pcs

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 re-duced to 0 ppm.

Specifications

Air compressor	5 m3/h
The volume of charcoal (CF-01, CF02)	500 kg
Numbers of charcoal columns	2 pcs



Flare

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	3300 m³/h
Quantity:	1 pcs

Gas analyzer (CH4, CO2, H2S, O2)

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

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

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

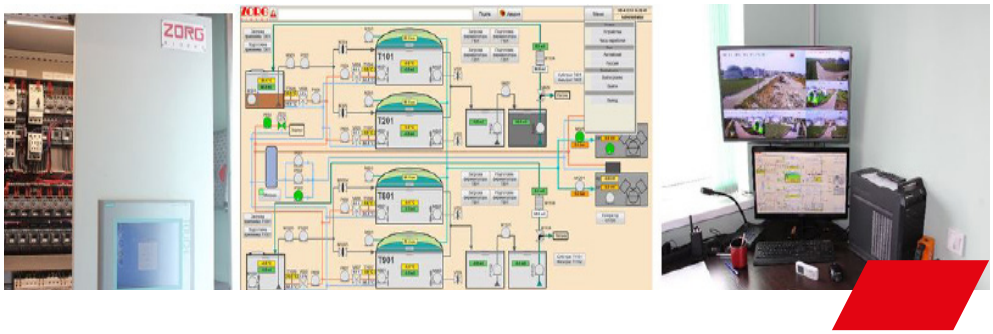
Circulating pump feeding heat carrier heating	
Flow	30 m3 / h;
Pressure	1 bar
Circulating pump feeding heat carrier to the digester	
Flow	18 m3 / h;
Pressure	1.1 bar
The pumping station feeding propylene glycol	
Flow	0.8 m3 / h;
Pressure	4 bar

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

Power (cooling)	100 kW
Length:	3,0 m
Width:	2,5 m
Height:	1,5 m
Power electrical	4 kW
Quantity:	3 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

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

EQUIPMENT SPECIFICATION LIST

№	Equipment	Characteristic	Quantity
1	**Solid feeder**	**V=20 m3**	**3**
1.1	Container bunker		3
1.2	Feeding screws	set.	3
2	**Submersible mixer of the filtrate tank**	**N=3.0kW**	**1**
2.1	Airtight motor gearbox		1
2.2	Hydraulic screw (wear-resistant steel)		1
2.3	Mixer control mechanism		1
2.4	Electric motor mount		1
2.5	Set of fasteners		1
3	**Digester vertical mixer**	**N=15 kW**	**15**
3.1	Airtight motor gearbox		15
3.2	Hydraulic screw (wear-resistant steel)		15
3.3	Shaft (adapted to the height of the fermenter)		15
3.4	Blade		15
3.5	Frequency converter		15
3.6	Mounting bracket to bottom of the mixer		15
4	**Digester inclined mixer**	**N=15 kW**	**4**
5	**Safety valve of digesters**		**4**
6	**Window with a searchlight**	**set**	**4**
6.1	Inspection window RD300 (mounts and sealant included)	Ø300	8
6.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	4
7	**Substrate pump**	**30 m3/hour N=7.5 kW**	**3**

№	Equipment	Characteristic	Quantity
9	**Digested substrate pump**	**N=11 kW, Q=35m3/h**	**2**
10	**Separator**	**N=7.5kW, Q=8-15m3/h**	**2**
10.1	Body		2
10.2	Substrate Supply Pipe 4 ’’		2
10.3	Engine - Gearbox	N=7.5 kW	2
10.4	Frame		2
10.5	Screw		2
10.6	Sieve for filtration		2
11	**Filtrate pump**	**40 m3/hour N=11kW**	**2**
12	**PVC gas holder 1/5D**	**674 m3**	**1**
12.1	Weather protection film	Ø22m	1
12.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm bio-gas resistant		1
12.3	Air blower	16A, 0,5kW	1
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**	**1650 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	**500 kg**	2

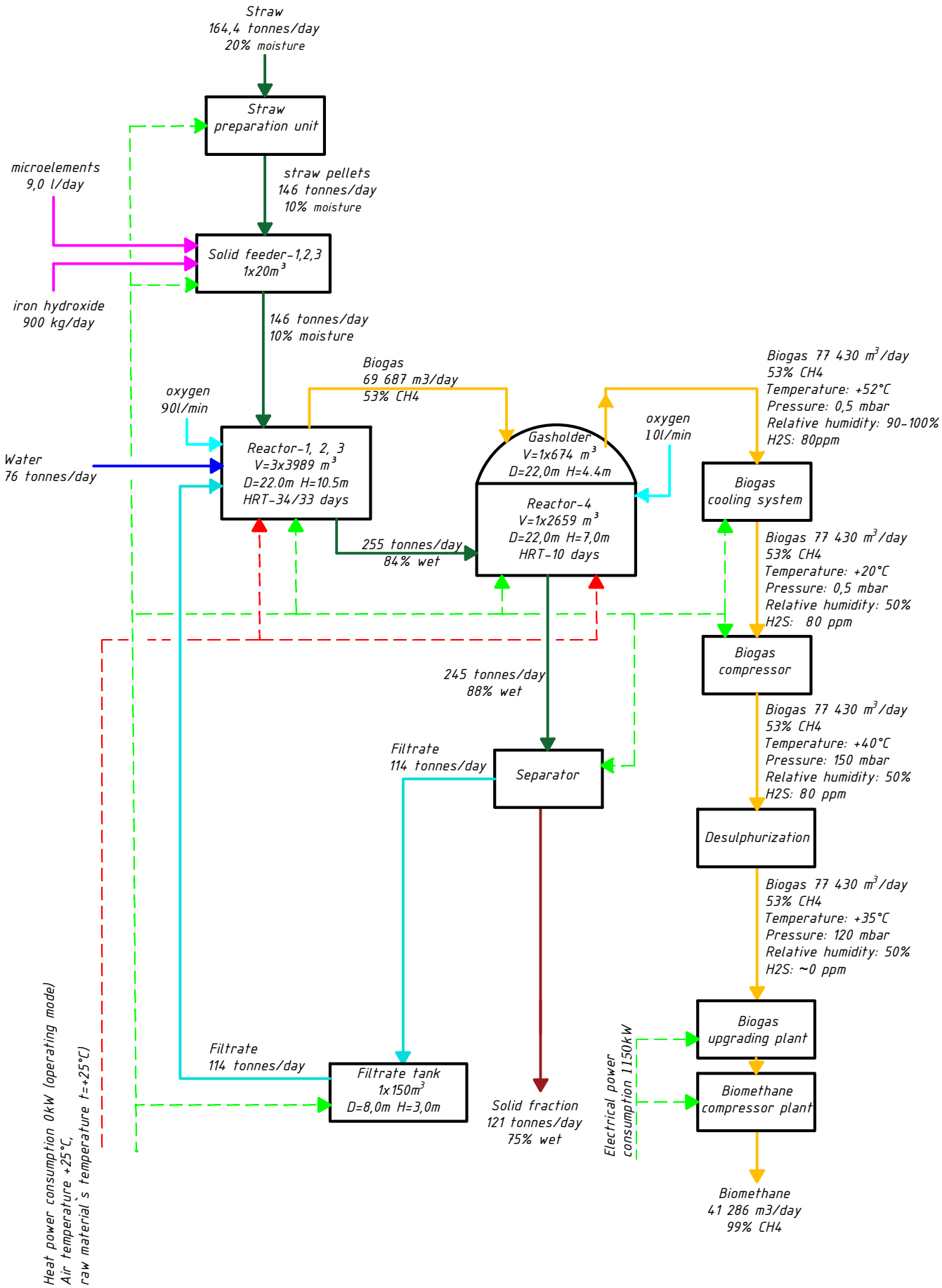
№	Equipment	Characteristic	Quantity
12	**Biogas compressor**	**Q=3400 m³/h H=150mBar N=30kW**	**2**
13	**Biogas analyzer (CH4 , CO2 , H2S, O2)**		**1**
14	**Electromagnetic flow meter**		**1**
15	**Flare**	**3400 m3/h**	**1**
16	**Gas equipment included**	**set**	**1**
16.1	Drainage pump with float	DN=50 Q=1m³/h H=13 m	2
17	**The heat supply system**	**set**	**1**
17.1	Diaphragm expansion tank	V=1000 l P=6Bar T=120°C	1
17.2	Circulating pump for supplying heat carrier	Q=30 m³/h H=1bar	1
17.3	Propylene glycol feed pump station heating systems	Q=1,0 m³/h, H=4 bar	1
17.4	Circulation pump for supplying heat carrier to the digester	Q=18 m3/h, H=1.1 bar	4
18	**Water supply and sewerage system, complete, disassembled**	**set**	**1**
19	**Automation with electrical equipment complete, disassembled**	**set**	**1**
19.1	Incoming distribution cabinet with a set of automation DB-1		1
19.2	Incoming distribution cabinet with a set of automation DB-2		1
20	**Sensors, set**		**1**
20.1	Gas pressure sensor 0,025Bar		4
20.2	Gas pressure sensor 0,4Bar		4
20.3	Pressure sensor(substrate level) 1,0Bar		5
20.4	Pressure sensor (substrate pressure) 2,5bar		5

№	Equipment	Characteristic	Quantity
20.5	Resistive thermometer (gas temperature)		5
20.6	Resistive thermometer with thermo well (fermenter substrate temperature)		5
20.7	Resistive thermometer with thermo-well (digester tank substrate temperature)		5
20.7	Resistive thermometer (heat conductor temperature)		5
20.9	Conductometric sensor of maximum level		2
20.10	Conductometric sensor of water level		5
20.11	Dome position sensor		1
20.12	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	4
20.13	Humidity and gas temperature sensor	ESFTF-I	2
21	**Dry cooler 100kW heat pow.**		**3**

APPENDICES

Material flow diagram

Appendix 1



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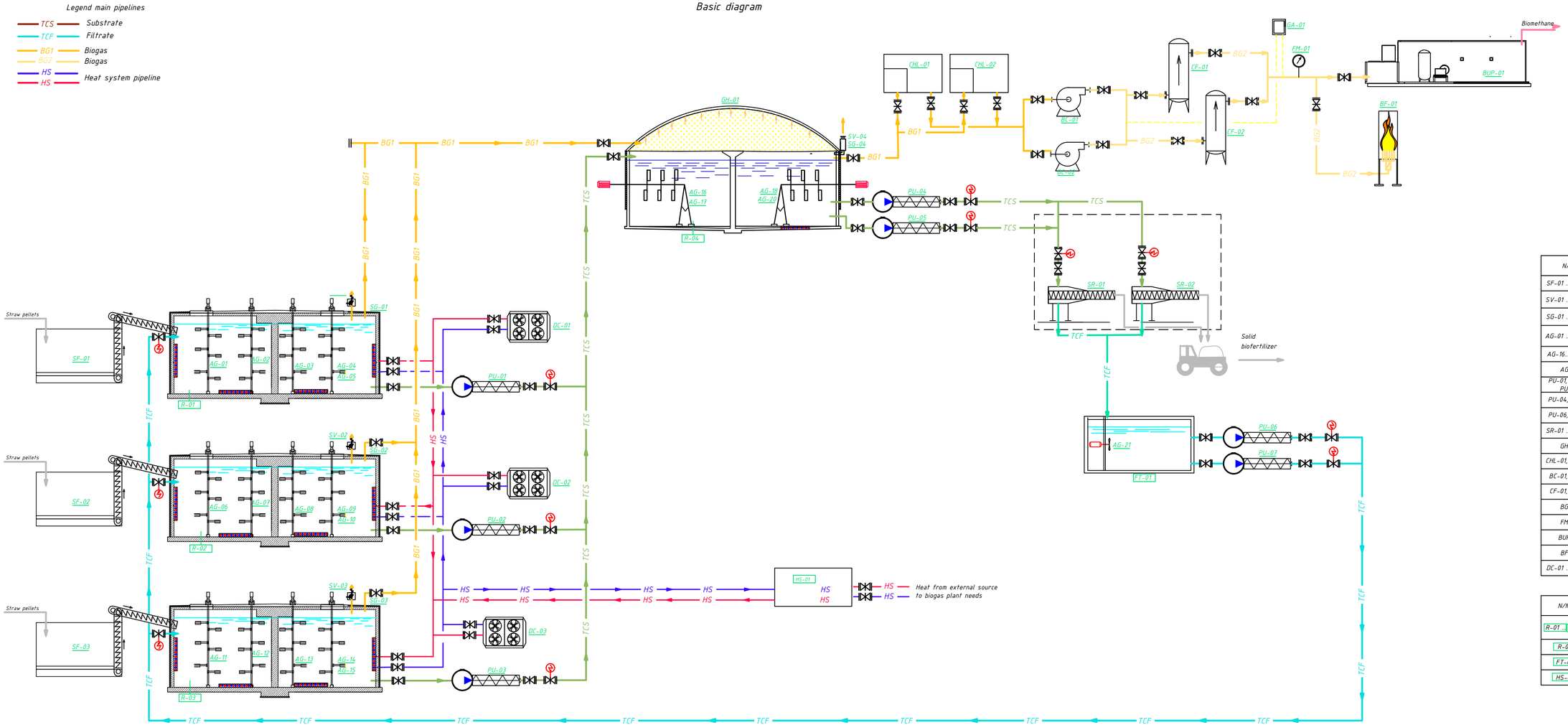
Basic diagram



Explication

N/№	Name	Quantity
SF-01 ... SF-03	Solid feeder	3
SV-01 ... SV-04	Safety valve	4
SG-01 ... SG-04	Inspection windows	4
AG-01 .... AG-15	Vertical Paddle agitator of Reactor-1,2,3	3x5
AG-16... AG-20	Inclined agitator of Reactor-4	4
AG-21	Submersible agitator	1
PU-01, PU-02, PU-03	Substrate pump to Reactor-4	3
PU-04, PU-05	Digested substrate pump to separators	2
PU-06, PU-07	Filtrate pump	2
SR-01 ... SR-03	Separator	3
GH-01	Gasholder	1
CHL-01, CHL-02	Biogas cooling system	2
BC-01, BC-02	Biogas blower	2
CF-01, CF-02	Desulphurisation system	2
BG-01	Biogas analyzer	1
FM-01	Biogas flow meter	1
BUP-01	Biogas upgrading plant	1
BF-01	Biogas flare	1
DC-01 ... DC-03	Dry cooler	3

Structure

N/№	Name	Quantity
R-01 ... R-03	Reactor - 1,2,3 (HLR)	3
R-04	Reactor-4 (CSTR)	1
FT-01	Filtrate tank	1
HS-01	Heat sub-station	1

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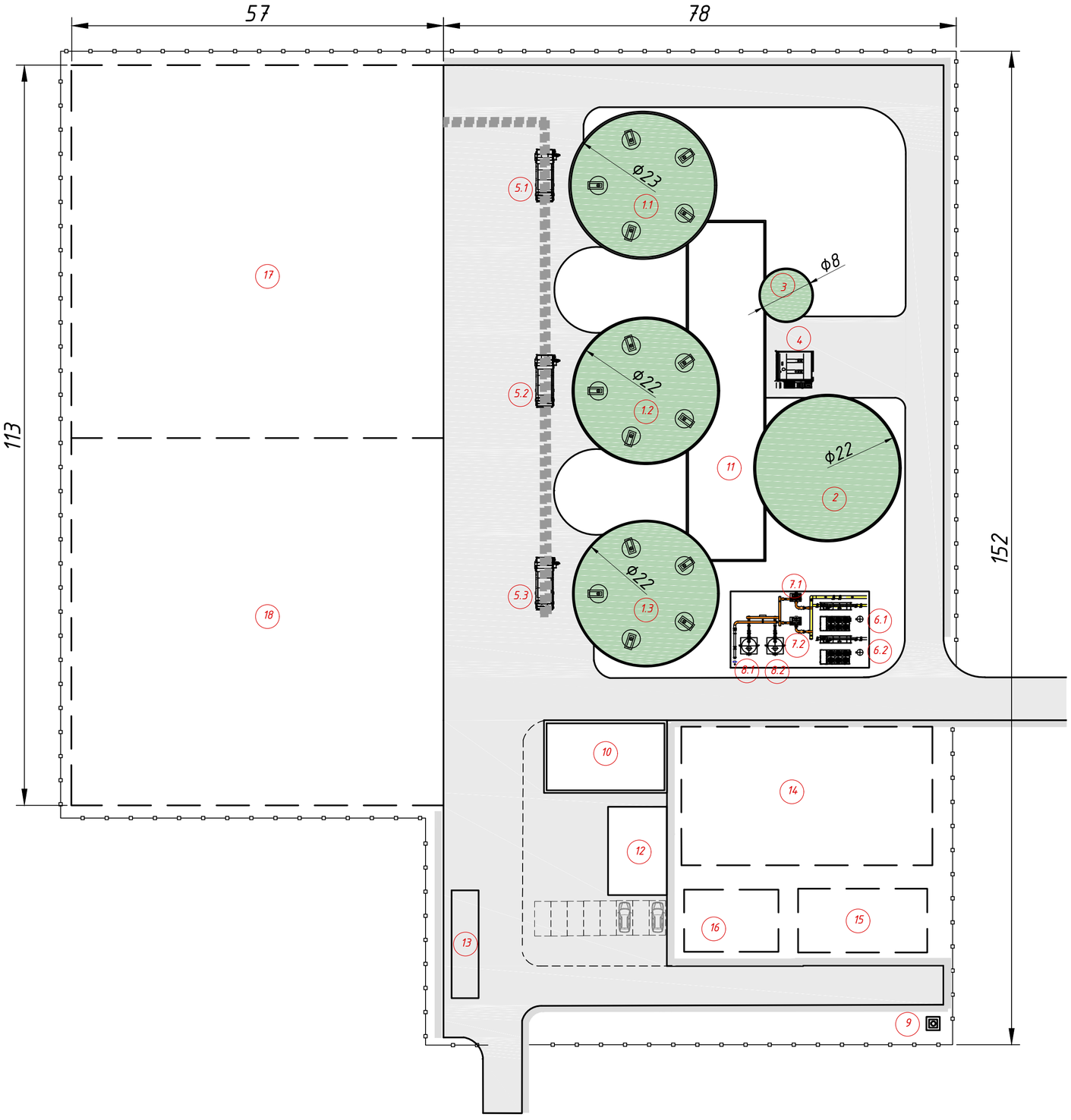
Preliminary layout proposal



Explication

N/№	Name	Note
1.1 -1.3	Reactor-1,2,3 (HLR)	R-01 ... R-03
2	Reactor-4 (CSTR)	R-04
3	Filtrate tank	FT-01
4	Separation area	SR-01, SR-02
5.1 ... 5.2	Solid feeder	SF-01 ...SF-03
6.1 , 6.2	Biogas cooling system	CHL-01, CHL-02
7.1 , 7.2	Biogas compressor	BC-01, BC-02
8.1 , 8.2	Carbon filter (desulphurization)	CF-01, CF-02
9	Biogas flare	BF-01
10	Technical room (operator room)	
11	Equipment room	
12	Warehouse	
13	Truck scale	
14	Biogas upgrading plant	BUP-01
15	Biomethane compressor plant	BCP-01
16	Gas station	GS-01
17	Strew preparation unit	
18	Strew storage	

Biogas plant area – 1,1 ha

Total plant area with options – 1,82 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**
Straw preparation line	290,0	1	290,0	4,0	1160,0
Loader V=20 m^3	18,0	3	54,0	6,0	324,0
Screw set.	24,0	3	72,0	6,0	432,0
Digester 1,2,3 Vertical agitator	15,0	18	270,0	18,0	4860,0
Digester 4 Inclined agitator	15,0	4	60,0	18,0	1080,0
Submersible mixer in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	46,0	2	92,0	24,0	2208,0
Biogas compressor	30,0	2	60,0	12,0	720,0
Doigested substrate pump	7,5	3	22,5	4,0	90,0
Separator	7,5	2	15,0	12,0	180,0
Substrate pump to separator	11,0	2	22,0	12,0	264,0
Filtrate pump	7,5	1	7,5	2,0	15,0
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	3	12,0	24,0	288,0
Circulation pump for supplying heat carrier to the digester	0,8	3	2,3	24,0	54,0
Circulation pump for supplying heat carrier to the digester cooling system	2,0	3	6,0	24,0	144,0
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	1	0,1	0,5	0,0
Working lighting of switchboard	0,1	1	0,1	0,5	0,1
Total installed power, kW			**705**		
Total consumed electric energy, kWh per day					**11892**
Total consumed power, kW					**496**

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	516,2	1	516,2	24,0	12388,7
Biomethane compressor plant up to 250 bar	137,6	1	137,6	24,0	3302,9
Total installed power, kW			**516,2**		
Total consumed electric energy, kWh per day					**15692**
Average consumed electric power, kW					**654**

Total average consumed electric power, kW					**1150**

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Appendix 5

Prices for equipment and Zorg' services EXW Memmingen, DE

Pos	Name	Number of units	Unit price, EUR	Discounts*	Discounted unit price, EUR	Discounted price sub-total, EUR
A	Project documention	1	137.000	0%	137.000	137.000
B	Supervision	1	60.000	0%	60.000	60.000
C	Startup and training	1	60.000	0%	60.000	60.000
D	Living and travel expences	1	60.000	0%	60.000	60.000
E	Delivery of the equipment	28	4.000	0%	4.000	112.000
F	Laboratory	1	28.000	0%	28.000	28.000
G	Straw storage area	1	500.000	0%	500.000	500.000
I	Straw preparation line equipment	1	5.000.000	0%	5.000.000	5.000.000
J	Biogas upgrading plant 3300 m3/h	1	4.980.000	0%	4.980.000	4.980.000
K	Biomethane compressor plant 1720 m3/h	1	450.000	0%	450.000	450.000
L	Construction	1	5.000.000	0%	5.000.000	5.000.000
1	Solid feeder	3	135.000	0%	135.000	405.000
2	Auger set	3	145.000	0%	145.000	435.000
3	Digester-1,2,3 vertical agitator 15kW	18	79.000	0%	79.000	1.422.000
4	Frame to pos.1	18	6.000	0%	6.000	108.000
5	Digester-4 inclined agitator 15 kW	4	75.000	0%	75.000	300.000
6	Substrate pump 7,5kW	3	28.400	0%	28.400	85.200
7	Digested substrate pump 11kW	2	28.500	0%	28.500	57.000
8	Filtrate supply pump 11kW	2	23.500	0%	23.500	47.000
9	Separator 7,5kW	2	52.000	0%	52.000	104.000
10	Gasholder 647 m3	1	80.500	0%	80.500	80.500
11	Biogas chiller (Biogas cooling system) 1600 m3/h	2	155.500	0%	155.500	311.000
12	Biogas blower 3300 m3/h	2	68.000	0%	68.000	136.000
13	Desulphurization column with active coal	2	58.500	0%	58.500	117.000
14	Biogas burner 3400 м3/год	1	178.200	0%	178.200	178.200
15	Gas conditioning unit	1	48.500	0%	48.500	48.500
16	Gas analyzer	1	28.300	0%	28.300	28.300
17	Over- and under pressure safeguard	4	5.400	0%	5.400	21.600
18	Sight glasses/viewing windows with projector	4	6.600	0%	6.600	26.400
19	Dry-cooler	3	28.700	0%	28.700	86.100
20	Heat supply station	1	119.000	0%	119.000	119.000
21	Water supply and canalization system	1	61.300	0%	61.300	61.300
22	Sensors (set)	1	157.000	0%	157.000	157.000
23	Automation and electric cabinet	1	470.000	0%	470.000	470.000
			TOTAL, EUR			**21.191.100**

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Appendix 6

Payments for equipment and Zorg' services

Payments for documention A	**Payments in %**		
Advance for documention	50%		68500
after 2 months	50%		68500
Payments for supervision B	**Payments in %**		
Advance forsupervision	50%		30000
after 3 months	25%		15000
after 6 months	25%		15000
Payments for startup and training C	**Payments in %**		
Advance for startup and training	50%		30000
after 2 months	50%		30000
Payments for living and travel D	**Payments in %**		
Advance	25%		15000
after 3 months	25%		15000
after 6 months	25%		15000
after 8 months	25%		15000
Payments for equipments			
	Payments in %	**Deliveries**	**15.374.100**
Advance against of the corporate guarantee	35%		5380935
after 2 months	10%		1537410
after 4 months	20%		3074820
after 6 months	30%		4612230
in 15 days after reaching 100% capacity and demonstrating 91% capacity during 4 months	5%		768705

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Project documentation	50%			50%														
Equipment supply					30%		20%		20%		20%	10%						
BUP					30%			30%			30%		10%					
Construction																		
Supervision					20%		20%		20%		20%		20%					
Plant start-up															25%	25%	25%	25%

Contracts

Project implementation is executed simultaneously under several contracts

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

ZORG BIOGAS

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