ZORG BIOGAS

Proposal

Biogas plant 920 tonnes stillage/day

Date: 21/06/2024

Validity: 3months

CONTENTS

OVERVIEW

Zorg Biogas offers a solution to process stillage from ethanol distillery into biogas. The produced biogas is used to replace natural gas in the existing boiler. A 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.

The offered biogas plant processes 920 tonnes stillage a day. The produced biogas will replace 34 200 m3/day natural gas or any other fuel with 357 MWh thermal energy a day or 1230 MMBTU per day.

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)
Stillage	920	335 800	10	92	92,0	84,64	670	56 708	60	20 698 420

Biogas plant technical performances

Characteristics	Values	Figures
Number of digesters	units	3
Digester volume Work Overall	m^3	 7 870 8 203
Organic load	kgODM/ m^3	3.58
Hydraulic retention time	days	27
Temperature in the digester	^0C	52
Overall dimensions of the digester (diameter / height)	m	23.05/19.67
Number of gasholder	units	1
Gasholder volume	m^3	1000
Overall dimensions of the gasholder (diameter / height)	m	13.5/10.4

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

Stillage is loaded directly into reactors. In the reactors, the substrate is fermented at temperature of + 52 C. Thus, a constant temperature is maintained in the digester throughout the entire fermentation process. The substrate is mixed with a central vertical agitator. The average fermentation time is 28 days. Biogas rises and collects under the conical arch of the digesters. To prevent excess pressure above acceptable, the digesters are equipped with a safety valves that starts to operate at a pressure of 10 mbar and releases biogas into the atmosphere.

The biogas from the digesters enter to an external gasholder. In the gasholder, pressure and biogas composition are averaged. Through pipelines, biogas from gasholder enters the biogas 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 + 35..40 ° 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 for supplying to purification from hydrogen sulphide in activated carbon columns and then can be use to replace natural gas in existing boiler plant. 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

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

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.

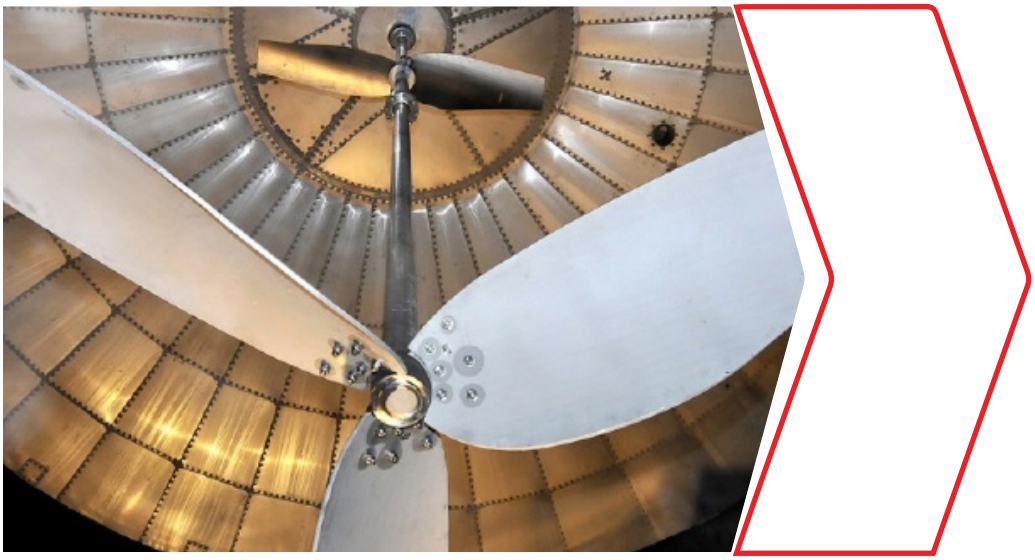
Steel panels are joined on bolted joints with a special sealant. The enamel coating is layered according to the PUESTA method. This is a special powder that is laid in layers by electrostatic attraction. Thus, uniformity of coating, density and smoothness are achieved. Bolts made of stainless steel. 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 :	23.05 m
Diameter :	19.67 m
The total volume :	8203 m^3
Quantity:	3 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)

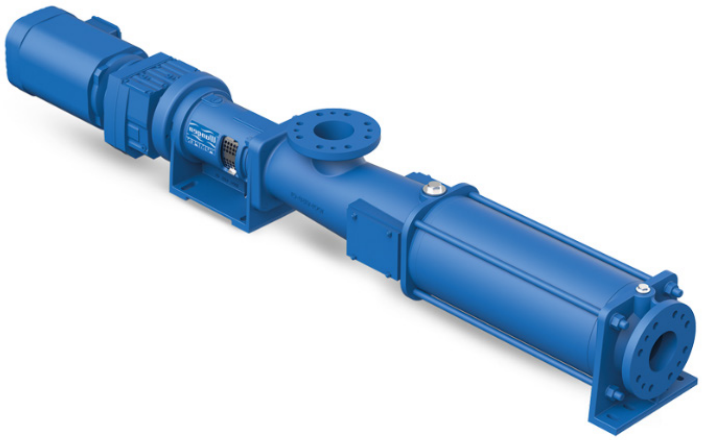


Reactor`s central agitator (AG-01, AG-02, AG-03)

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=35 kW
Quantity (per digester):	3 pcs

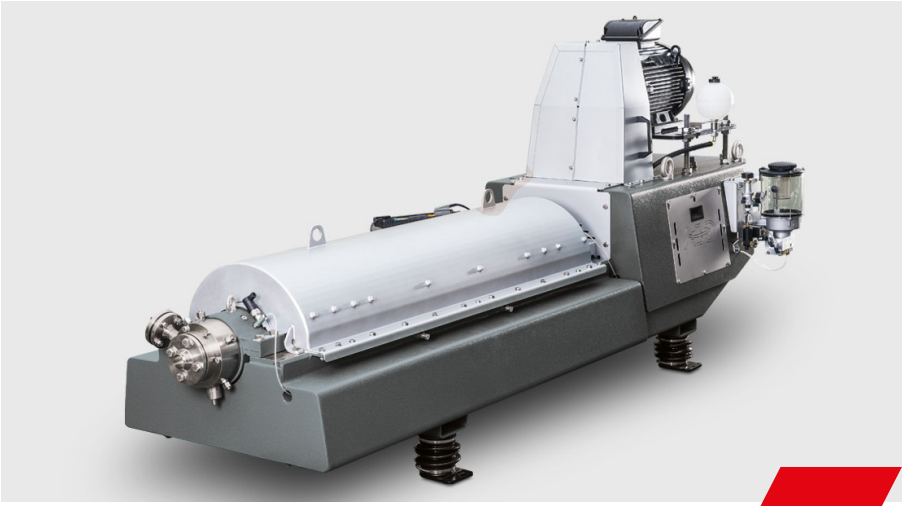


Pump equipment (PU-01...PU-08)

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. 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 13% 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

Digested Substrate pump (PU-01, PU-02, PU-03)	
Flow rate:	60 m3/hour
Engine power:	18.5 kW
Quantity:	3 pcs
Substrate circulation pump (PU-04, PU-05, PU-06)	
Flow rate:	45 m3/hour
Engine power:	15 kW
Quantity:	3 pcs
Filtrate pump (PU-07, PU-08)	
Flow rate:	60 m3/hour
Engine power:	18.5 kW
Quantity:	2 pcs
Substrate feed pump (PU-09, PU-10) optional	
Flow rate:	60 m3/hour
Engine power:	18.5 kW
Quantity:	2 pcs



Decanter (DR-01, DR-02, DR-03)

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:	60 m3/hour
Engine power:	30.0 kW
Quantity:	3 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:	12.81 m
Height	4.27 m
Total volume:	551 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-04, AG-05)

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= 11kW
Quantity:	2 psc

Spiral Heat Exchanger (HE-01, HE-02, HE-03)

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	3 pcs

Window with spotlight (SG-01, SG-02, SG-03)

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

Reeservoir for reception of liquid kinds of reagents. The tank is a system ready to instal with automation and control cabinet to manage proceses 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

Iron chloride tank

Diameter:	2,0 m
Height	4.7 m
Total volume:	15.0 m^3
Quantity:	1 pcs.

Anti-foam reagent tank

Diameter:	3.4 m
Height	4.9 m
Total volume:	40 m^3
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 :	10.4 m
Diameter :	13.5 m
The total volume :	1000 m^3
Quantity:	1pcs

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 (CHL-01...CHL-03)

Gas volume flow	1 200 m^3/ h
Gas inlet temperature	+55 C
Gas outlet temperature	+10C
Engine power	26 kW
Quantity:	2 pcs

Biogas compressor (BC-01, BC-02)

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

Specifications

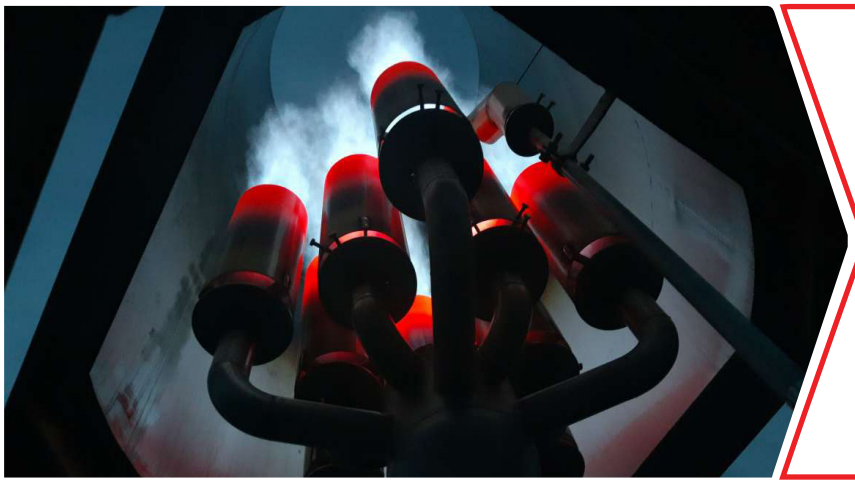
Flow rate	2450 m^3/h
Pressure	150 mbar
Engine	26 kW
Quantity	2 pcs

Desulphurization system

The desulphurization system is a 2-step system. Stage 1 is adding Iron Chloride. After 1-st step the sulphur contcentration is 80 ppm. Stage 2 - 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

The volume of charcoal	700 kg
Numbers of charcoal columns	2 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	2400 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)

Dry cooler (DC-01, DC-02, DC-03)

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:	6.0 kW
Quantity:	3 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

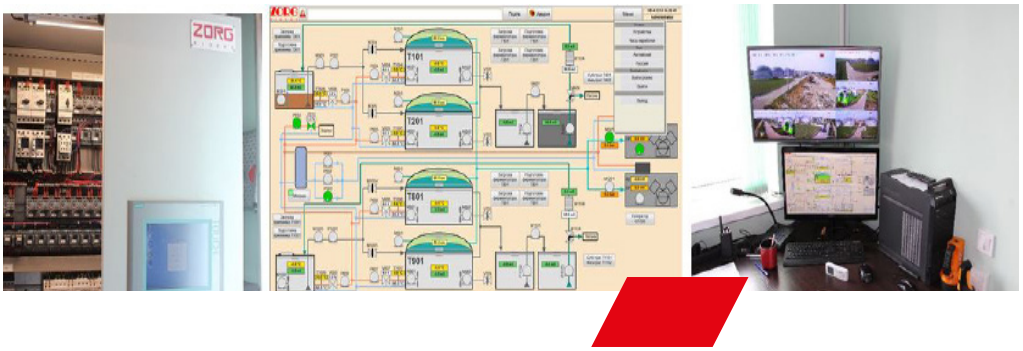
The water supply system provides biogas plant with water for technological needs, water for heating-cooling system, water for drinking and domestic use, and water for fire safety systems. As used, centrifugal single-stage pumps are the main pumping elements. These pumps are designed for pumping wastewater, 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=551m³**	**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=11 kW**	**2**
2.1	Three phase motor, pressure-proof		2
2.2	Belt drive unit		2
2.3	Double acting mechanical seal		2
2.4	PTC motor control		1
2.5	Base-frame for the assembly		2
3	**Reactor (steel enamel tank)**	**V=8203 m³**	**3**
3.1	Windows with spotlight, complete, disassembled	set	3
3.2	Flanges to connection engineering communication	set	3
3.3	Service sites (for mixers gear, valves and connections)	set	3
3.4	Fixing for engineering communication	set	3
4	**Reactor`s vertical agitator**	**N=35kW**	**3**
4.1	Airtight motor gearbox		3
4.2	Hydraulic screw (wear-resistant steel)		3
4.3	Shaft (adapted to the height of the fermenter)		3
4.5	Frequency converter		3
5	**Circulation substrate pump**	**Q=50 m³/h**	**3**
6	**External heat exchanger**	**200 kW**	**3**

№	Equipment	Characteristic	Q-ty
7	**Digested substrate pump**	**Q=60m³/h**	**3**
8	**Filtrate pump**	**Q=60 m³/h N=18.5 kW**	**2**
9	**PVC external gas holder**	**Ø13,5m**	**1**
9.1	Weather protection film	Ø13.5 m	1
9.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm biogas resistant		1
9.3	Air blower	16A, 0,5kW	1
9.5	Excess and minimum pressure valve		1
9.6	Dome level sensor		1
9.7	Mounting system		1
9.8	Accessories	set	1
10	**Digester safety valve**		**2**
11	**Biogas compressor**	**Q=2450 m³/h N=18 kW**	**2**
12	**Biogas Cooling System**	**1200 m³/h**	**2**
12.1	Chiller		2
12.2	Heat exchanger		2
12.3	Polypropylene glycol tank		2
13	**Desulphurisation system**		**set**
13.1	Filter with activated charcoal	700 kg	2
14	**Biogas analyzer (CH4 , CO2 , H2S)**		**set**
15	**Electromagnetic flow meter**		**1**

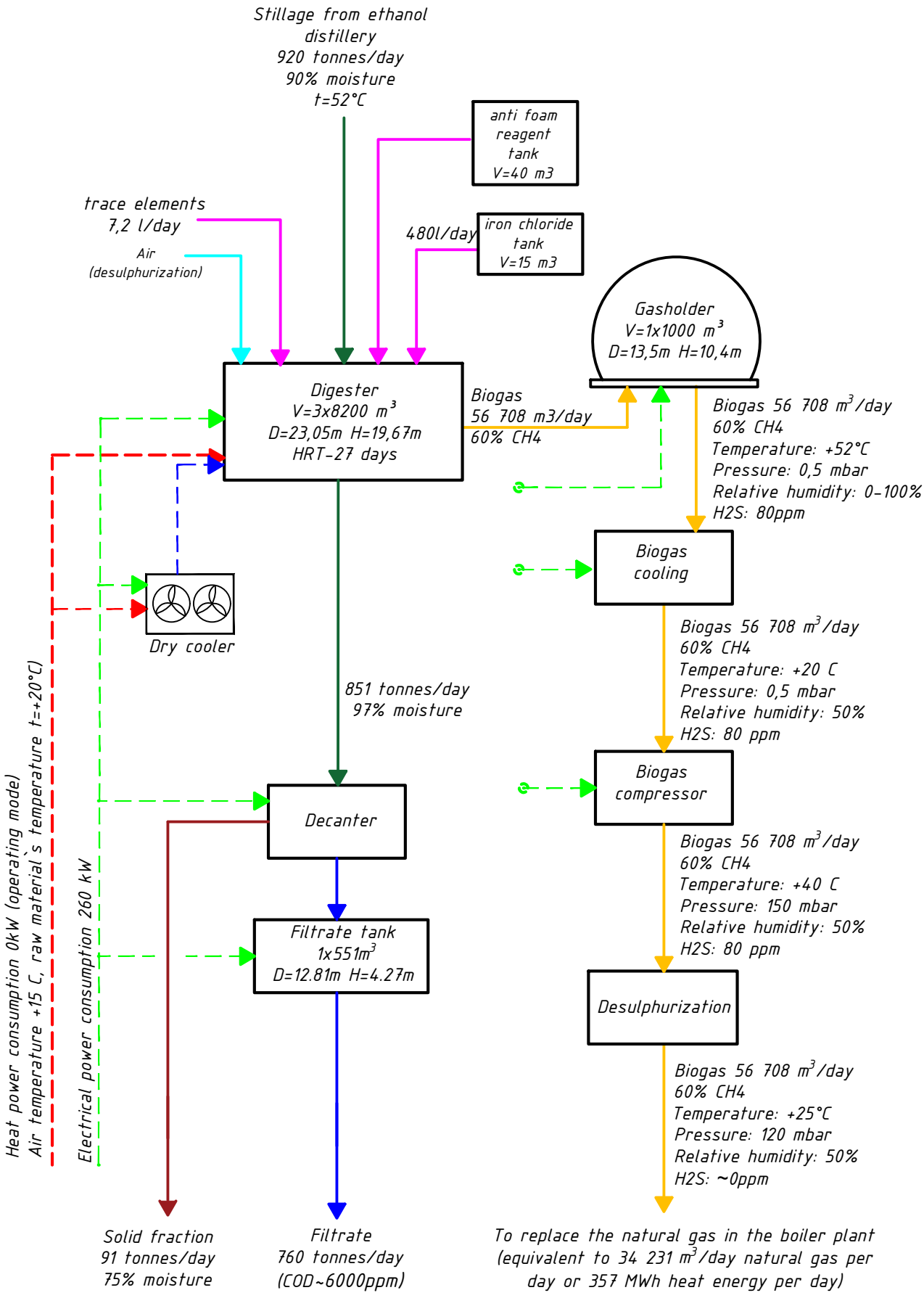
№	Equipment	Characteristic	Q-ty
16	**Flare**	**2400 m³/h**	**1**
16.1	Compressor		1
16.2	Manual locking element		1
16.3	Deflagration fuse		1
16.4	On-site control cabinet		1
16.5	Auto ignition system		1
16.6	Auto Main Gas Solenoid Valve		1
17	**The heat supply system**		**1**
17.1	Diaphragm expansion tank	V=1000 l P=6Bar T=120°C	1
17.2	Circulating pump for supplying heat carrier	Q=12 m³/h N=3,5 kW	3
17.3	Circulation pump for supplying heating water to the office building	N=0,165 kW	1
18	**Dry cooler**	**100kw heat pow.**	**3**
19	**Automation with electrical equipment complete, disassembled**		**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
19.3	Incoming distribution cabinet with a set of automation DB-3		1
20	**Sensor set**		**1**
21.1	Conductivity sensor	31SCM50	4
21.2	Pressure / level sensor	SEN-3251 B025 G1 1Bar	8
21.3	Ultrasonic sensor	SPA-380-08	4
21.4	Gas pressure sensor	G1/2 0,4Bar	4

№	Equipment	Characteristic	Q-ty
21.5	Thermal converter		4
21.6	Thermowells for thermocouples	TR10-B	4
21.7	Thermal converter heating circuit	TR3	4
21.8	Substrate pressure sensor	G1 4Bar	8
21.9	Substrate pressure sensor	G1 2,5Bar	8
21.10	Coolant pressure sensor	G1/2 6Bar	3
21.11	Immersion level sensor	LS-10 0,6Bar 4-20 mA	4
21.12	Humidity and gas temperature sensor	ESFTF-I	3

APPENDIXES

Material flow diagram

Appendix 1



ZORG BIOGAS

Appendix 3

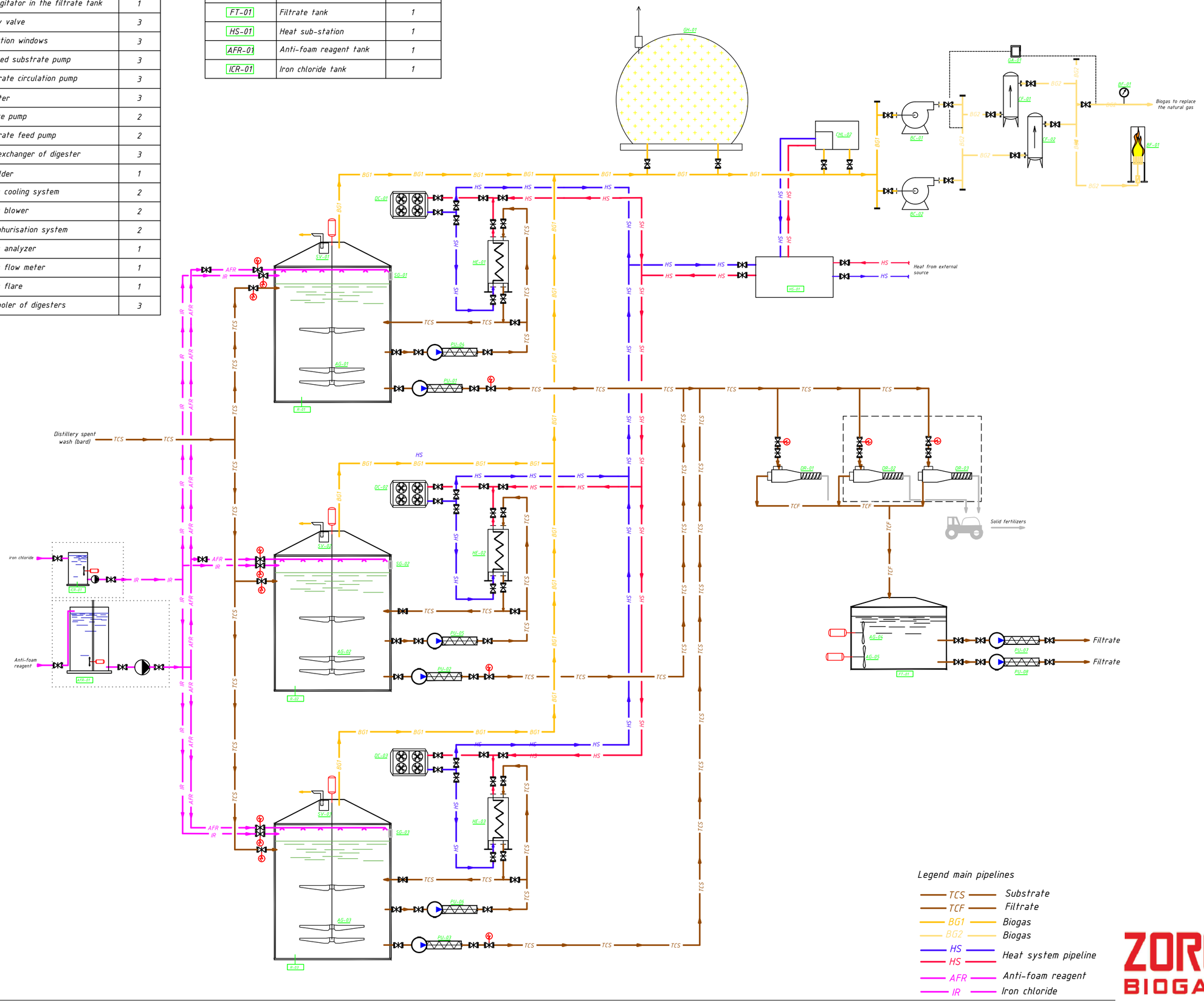
Explcation

N/№	Name	Quantity
AG-01, AG-02, AG-03	Reactor`s central agitator	3
AG-04	Side agitator in the filtrate tank	1
SV-01 ... SV-03	Safety valve	3
SG-01 ... SG-03	Inspection windows	3
PU-01...PU-03	Digested substrate pump	3
PU-04 ... PU-06	Substrate circulation pump	3
DR-01... DR-03	Decanter	3
PU-07, PU-08	Filtrate pump	2
PU-06, PU-07	Substrate feed pump	2
HE-01 ... HE-03	Heat exchanger of digester	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
BF-01	Biogas flare	1
DC-01 ... DC-03	Dry cooler of digesters	3

Structure

N/№	Name	Quantity
R-01, R-02, R-03	Reactor	3
FT-01	Filtrate tank	1
HS-01	Heat sub-station	1
AFR-01	Anti-foam reagent tank	1
ICR-01	Iron chloride tank	1

Basic diagram



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

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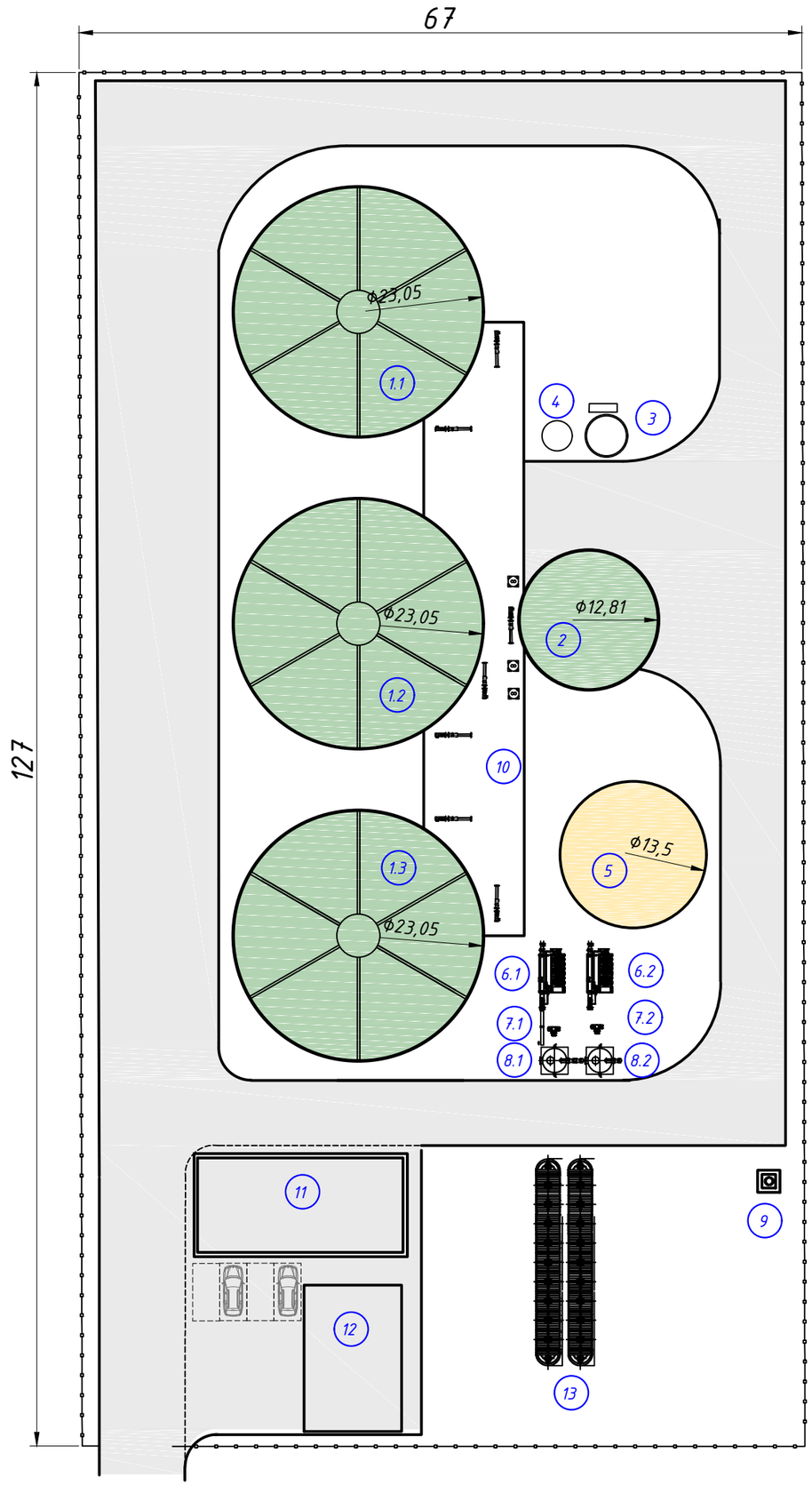
Preliminary layout proposal



Explication

N/№	Name	Note
1.1, 1.2, 1.3	Reactor	R-01, R-02, R-03
2	Filtrat tank	FT-01
3	Anti-foam reagent tank	AFR-01
4	Iron chloride tank	ICR-01
5	Gasholder	GH-01
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 burner	BF-01
10	Equipment room	ER-01
11	Technical room	TR-01
12	Warehouse	WH-01
13	Fire water tank	FWT

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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
Digester Vertical agitator	35,0	3	105,0	16,0	1680,0
Submersible mixer in filtrate tank	11,0	2	22,0	8,0	176,0
Substrate feed pump to digester	18,5	3	55,5	6,0	333,0
Substrate pump to decanter	18,5	3	55,5	6,0	333,0
Substrate circulation pump	15,0	3	45,0	9,0	405,0
Filtrate pump	18,5	2	37,0	8,0	296,0
Decanter	30,0	3	90,0	9,0	810,0
Anti-foam pump	2,5	1	2,5	1,0	2,5
Iron-ichloride pump	2,0	1	2,0	1,5	3,0
Mixer in anti-foam reagent tank	1,5	1	1,5	3,0	4,5
Mixer in iron chlorided tank	0,3	1	0,3	1,0	0,3
Biogas cooling system	26,0	2	52,0	24,0	1248,0
Biogas compressor	26,0	2	52,0	12,0	624,0
Dry cooler (Digester cooling system)	6,0	3	18,0	at t>55°C	
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	3	2,3	24,0	54,0
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	3	4,5	24,0	108,0
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			**556**		
Total consumed electric energy, kWh per day					**6243**
Total consumed power, kW					**260**

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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	120.000	0%	120.000	120.000
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	50.000	0%	50.000	50.000
E	Delivery of the equipment	40	2.500	0%	2.500	100.000
F	Laboratory	1	25.000	0%	25.000	25.000
G	Construction	1	2.000.000	0%	2.000.000	2.000.000
I	Filtrate Storage (V=4000 m3)	1	40.000	0%	40.000	40.000
1	Digester Enameled steel tank V=8203 m³ (including servise stairs, platforms, manholes, pipe flanges, suppotrs, fixing etc.)	3	862.000	0%	862.000	2.586.000
2	Filtrate Enameled steel tank V=551 m³ (including servise stairs, platforms, manholes, pipe flanges, suppotrs, fixing etc.)	1	157.500	0%	157.500	157.500
3	Digester central agitator 35kW	3	148.000	0%	148.000	444.000
4	Side agitator 11 kW	2	42.300	0%	42.300	84.600
5	Digested substrate pump 18,5kW	3	29.000	0%	29.000	87.000
6	Circulation pump 15kW	3	23.100	0%	23.100	69.300
7	Filtrate supply pump 18,5kW	2	26.000	0%	26.000	52.000
8	External heat exchanger	3	93.500	0%	93.500	280.500
9	Decanter 30kW	3	136.000	0%	136.000	408.000
10	Gasholder 1000 m3	1	127.500	0%	127.500	127.500
11	Biogas chiller (Biogas cooling system) 1200 m3/h	2	115.000	0%	115.000	230.000
12	Biogas blower 2450 m3/h	2	32.000	0%	32.000	64.000
13	Desulphurization column with active coal 700 kg	2	53.000	0%	53.000	106.000
14	Biogas burner 2400 м3/год	1	125.000	0%	125.000	125.000
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	3	5.400	0%	5.400	16.200
18	Sight glasses/viewing windows with projector	3	6.600	0%	6.600	19.800
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	110.000	0%	110.000	110.000
23	Automation and electric cabinet	1	360.000	0%	360.000	360.000
24	Iron chloride reagent tank 15m3 system, as a unit.	1	43.000	0%	43.000	43.000
25	Anti-foam reagent tank 40m3 system, as a unit.	1	115.500	0%	115.500	115.500
			TOTAL, EUR			**8.284.100**

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Appendix 6

Payments for equipment and Zorg' services

Payments for documention A	**Payments in %**		
Advance for documention	50%		60000
after 2 months	50%		60000
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%		12500
after 3 months	25%		12500
after 6 months	25%		12500
after 8 months	25%		12500
Payments for equipments	**Payments in %**	**Deliveries**	**5.829.100**
Advance against of the corporate guarantee	35%		2040185
after 2 months	10%		582910
after 4 months	20%		1165820
after 6 months	30%		1748730
in 15 days after reaching 100% capacity and demonstrating 91% capacity during 4 months	5%		291455

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12
Project documentation	50%		50%									
Approvals and permits												
Equipment supply	35%		10%	20%		30%					5%	
Biogas upgrading plant												
Construction												
Supervision	50%			25%			25%					
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**

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