ZORG BIOGAS

Proposal

Biogas plant using 50 tonnes poultry dung a day (electric power 631 kW)

Date: 01/05/2024

Validity: 6 month

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OVERVIEW

Zorg Biogas offers a solution to process chicken dung into biogas and electric power in a biogas plant. Poultry dung differs from other feedstock. It has a lot of protein and ammonia is produced, that inhibits the reaction. Most of competitors offer an addition of cow dung, maize or an expensive ANA-strip reactors. We use another method, that doesn't require any special capital expenses or much of chemical additives either.

Raw material potential

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	DM content: (%)	ODM content (%)	DM quantity (tonnes / day	ODM quantity (tonnes / day	Biogas yield (m^3 / tonneDDM)	Biogas (m^3 /day)	Methane content (%)	Biogas (m^3 / year)
Chicken dung	50	18 250	30	75	15	11.25	550	6 187	60	2 258 255

Biogas plant technical performances

Characteristics	Values	Figures
Number of digesters	units	1
Digester volume Work Overall	m^3	 2460 2609
Organic load	kgODM/ m^3	4.57
Hydraulic retention time	days	28
Temperature in the digester	^0C	38
Overall dimensions of the digester (diameter / height)	m	15.37/14.07
Number of gasholder	units	1
Gasholder volume	m^3	210
Overall dimensions of the gasholder (diameter / height)	m	9.4/4.8

WORKING PRINCIPLE

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

Chicken dung is transported to the biogas plant area and discharged into a solid feeder. The solid feeder inputs substrates by portion to a digester using augers.

In the digester, the substrate is fermented at temperature of + 38 °C. Thus, a constant temperature is maintained in the digester throughout the entire fermentation process. The substrate is mixed with a vertical agitator. The average fermentation time is 27 days. Biogas rises and collects under the conical arch of the digester. To prevent excess pressure above acceptable, the digester is equipped with a safety valve that starts to operate at a pressure of 10 mbar and releases biogas into the atmosphere.

The biogas from the digester enters to an external gasholder. In the gasholder, pressure and biogas composition are averaged. Through pipelines, biogas from the gasholder enters to a biogas scrubber to remove hydrogen sulfide (H2S). Then biogas goes to a cooling system. The cooling system is a heat exchanger with its own cooling circuit. After cooling the biogas to + 20 °C, condensate formed is removed from the cooling system. After cooling, the biogas is heated to + 30 ° C to reduce the relative humidity of the biogas. After cooling biogas flows through the pipeline to the compressor, where its pressure rises to 80-150 mbar. After the compressor, biogas is fed to activated coal filters to fine purification. After the filters, biogas goes to a cogeneration power plant, where it is used as fuel for production of electricity and heat energy to biogas plant self consumption needs. Heat from the cogenerators is fed to a heat exchanger for heating the digesters. Heating equipment is used for distribution of heat between biogas plant facilities.

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

MAIN EQUIPMENT

Solid feeder (SF-01)

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:	8.7 m
Width:	2.6 m
Height	3.4 m
Volume:	30 m³
Quantity:	1 pcs.

Digester (D-01)

Digester 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 smoothness are achieved. Bolts made of stainless steel. All elements (flanges, etc.) are connected through an EPDM membrane to protect the enamel.

To reduce heat consumption and maintain a constant temperature, the digester is isolated. Outside the digester is coated with a decorative coating.

Specifications

Height :	14.07 m
Diameter :	15.37 m
The total volume :	2609 m^3
Quantity:	1 pcs.

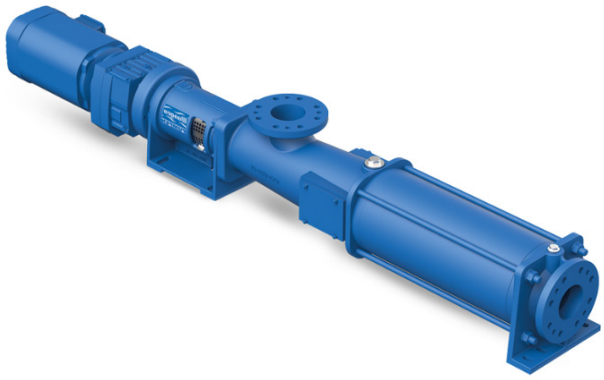
Plates (tank wall enamelled, roof)
Flange, nozzle, lap joint flanges outside
2 off control glass 2 x DN 250 with water flush
Ex light
Manhole
Ladder, stair and walkway
Brackets and clamps for pipe along tank edge (internal/external)

Digester central 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:	N=17 kW
Quantity (per digester):	1 pcs



Pump equipment (PU-01...PU-03)

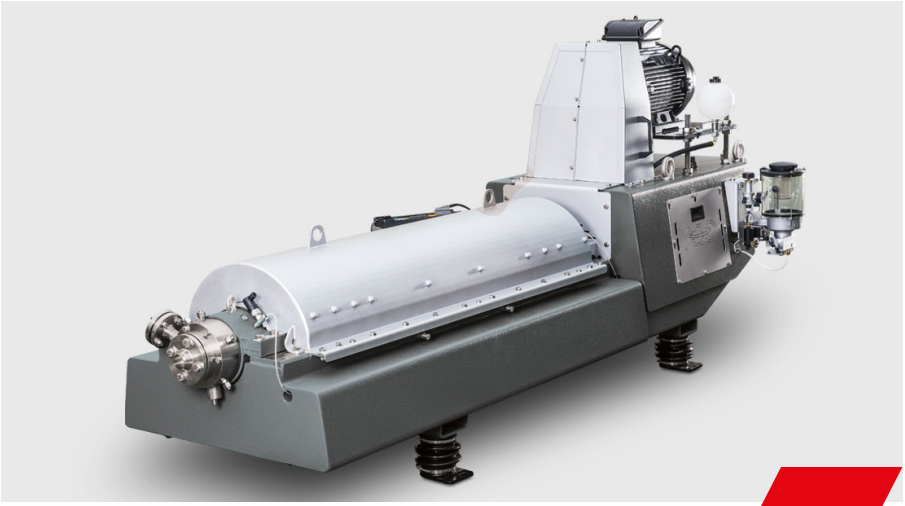
Pumps are used to transport substrate to the equipment and facilities in the biogas plant and away. Kinematic viscosity is a real physical factor that influences pump curves, and thus the choice of pump. Viscosity is essentially resistance to flow and this has implications for pumps. Fluid viscosity or thickness will affect how it will behave in a pump. Based on it we use type of pumps according substrate types.

Screw pumps are used for pumping flowable thin sludge,excess sludge and mechanically thickened sludge and conveying the substrates with their mostly high dry substance contents (DS) containing up to 12% dry matter.

Optimum pumping results are guaranteed by the flow-optimized suction housing and a constant joint diameter which prevents the plaiting of long fibers.

Specifications

Substrate circulation pump (PU-01)	
Flow rate:	25 m3/hour
Engine power:	5.5 kW
Quantity:	1 pcs
Digested substrate pump (PU-02)	
Flow rate:	25 m3/hour
Engine power:	5.5 kW
Quantity:	1 pcs
Filtrate pump (PU-03)	
Flow rate:	25 m3/hour
Engine power:	5.5kW
Quantity:	1 pcs



Decanter (DC-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 centrip-etal 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

Flow rate:	25 m^3/hour
Engine power:	9.0 kW
Quantity:	1 pcs

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.

Specifications

Diameter:	4.27 m
Height	4.27 m
Total volume:	61 m^3
Quantity:	1 psc

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)

Side Spiral agitator (AG-02)

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.

The side agitator of this series has an installed motor with a power of 15 to 22 kW, which allows it to mix a substrate with a volume of up to 31,800 m³/h. 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

Nominal power:	N= 3.0 kW
Quantity:	1 psc

Spiral Heat Exchanger (HE-01)

Using as modular design for slurry, sludge and biological mass and for mediums that are badly contaminated and burden by solids with a distinctive fouling behavior. The main component of the Spiral Heat Exchanger is an aluminum cast member made of a no corrosive alloy. A number of left-handed and right-handed components, one on top of the other, from a compact, high-capacity heat exchanger. To avoid hard alteration of the direction of the flow, the spiral channel has an anti-clockwise curvature (left-hand element) and a clockwise curvature (right-hand element).

Specifications

Volumetric capacity	5 to 60 m^3 / h
Temperature	up to 90 ° C;
Working pressure	at 4 bar
Capacity of the heat exchanger	150-300 kW
Quantity	1 pcs

Window with spotlight (SG-01)

Inspection windows are designed for visual control of processes inside the fermenter and post-digester. 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
Quantity: 3 pcs

Reagent tanks (AFR), (FPDS)

Reservoir for reception of liquid kinds of reagents. The tank is a system ready to install with automation and control cabinet to manage process from filling, mixing to discharging by pump. The tank is manufactured with quality plastics, such as PE, PP, PVDF and PVC. Possible to use in the different of climate zones and for contact with the most aggressive media. Temperature resistant and use from -40°C to over + 100°C. Pressure and impact resistant welding and adhesive joints - created according to DVS guidelines - are just as resistant as the sheet material itself.
Electrically insulated or conductive – use of conductive materials for selected applications to avoid static electricity possible.

Specifications

Anti-foam reagent tank (AFR)

Diameter:	3.7 m
Height	4.9 m
Total volume:	40 m³
Quantity:	1 pcs.

Ferrum chloride tank (FPDS)

AxB:	1.0 x1.0 m
Height	1,0 m
Total volume:	1 m³
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 :	4.8 m
Diameter :	9.6 m
The total volume :	210 m^3
Quantity:	1pcs

Biogas scrubber (SC-01)

The biogas scrubber works by putting a gas stream in close contact with a flushing reagent liquid. Due to this contact, certain gaseous components, like H2S dissolve and remain in the water. Therefore, there is a transfer of components in the gas phase to the liquid phase, also called absorption. The solubility of the particles in the liquid will determine to what extent the gaseous components dissolve in that phase. Scrubbers are made of polyester reinforced with fiberglass (PRFV). Completely smooth interiors rich in polyester that allow a erfect evacuation and great chemical resistance to the different products to be stored. Specially designed for gas streams generated by industry and biogas plants. Each scrubber is made with the most suitable resins for each specific product and all equipment includes a nameplate and a manufacturing certificate.

Specifications

Gas volume flow	260 m^3/ h
Diameter	2.3 m
Height	12.0 m
Consumption el. power	1.5 kW
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	260 m^3/ h
Gas inlet temperature	+40 °C
Gas outlet temperature	+30 °C
Engine power	26 kW
Quantity:	1 pcs

Biogas compressor (BC-01)

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 (cogeneration power plant in our case)

Specifications

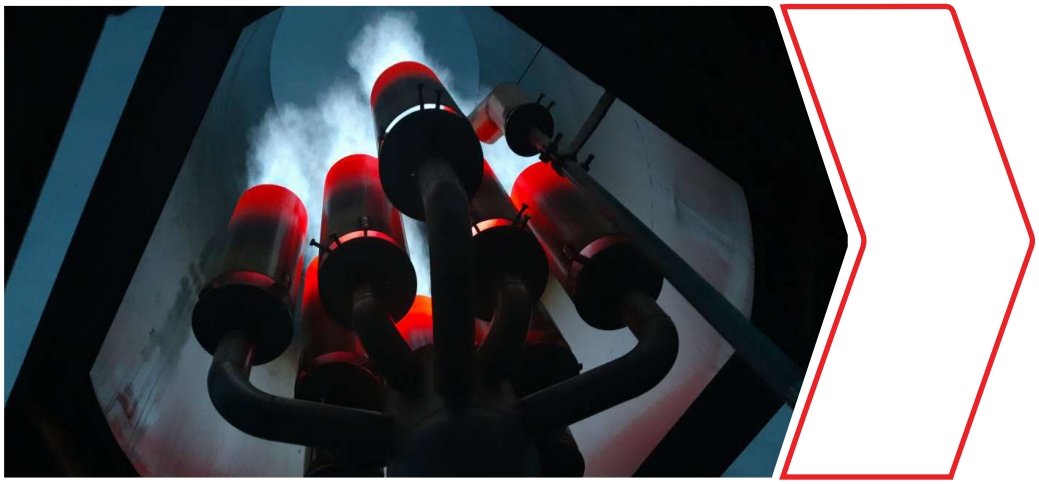
Flow rate	260 m^3/h
Pressure	150 mbar
Engine	4,5 kW
Quantity	1 pcs

Desulphurization system (CF-01)

The desulphurization system is a one-step purification of biogas to remove sulfur. The system cleans biogas of sulfur using 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

The volume of charcoal	200 kg
Numbers of charcoal columns	1 pcs



Flare (BF-01)

The 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	260 m^3/h
Quantity	1 pcs

Gas analyzer (CH4, CO2, H2S, O2) (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

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

Cogeneration Power Plant (CHP-01)

A cogeneration power plant (CHP) is used for producing electricity and heat. CHP is a very efficient technology for generating electricity and heat together. A CHP plant is an installation where there is simultaneous generation of usable electric power and heat in a single process, and it can provide a secure and highly efficient method of generating electricity and heat at the point of use. Due to the utilization of heat from electricity generation and the avoidance of transmission losses, due to electricity being generated on site, CHP typically achieves a 35 per cent reduction in primary energy usage compared with power stations and heat only boilers. This allows for economic savings where there is a suitable balance between heat and power loads. Another important factor, showing the benefits of cogeneration and CHP, is its low environmental impact. CHP produces lower quantities of pollutant emissions and heat pollution of the atmosphere. The current mix of CHP installations achieves a reduction of over 10 per cent in CO2 emissions in comparison with combined-cycle gas turbines.

Specifications

Produced electric power	637 kW
Produced heat power	671 kW
Emissions	NOx < 500 mg/Nm³ (5% O2)
Generator	400V, 50Hz
Quantity:	1 pcs

Dry cooler (DC-01)

The device is designed to cool the heat-carrie in heat supply system. When using highly temperature substrates, there is a chance of uncontrolled self-heating of the digester. The cooler is connected to the heating pipes, and when it is active according to temperature sensors, the same lines of heating supply are used. One cooler works with related spiral heat exchanger to cool the input substrates. Another one works with second heat exchanger to control temperature inside the digester.

Specifications

Power (cooling)	100 kW
Engine power:	4,0 kW
Quantity:	1 pcs

Heating system

The heating equipment is using for biogas plant heating and for sustaining a constant temperature in the fermenter. The heating equipment includes circulation pumps, heat exchangers, heating manifolds, and tubes. The heat from the boiler is transferred to biogas plant walls by using a heat exchanger and is pumped through the interior of the biogas plant by circulation pumps. The system prepares water with added ethyl glycol. The inlet and outlet temperature in the fermenter are 60C and 40C respectively.

Specifications

Circulating pump feeding heat carrier	
Flow	12 m3 / h;
Pressure	1.1 bar
Engine	3.5 kW
Circulating pump feeding heat carrier	
Flow	0.6 m3 / h;
Pressure	1 bar,
Engine	0.165 kW
The pumping station feeding propylene glycol	
Flow	1,0m3 / h;
Pressure	4 bar,
Engine	0.775 kW

Water supplying and sewerage system

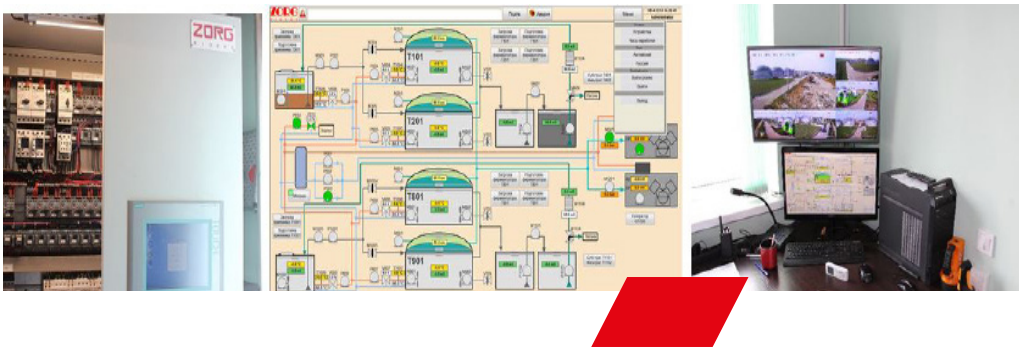
The water supply system provides biogas plant with water for technological needs, water for heating-cooling system, water for drinking and domestic use, and water for fire safety systems. As used, centrifugal single-stage pumps are the main pumping elements. These pumps are designed for pumping wastewater, water for drinking and domestic use, and sewage.

Pressure Boosting Systems are designed for pure water pressure boosting in industrial plants. The booster is comprised of 2 to 3 pumps connected in parallel and installed on a common base frame and provided with all required fittings.

Specifications

Water supply pump	
Pressure	2.5 bar
Flow	25 m3/h
Engine	3.0 kW
Submersible pump	
Pressure	1.1 bar
Flow	15 m3 / h
Engine	3,5 kW
Submersible pump with power cable	
Pressure	1.1 bar
Flow	1,7l / s
Engine	0,9 kW

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



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

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

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

SPECIFICATION LIST

№	Equipment	Characteristic	Quantity
1	**Filtrate tank (steel enamel tank)**	**V=61m³**	**1**
1.1	Manholes	set	1
1.2	Flanges to connection engineering communication	set	1
1.3	Service sites (for mixers gear, valves and connections)	set	1
1.4	Fixing for engineering communication	set	1
2	**Side Spiral agitator**	**N=3,0 kW**	**1**
2.1	Three phase motor, pressure-proof		1
2.2	Belt drive unit		1
2.3	Double acting mechanical seal		1
2.4	PTC motor control		1
2.5	Base-frame for the assembly		1
3	**Solid feeder**	**set**	**1**
3.1	Bufer bunker	**30 m³**	1
3.2	Screw set		1
4	**Digester (steel enamel tank)**	**V=2609 m³**	**1**
4.1	Windows with spotlight, complete, disas-sembled	set	1
4.2	Flanges to connection engineering communication	set	1
4.3	Service sites (for mixers gear, valves and connections)	set	1
4.4	Fixing for engineering communication	set	1
5	**Digester vertical agitator**	**N=17kW**	**1**
5.1	Airtight motor gearbox		1
5.2	Hydraulic screw (wear-resistant steel)		1
5.3	Shaft (adapted to the height of the fer-menter)		1
4.5	Frequency converter		1

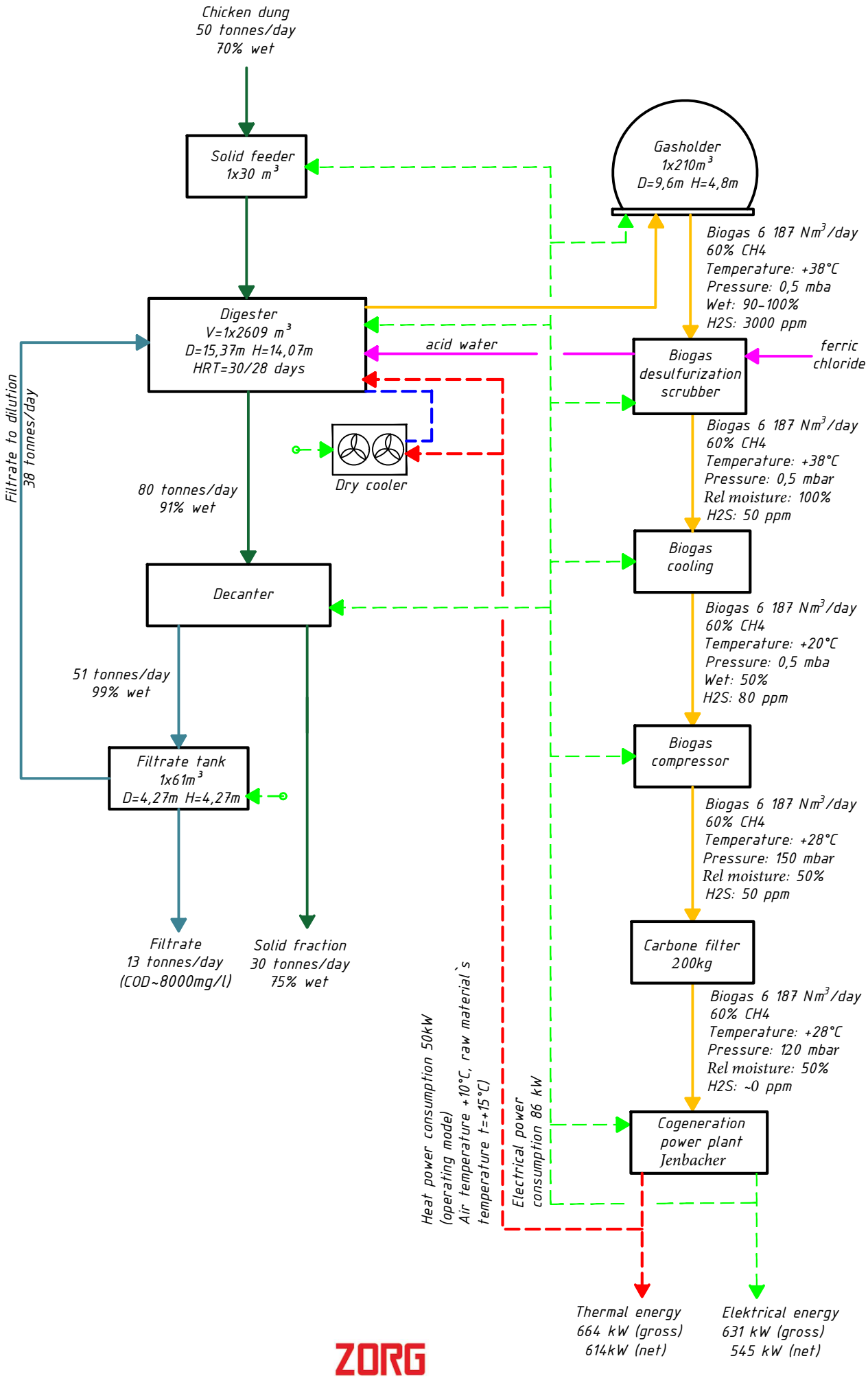
№	Equipment	Characteristic	Q-ty
6	**Circulation substrate pump**	**Q=25 m³/h**	**1**
7	**External heat exchanger**	**150 kW**	**1**
8	**Digested substrate pump**	**Q=25 m³/h**	**1**
9	**Filtrate pump**	**Q=25 m³/h**	**1**
10	**PVC external gas holder**	**Ø9.6 m**	**1**
10.1	Weather protection film	Ø9.6 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	1
10.5	Excess and minimum pressure valve		1
10.6	Dome level sensor		1
10.7	Mounting system		1
10.8	Accessories	set	1
11	**Digester safety valve**		**1**
12	**Biogas scrubber**	**Q=260 m³/h**	**1**
13	**Biogas compressor**	**Q=260 m³/h N=4.5 kW**	**1**
14	**Biogas Cooling System**	**260 m³/h**	**1**
14.1	Chiller		1
14.2	Heat exchanger		1
14.3	Polypropylene glycol tank		1
15	**Charcoal filter**		**set**
15.1	Filter with activated charcoal		1
16	**Biogas analyzer (CH4 , CO2 , H2S)**		**set**
17	**Electromagnetic flow meter**		**1**

№	Equipment	Characteristic	Q-ty
18	**Flare**	**260 m³/h**	**1**
18.1	Compressor		1
18.2	Manual locking element		1
18.3	Deflagration fuse		1
18.4	On-site control cabinet		1
18.5	Auto ignition system		1
18.6	Auto Main Gas Solenoid Valve		1
19	**Cogeneration power plant**	**637 kW**	
20	**The heat supply system**		**1**
20.1	Diaphragm expansion tank	V=1000 l P=6Bar T=120°C	1
20.2	Circulating pump for supplying heat carrier	Q=12 m³/h N=3,5 kW	1
20.3	Circulation pump for supplying heating water to the office building	N=0,165 kW	1
21	**Dry cooler**	**100kw heat pow.**	**1**
22	**Automation with electrical equipment complete, disassembled**		**1**
22.1	Incoming distribution cabinet with a set of automation DB-1		1
22.2	Incoming distribution cabinet with a set of automation DB-2		1
22.3	Incoming distribution cabinet with a set of automation DB-3		1
23	**Sensor set**		**1**
23.1	Conductivity sensor	31SCM50	2
23.2	Pressure / level sensor	SEN-3251 B025 G1 1Bar	3
23.3	Ultrasonic sensor	SPA-380-08	2

№	Equipment	Characteristic	Q-ty
23.4	Gas pressure sensor	G1/2 0,4Bar	4
23.5	Thermal converter		4
23.6	Thermowells for thermocouples	TR10-B	2
23.7	Thermal converter heating circuit	TR3	2
23.8	Substrate pressure sensor	G1 4Bar	3
23.9	Substrate pressure sensor	G1 2,5Bar	3
23.10	Coolant pressure sensor	G1/2 6Bar	2
23.11	Immersion level sensor	LS-10 0,6Bar 4-20 mA	4
23.12	Humidity and gas temperature sensor	ESFTF-I	2
24	**Anti-foam reagent tank**	**40m^3**	**1**
25	**Ferric chloride dosing storage tank**	**1 m^3**	**1**
26	**Laboratory**	**set**	**1**

APPENDIXES

Material flow diagram



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Specification

N/№	Name	Quantity
AG-01	Digester central agitator	1
SF-01	Solid feeder	1
AG-02	Side agitator	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	Filtrate pump	1
DR-01	Decanter	1
HE-01	Heat exchanger of digester	1
GH-01	Gasholder	1
SC-01	Biogas scrubber unit	1
CHL-01	Biogas cooling system	1
BC-01	Biogas blower	1
CF-01	Carbone filter	1
BG-01	Biogas analyzer	1
FM-01	Biogas flow meter	1
BF-01	Biogas flare	1
CHP-01	Cogeneration power plant	1

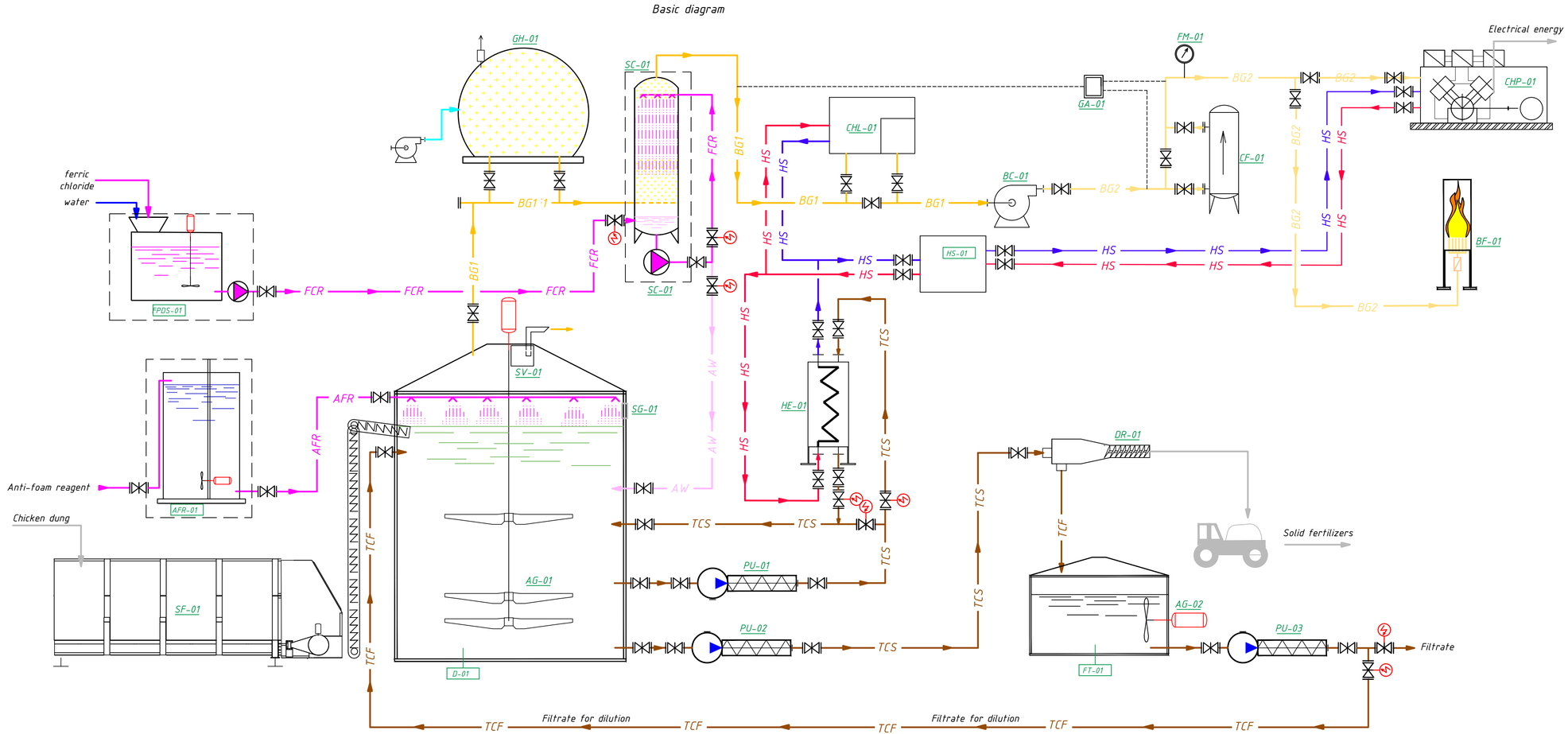
Structure

N/№	Name	Quantity
D-01	Digester	1
FT-01	Filtrate tank	1
HS-01	Heat sub-station	1
AFR	Anti-foam reagent tank	1
FPDS	Ferric chloride preparation and dosing station	1

Legend main pipelines

- TCS — Substrate
- TCF — Filtrate
- BG1 — Biogas
- BG2 — Biogas
- HS — Heat system pipeline
- HS — Heat system pipeline
- AFR — Anti-foam reagent
- FCR — Ferric chloride reagent
- AW — Acid water

Basic diagram



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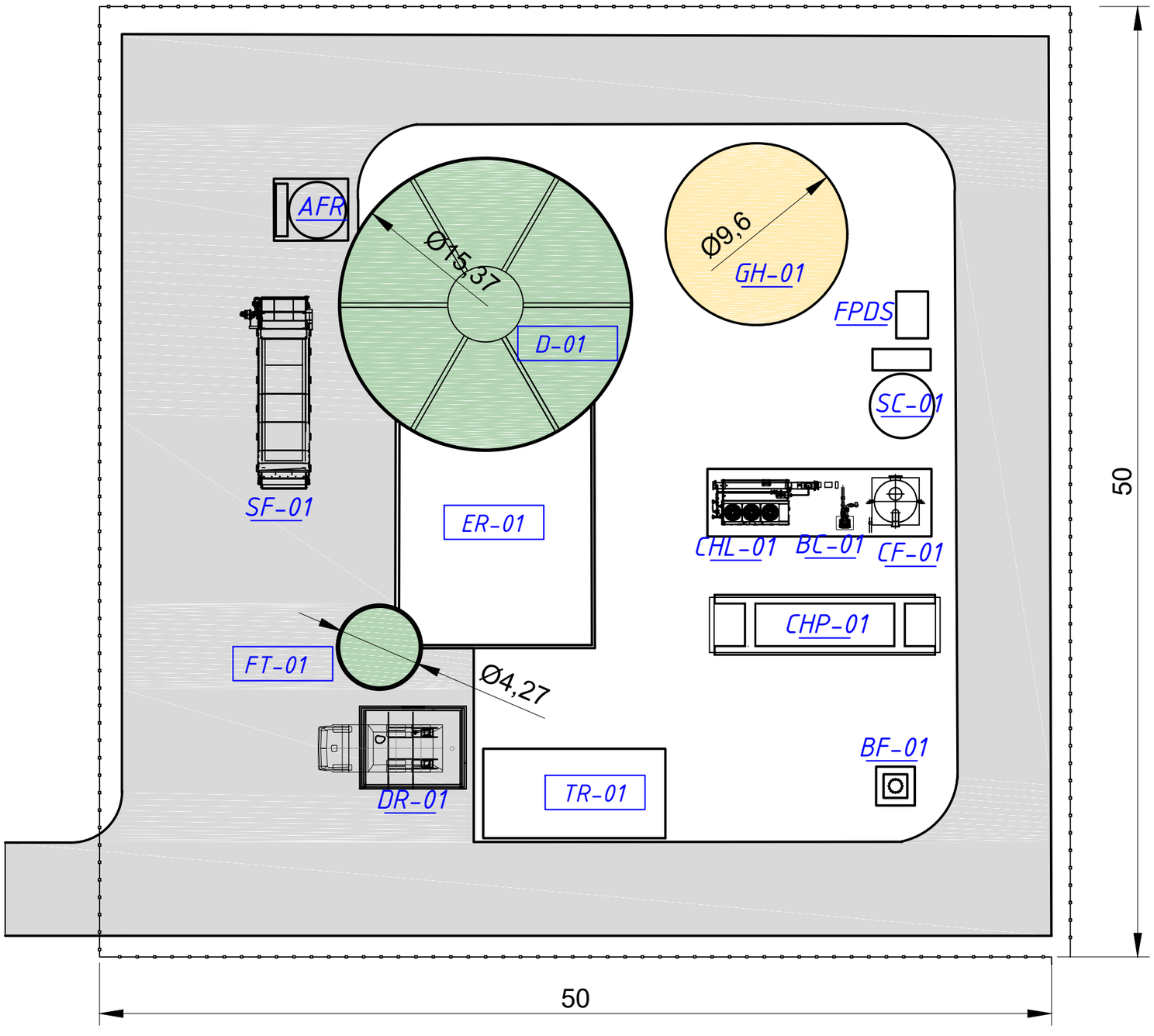
Preliminary layout proposal



Explication

N/№	Name	Note
SF-01	Solid feeder	
D-01	Digester	
FT-01	Filtrat tank	
DR-01	Decanter platform	
GH-01	Gasholder	
SC-01	Biogas scrubber	
CHL-01	Biogas cooling system	
BC-01	Biogas compressor	
CF-01	Carbon filter (desulphurization)	
BF-01	Biogas burner	
ER-01	Equipment room	
TR-01	Technical room	
CHP-01	Cogeneration power plant	
AFR	Anti-foam reagent tank	
FPDS	Ferric chloride preparation and dosing station	

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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**
Loader V=30 m^3	22,0	1	22,0	8,0	176,0
Screw set.	35,0	1	35,0	8,0	280,0
Digester Vertical agitator	17,0	1	17,0	18,0	306,0
Side mixer in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	26,0	1	26,0	24,0	624,0
Biogas compressor	4,5	1	4,5	12,0	54,0
Decanter	9,0	1	8,0	7,0	56,0
Substrate pump to decanter	5,5	1	8,0	7,0	56,0
Filtrate pump	5,5	1	3,0	4,0	12,0
Substrate circulation pump to heat exchanger	5,5	1	3,0	12,0	36,0
Biogas scrubber circulation pump	1,5	1	3,0	24,0	72,0
Reagent preparation and dosing station	1,5	1	3,0	3,0	9,0
Air blower for double membrane	1,0	1	1,0	24,0	24,0
Digester cooling system	4,0	1	4,0	24,0	96,0
Cogeneration power plant self-consumption	6,5	1	6,5	24,0	156,0
Circulation pump for supplying heat carrier to the digester	0,8	1	0,8	24,0	18,0
Circulation pump for supplying heat carrier to the digester cooling system	2,0	1	2,0	24,0	48,0
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			**154**		
Total consumed electric energy, kWh per day					**2070**
Total consumed power, kW					**86**

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Equipment price

Pos.	Description	Quantity	Unit Price, EUR	Total Price, EUR
1	Gasholder external (set) 210 m³	1	45 000,00	45 000,00
2	Over- and underpressure safeguard	1	5 400,00	5 400,00
3	Sight glasses/viewing windows with projector	1	6 300,00	6 300,00
4	Digester central agitator 17kW	1	85 000,00	85 000,00
5	Solid feeder 50 m3	1	135 000,00	135 000,00
6	Loading suger set	1	115 000,00	115 000,00
7	Substrate circulation pump N=5,5 kW	1	20 000,00	20 000,00
8	Digested substrate pump N=5,5 kW	1	20 000,00	20 000,00
9	Filtrate pump N=5,5kW	1	20 000,00	20 000,00
10	Decanter N=9,0 kW	1	80 000,00	80 000,00
11	Side agitator 3 kW (Filtrate tank)	1	14 000,00	14 000,00
12	Scrubber 260 m³/hour as unit	1	200 000,00	200 000,00
13	Biogas cooling system 260 m³/hour	1	42 000,00	42 000,00
14	Biogas blower 260 m³/hour	1	5 700,00	5 700,00
15	Desulfurization system 200 kg	1	26 700,00	26 700,00
16	Gas analyzer	1	33 000,00	33 000,00
17	Gas conditioning unit 260 m³/hour	1	26 000,00	26 000,00
18	Biogas burner 260 m³/hour	1	27 500,00	27 500,00
19	Heat supply station, as a unit, knocked-down.	1	87 000,00	87 000,00
20	Automatic with electric equipment, as a unit	1	195 000,00	195 000,00
21	Sensors (set)	1	50 000,00	50 000,00
22	Water supply and canalization system, as a unit.	1	55 700,00	55 700,00
23	Digester dry-cooler 100 kW	1	34 000,00	34 000,00
24	Digester Enameled steel tank V=2609 m³ (including servise stairs, platforms, manholes, pipe flanges, suppotrs, fixing etc.)	1	350 000,00	350 000,00
25	Filtrate Enameled steel tank V=61 m³ (including servise stairs, platforms, manholes, pipe flanges, suppotrs, fixing etc.)	1	46 000,00	46 000,00
26	Ferric chloride storage dosing system 1m³	1	15 500,00	15 500,00
27	Anti-foam reagent tank 40m³ system, as a unit.	1	105 000,00	105 000,00
	TOTAL (EXW, Memmingen, Germany):			**1 844 800,00**

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Price

Name	Price (EXW, Memmingen)
Project documentation	62 000 Euro
Supervision	30 000 Euro
Start-up, training	40 000 Euro
Living and travel expenses	40 000 Euro
Equipment	1 844 800 Euro
Cogeneration power plant (1x637kW)	350 000 Euro
Laboratory	35 000 Euro
Delivery to a port worldwide (5 containers x10 000Euro)	50 000 Euro
Construction and installation	600 000* Euro
Total	2 301 800 Euro

* Excavation 0,8 m; tank's concrete foundations; technical building; steel structures, reactor`s insulation and decorative cladding; gas pipelines (stainless steel); substrate pipes (stainless steel); heating lines; cables; foundations for gas equipments, torch; heating point; installation of equipment; rental of equipment, cables, construction machinery lease, equipment installation. Construction and installation works are performed by local companies on site.

Implementation terms and payment

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

Contracts

Project implementation is executed simultaneously under several contracts

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

ZORG
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