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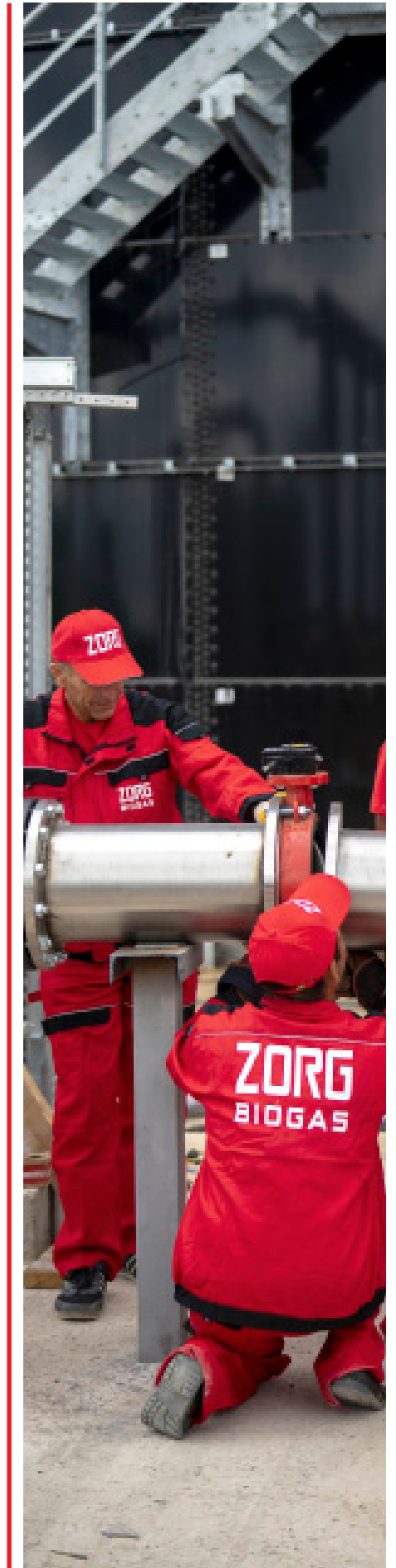
Proposal

Biogas plant
150 tonnes/day banana waste



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OVERVIEW

We offer a solution to process 150 tonnes banana waste into biogas and 1,5MW electric power in a high-load reactor (HLR). If 100 tonnes waste/day a loaded, the plant will work at 70% capacity.

The design is very reliable. The vertical agitators don't require stops for maintenance. The anaerobic digestion part and the biogas production works 24/7 for 10 years without stop. Only the outside equipment requires maintenance that's equal to 200-300 hours annually.

Another advantage is that the gasholder is located lower closer to the land surface and not on-top of the reactors. That's helps to withstand strong winds

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 (%)
Banana waste	150	54 750	17	94	25.50	23.97	670	16 060	53

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Banana waste	100	36 500	17	94	17.00	15.98	670	10 707	53

Biogas plant characteristics

Characteristics	Values	Figures
Number of digesters	units	1
Digester		
a) volume:		
Work	m ³	4005
Overall	m ³	4292
b) Organic load		
150 tons	kgODM/ m ³	5.58
100 tons	kgODM/ m ³	3.72
c) Hydraulic retention time (gross)		
150 tons	days	28/27
100 tons	days	43/41
d) Overall dimensions of the digester (diameter / height)	m	27.0/7.5
e) Temperature	°C	+52
Gasholder (external)		
a) Volume	m ³	400
b) Number of gasholders	units	1
c) Dimensions of the gasholder (diameter / height)	m	10.1/7.8



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 → C₅H₇N₀2 + H₂CO₃.

Further conversion of obtained dissolved compounds like organic acids and alcohols (C₅H₇N₀2, H₂CO₃) into gases - CH₄, CO₂. C₅H₇N₀2 + H₂CO₃ + 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 H₂O 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

Banana waste is transported to a biogas plant area and discharged into loaders. The loaders input substrates by portion to digesters using augers. In the digesters 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 digesters operating regime is thermophilic. The heated substrate in the digesters is blended periodically. Mixing is performed by vertical mixers. The average time of processing in the digesters is 28 days. After the digesters, the substrate is fed by pump to a separator area where it is separated into solid and liquid bio-fertilizer. Solid bio-fertilizer is discharged to the separation area and transported for storage; liquid filtrate is directed to a liquid residue storage tank. Biogas goes up under overlap and delivered into an external gas holder through pipeline.

The gas holder's weather protective film protects the gasholder from precipitation and damage by foreign objects. The weather protective film is fixed firmly by a special system. To protect the gas-

holder from overpressure, digesters are equipped with safety valves, which start working at a pressure of 5 mbars and bleeds biogas to the atmosphere.

Then accumulated in gasholders biogas goes through a gas pipeline to a biogas cooler with a condensate discharge unit and then to a compressor, where the pressure is raised up to 80-150 mbar to meet engine requirements. After the compressor, biogas is fed to cogeneration power plants, 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 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





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:	11,0 m
Width:	3.6 m
Height	4.2 m
Volume:	50 m ³
Quantity:	1 pcs.



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

Reinforced concrete reservoir is divided in half by a partition. One half of the filtrate tank and the other is a receiving tank. for reception of liquid kinds of raw materials. The reservoirs are equipped with level sensors and submersible agitators for mixing substrate.

Specifications

Receiving tank (RT-01)

Diameter:	8.0 m
Height	3.0 m
Total volume:	151 m ³
Receiving tank`s volume	75 m ³
Quantity:	1 pcs

Filtrate tank (FT-01)

Diameter:	8.0 m
Height	3.0 m
Total volume:	151 m ³
Filtrate tank`s volume	75 m ³
Quantity:	1 pcs



Submersible mixer (AG-06..07)

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

Filtrate tank (FT-01)

Nominal power
Quantity:

N= 3.0 kW
1 pcs

Receiving tank (RT-01)

Nominal power
Quantity:

N= 15.0 kW
1 pcs



Digester (D-01)

Digester 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 chapter. Overlap of digester 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 con-

sumption, the digester 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 digester bottom has a slope 1%.

Specifications

Height :	7,5 m
Diameter :	27,0 m
The total volume :	4292 m ³
The substrate volume :	4005 m ³
Quantity:	1 pcs



Digester vertical mixer (AG-01 ... AG-05)

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:	5 pcs

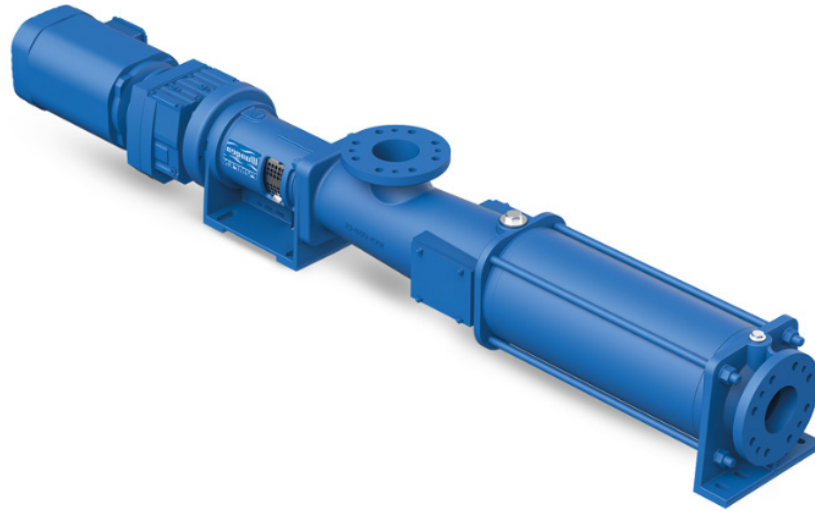


Window with spotlight (SG-01)

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

Specifications

Inspection windows Ø300
Spotlight VISULUX UL50 -G -H
230V, 50W, IP65



Pump equipment (PU-01, PU-02, PU-3)

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 to separator (PU-01)

Flow rate:	30 m3/hour
Engine power:	7.5 kW
Pressure:	4 bar
Quantity:	1 pcs

Filtrate pump (PU-02)

Flow rate:	30 m3/hour
Engine power:	7.5 kW
Pressure:	4 bar
Quantity:	1 pcs

Substrate pump (PU-03)

Flow rate:	30 m3/hour
Engine power:	7.5 kW
Pressure:	4 bar
Quantity:	1 pcs



Separator (SR-01)

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	5.5 kW
Flow rate	5-12 m³ / h
Quantity	1 pcs
Equipment	
Frame	
Screw	
Sieve for the filtration	
Counterweights	
The design of the protective room	



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 $260 \text{ cm}^3/\text{m}^2 \cdot 1 \text{ bar}$ biogas resistance. The gasholder film temperature range allows operation from -30°C to $+60^\circ\text{C}$.

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 hand-made 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 :	7.8 m
Diameter :	10.1 m
The total/working volume :	400 m ³
Quantity:	1 pcs



Biogas dryer and cooling (CHL-01)

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

Specifications

Gas volume flow	700 m ³ / h
Gas inlet temperature	+50 C
Gas outlet temperature	+20 C
Cooling power	100 kW
Engine power	30 kW



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 (biogas upgrading plant in our case).

Specifications

Flow rate:	700 m ³ /h
Pressure:	150 mbar
Engine power:	6.7 kW
Quantity:	1 pcs

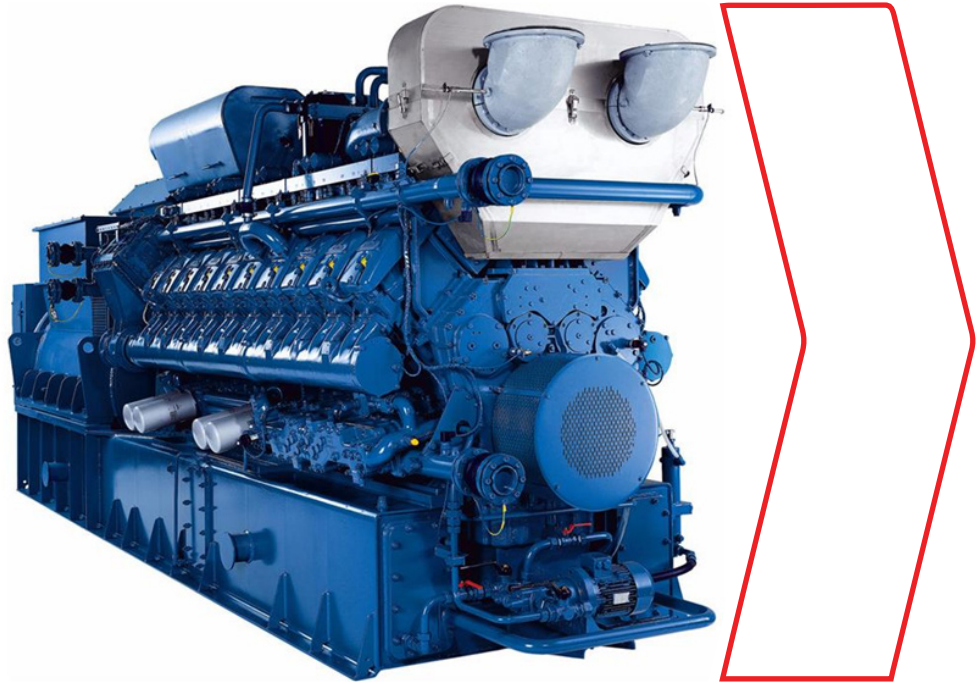


Desulphurization system

The desulphurization system is a two-step purification of biogas to remove sulfur. Stage 1 - adding a certain portion of iron hydroxide and air to the digesters. Stage 2 - 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...5 ppm.

Specifications

The volume of charcoal	300 kg
Numbers of charcoal columns	1 pcs

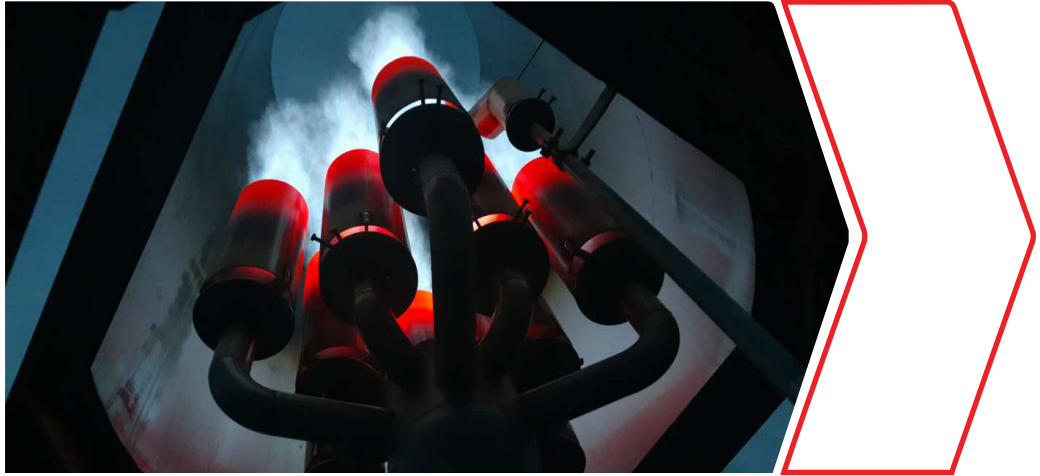


Cogeneration Power Plant (CHP-01)

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	1560 kW
Produced heat power	1577 kW
Emissions	NO _x < 500 mg/Nm ³ [5% O ₂]
Generator	400V, 50Hz
Quantity:	1 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

700 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 used 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

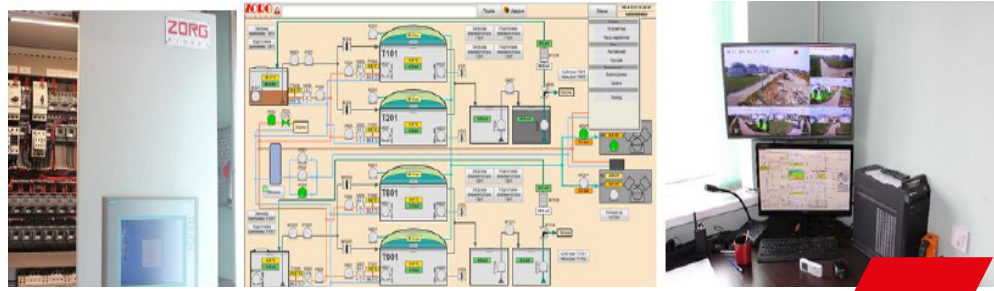


Dry cooler (cooling substrate system)

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:	1 pcs



Automation and electrical equipment

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

The control cabinet is designed based on the industrial controller Siemens CPU315-DP2, using periphery distributing system Simatic ET200S, and operator panel OP277 Touch with touch-sensitive controls. Communications is executed by PROFIBUS and MPI with physical interface RS-485. The control program is designed based on the Simatic Step7. The control cabinet is a modular design. The upper part has a power box with central and front-end processor. The periphery distributing system, Simatic ET200S, 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



Nº	Equipment	Characteristic	Quantity
1	Solid feeder	V=50 m3	1
1.1	Container bunker		1
1.2	Feeding screws	set.	1
2	Submersible mixer	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	5
3.1	Airtight motor gearbox		5
3.2	Hydraulic screw (wear-resistant steel)		5
3.3	Shaft (adapted to the height of the fermenter)		5
3.4	Blade		5
3.5	Frequency converter		5
3.6	Mounting bracket to bottom of the mixer		5
4	Safety valve of digesters		1
5	Window with a searchlight	set	1
5.1	Inspection window RD300 (mounts and sealant included)	Ø300	1
5.2	Spotlight (mount system bundled) VISULUX UL50 -G -H	230V, 50W, IP65	1
6	Substrate digested pump	30 m3/hour N=7.5 kW	1

Nº	Equipment	Characteristic	Quantity
7	Separator	N=5.5 kW, Q=8-12m3/h	1
7.1	Body		1
7.2	Substrate Supply Pipe 4 ''		1
7.3	Engine - Gearbox	N=5,5 kW	1
7.4	Frame		1
7.5	Screw		1
7.6	Sieve for filtration		1
8	Filtrate pump	30 m3/hour N=7.5kW	1
9	PVC external gas holder	Ø10.1m	1
9.1	Weather protection film	Ø10.1m	1
9.2	Gasholder film PELD methane permeation max.260 cm3/m2*d*1 bar, 650 N/5cm bio-gas resistant		1
9.3	Air blower	16A, 0,5kW	1
9.4	Excess and minimum pressure valve		1
9.5	Dome level sensor		1
9.6	Mounting system		1
9.7	Accessories		1
9.8	Safety valve		1
10	Biogas Cooling System	700 m3/h	1
10.1	Chiller		1
10.2	Heat exchanger		1
10.3	Polypropylene glycol tank		1
11	Desulphurization system		1
11.1	Numbers of charcoal columns	300 kg	1

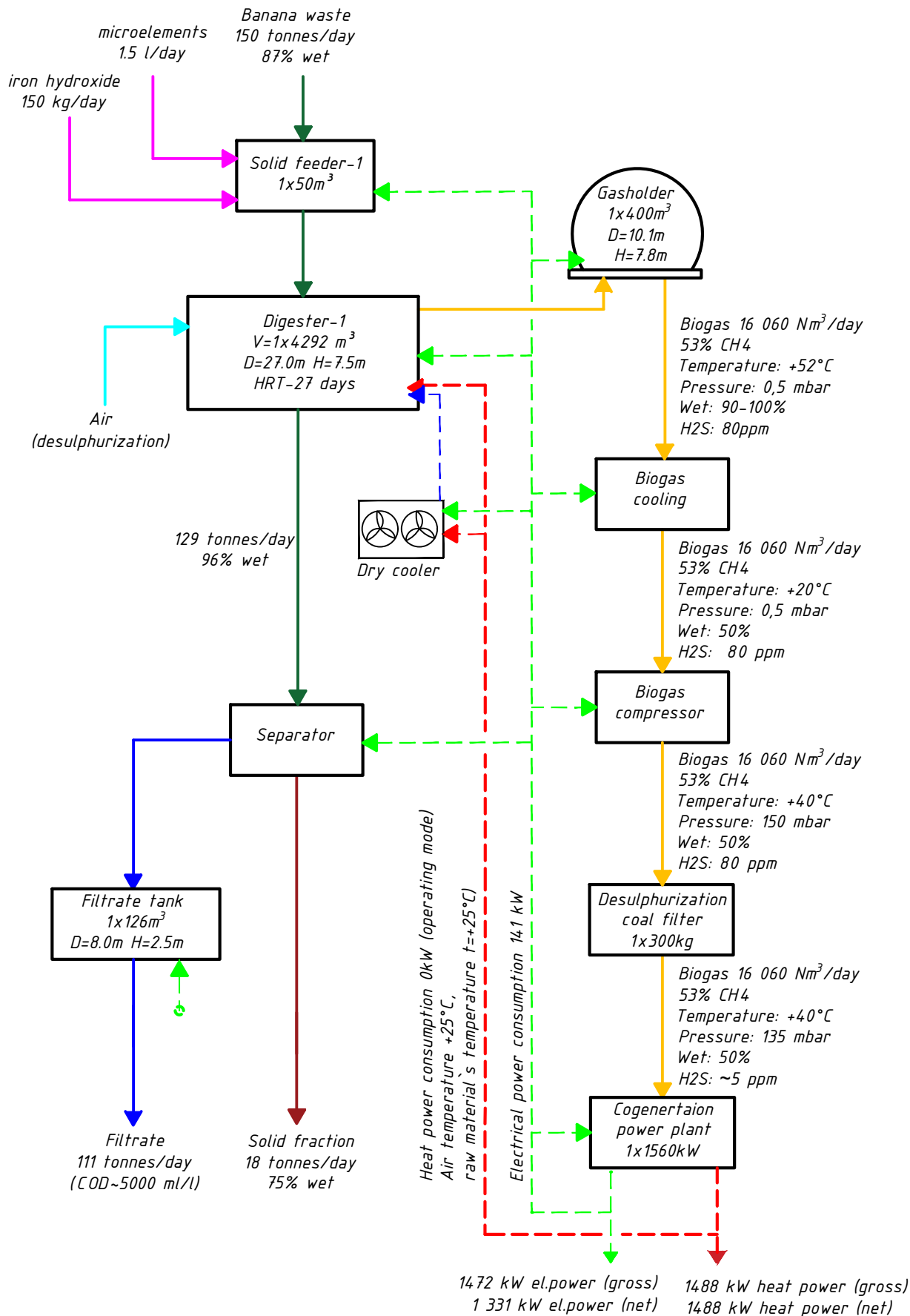
Nº	Equipment	Characteristic	Quantity
12	Biogas compressor	Q=700m³/h H=150mBar N=6.7kW	1
13	Biogas analyzer (CH4 , CO2 , H2S, O2)		1
14	Electromagnetic flow meter		1
15	Flare	700 m3/h	1
16	Cogeneration power plant	1560 kW	1
17	Gas equipment included	set	1
17.1	Drainage pump with float	DN=50 Q=1 m³/h H=13 m	1
18	The heat supply system	set	1
18.1	Diaphragm expansion tank	V=1000 l P=6Bar T=120°C	1
18.2	Circulating pump for supplying heat carrier	Q=30 m³/h H=1bar	1
18.3	Propylene glycol feed pump station heating systems	Q=1,0 m³/h, H=4 bar	1
18.4	Circulation pump for supplying heat carrier to the digester	Q=18 m3/h, H=1.1 bar	1
19	Water supply and sewerage system, complete, disassembled	set	1
20	Automation with electrical equipment complete, disassembled	set	1
20.1	Incoming distribution cabinet with a set of automation DB-1		1
20.2	Incoming distribution cabinet with a set of automation DB-2		1
21	Sensors, set		1
21.1	Gas pressure sensor 0,025Bar		1
21.2	Gas pressure sensor 0,4Bar		1
21.3	Pressure sensor(substrate level) 1,0Bar		2
21.4	Pressure sensor (substrate pressure) 2,5bar		2

Nº	Equipment	Characteristic	Quantity
21.5	Resistive thermometer (gas temperature)		2
21.6	Resistive thermometer with thermo well (fermenter substrate temperature)		2
21.7	Resistive thermometer with thermo-well (digester tank substrate temperature)		2
21.7	Resistive thermometer (heat conductor temperature)		2
21.9	Conductometric sensor of maximum level		1
21.10	Conductometric sensor of water level		1
21.11	Dome position sensor		1
21.12	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	1
21.13	Humidity and gas temperature sensor	ESFTF-I	1
22	Dry cooler 100kW heat pow.		1
23	Laboratory		1
24	Substrate pump	30 m3/hour N=7.5 kW	1
25	Submersible mixer	N=15.0kW	1
25.1	Airtight motor gearbox		1
25.2	Hydraulic screw (wear-resistant steel)		1
25.3	Mixer control mechanism		1
25.4	Electric motor mount		1
25.5	Set of fasteners		1

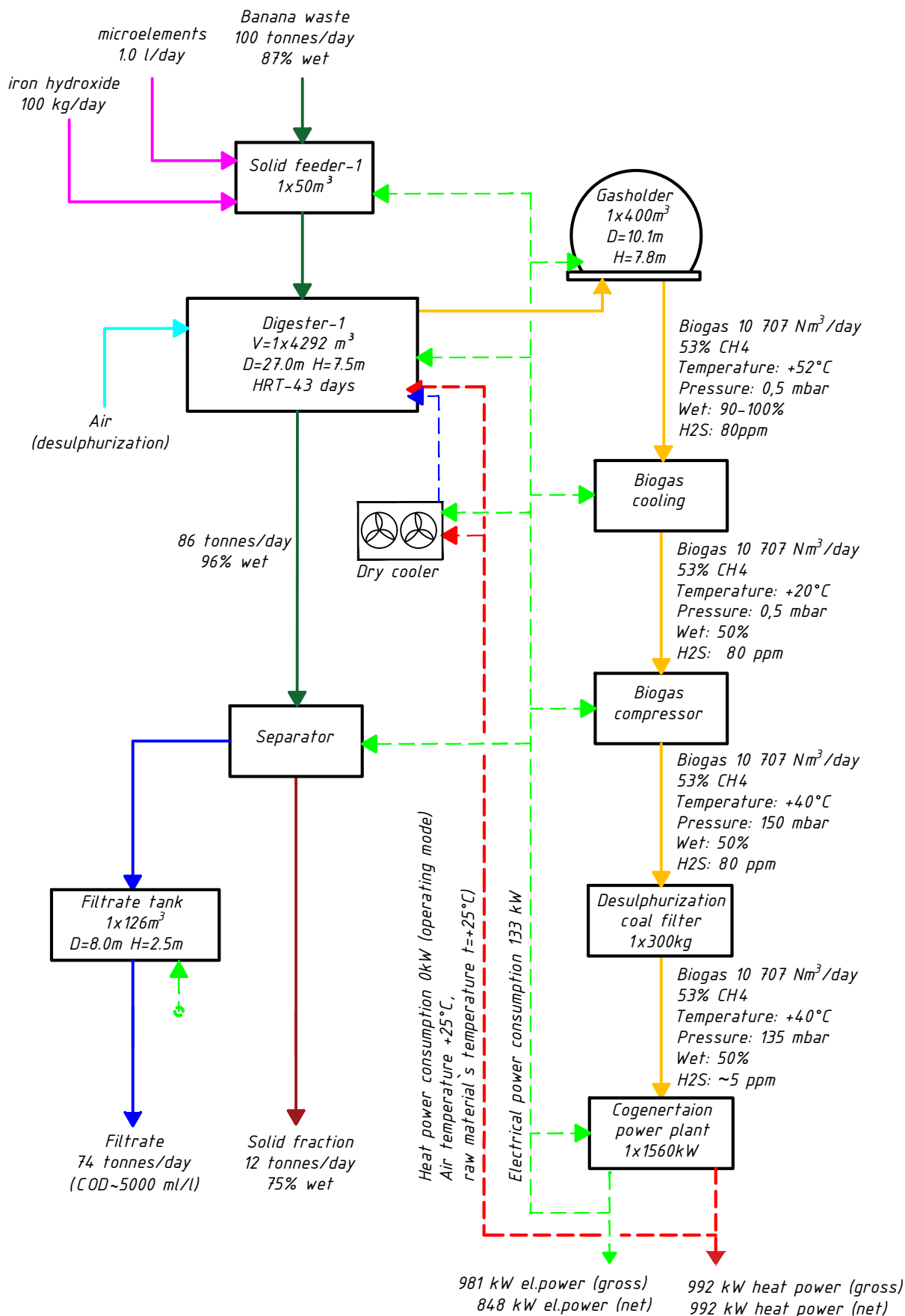
APPENDICES



Material flow diagram



Material flow diagram



Explication

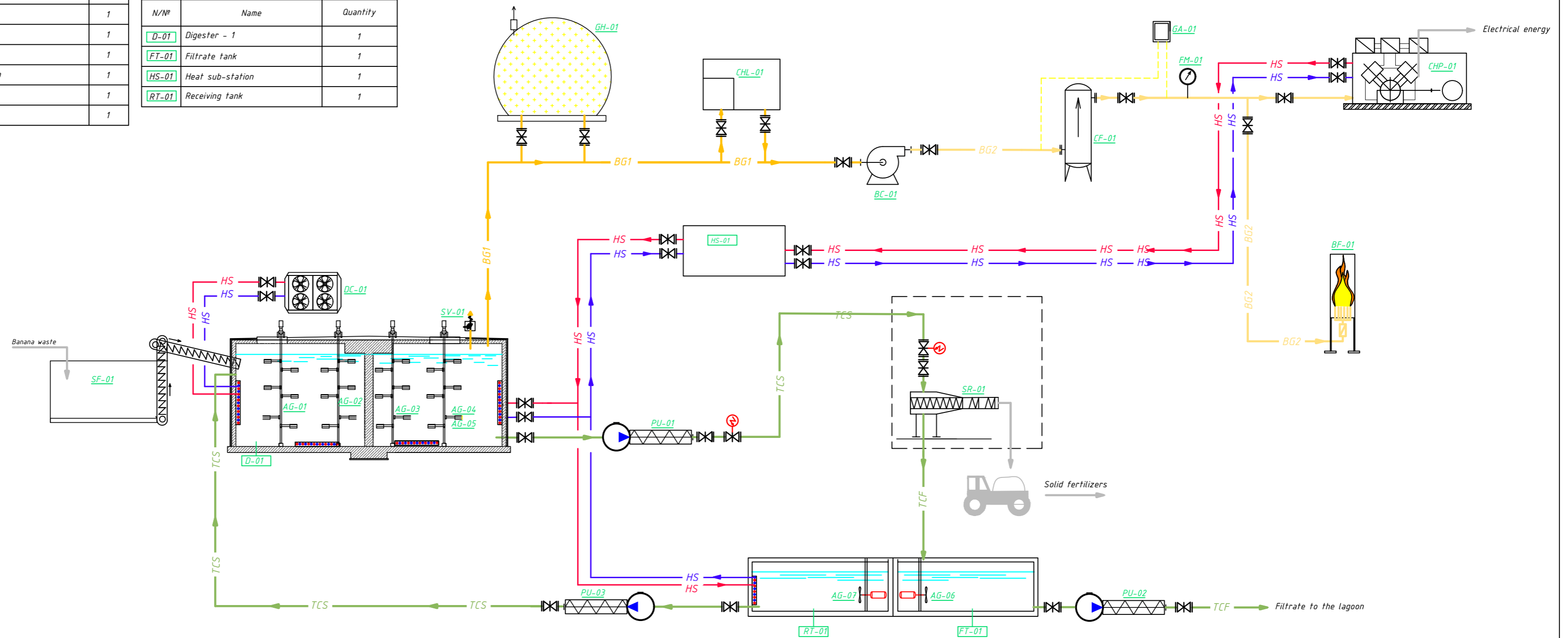
N/Nº	Name	Quantity
SF-01	Solid feeder	1
SV-01	Safety valve	1
SG-01	Inspection windows	1
AG-01 ... AG-05	Vertical Paddle agitator of Digester	5
AG-06	Submersible agitator of the filtrate tank	1
PU-01	Substrate pump from the Digester to separator	1
PU-02	Filtrate pump	1
SR-01	Separator	1
GH-01	Gasholder	1
CHL-01	Biogas cooling system	1
BC-01	Biogas blower	1
CF-01	Desulphurisation system	1
BG-01	Biogas analyzer	1
FM-01	Biogas flow meter	1

N/Nº	Name	Quantity
CHP-01	Cogeneration power plant	1
BF-01	Biogas flare	1
DC-01	Dry cooler	1
AG-07	Submersible agitator of the receiving tank	1
PU-03	Substrate pump to Digester	1

Structure

N/Nº	Name	Quantity
D-01	Digester - 1	1
FT-01	Filtrate tank	1
HS-01	Heat sub-station	1
RT-01	Receiving tank	1

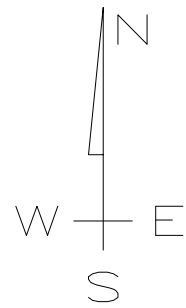
Basic diagram



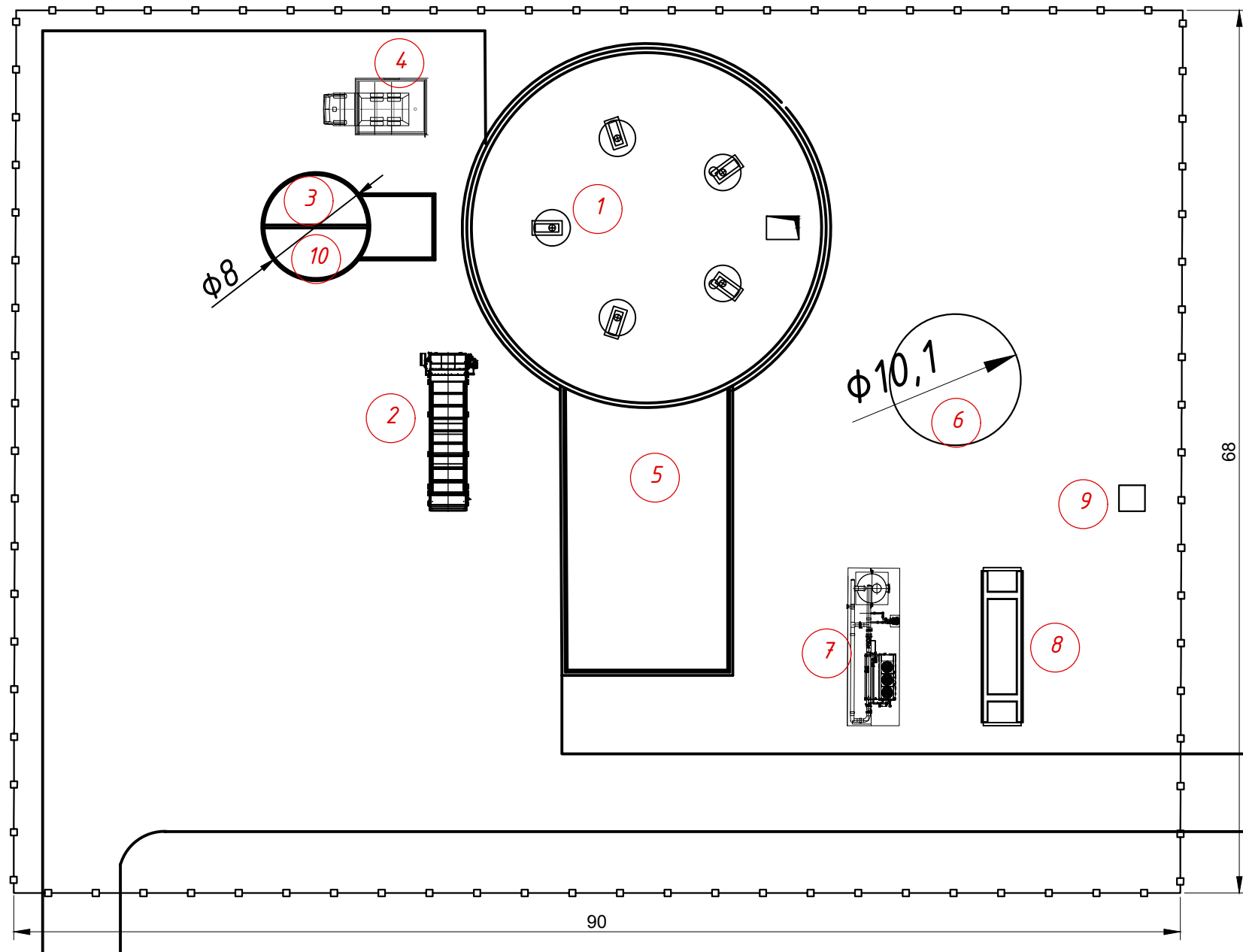
Legend main pipelines

—	TCS	Substrate
—	TCF	Filtrate
—	BG1	Biogas
—	BG2	Biogas
—	HS	Heat system pipeline
—	HS	Heat system pipeline





Plan



Explication

N/Nº	Name	Note
1	Reactor	
2	Solid loader	
3	Filtrate tank	
4	Separator area	
5	Technological room	
6	Gasholder	
7	Gas preparation	
8	Cogenerator power plant	
9	Biogas flare	
10	Receiving tank	

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Appendix 4.1

Biogas plant					
Name equipment	Instal. Pow. (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Loader V=100 m ³	28,0	1	28,0	8,0	224,0
Screw set.	18,5	1	18,5	8,0	148,0
Digester Vertical mixer	15,0	5	75,0	18,0	1350,0
Submersible mixer in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	30,0	1	30,0	24,0	720,0
Biogas compressor	6,7	1	6,7	12,0	80,4
Separator	5,5	1	5,5	9,0	49,5
Substrate pump to separator	7,5	1	7,5	9,0	67,5
Filtrate pump	7,5	1	7,5	4,0	30,0
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	20,0	1	20,0	24,0	480,0
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	1	1,0	0,5	0,5
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			212		
Total consumed electric energy, kWh per day					3382
Total consumed power, kW					141

Appendix 4.2

Biogas plant					
Name equipment	Instal. Pow. (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Loader V=50 m ³	28,0	1	28,0	5,0	140,0
Screw set.	18,5	1	18,5	5,0	92,5
Digester Vertical mixer	15,0	5	75,0	18,0	1350,0
Submersible mixer in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	30,0	1	30,0	24,0	720,0
Biogas compressor	6,7	1	6,7	12,0	80,4
Separator	5,5	1	5,5	6,0	33,0
Substrate pump to separator	7,5	1	7,5	6,0	45,0
Filtrate pump	7,5	1	7,5	3,0	22,5
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	20,0	1	20,0	24,0	480,0
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	1	1,0	0,5	0,5
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			212		
Total consumed electric energy, kWh per day					3196
Total consumed power, kW					133

Prices for equipment and services for 1.5MW biogas plant 150 tonnes/day banana waste based

Pos	Name	Number of units	Unit price, EUR	Discounts*	Discounted unit price, EUR	Discounted price sub-total, EUR
A	Project documentation	1	65 000	0%	65 000	65 000
B	Supervision	1	50 000	0%	50 000	50 000
C	Startup and training	1	50 000	0%	50 000	50 000
D	Living and travel expenses	1	50 000	0%	50 000	50 000
E	Delivery of the equipment (containers)	7	15 000	0%	15 000	105 000
F	Laboratory	1	27 000	0%	27 000	27 000
1	Solid feeder (dosing buffer machine)	1	135 000	0%	135 000	135 000
2	Screw conveyor	1	124 000	0%	124 000	124 000
3	Digester vertical agitator	5	78 000	0%	78 000	390 000
4	Frame for pos.3	5	6 000	0%	6 000	30 000
5	Digested substrate pump	1	29 000	0%	29 000	29 000
6	Filtrate supply pump	1	29 000	0%	29 000	29 000
7	Substrate separation unit	1	48 000	0%	48 000	48 000
8	Submersible mixer for filtrate tank	1	10 000	0%	10 000	10 000
9	Over- and under pressure safeguard	1	4 900	0%	4 900	4 900
10	Sight glasses/viewing windows with projector	1	4 900	0%	4 900	4 900
11	Water supply and canalization system	1	27 000	0%	27 000	27 000
12	Heat supply station	1	37 000	0%	37 000	37 000
13	Dry-cooler (Substrate cooling system for fermenter)	1	17 000	0%	17 000	17 000
14	Automation and electric cabinet	1	149 000	0%	149 000	149 000
15	Sensors (set)	1	50 000	0%	50 000	50 000
16	Gas holder	1	65 000	0%	65 000	65 000
17	Biogas chiller (Biogas cooling system)	1	75 000	0%	75 000	75 000
18	Biogas blower	1	18 000	0%	18 000	18 000
19	Desulphurization column with active coal	1	32 000	0%	32 000	32 000
20	Biogas burner	1	67 000	0%	67 000	67 000
21	Gas analyzer	1	27 000	0%	27 000	27 000
22	Motorized valves (set)	2	5 200	0%	5 200	10 400
23	Gas conditioning unit	1	29 000	0%	29 000	29 000
24	Cogenerator power plant	1	540 000	0%	540 000	540 000
25	Substrate pump	1	29 000	0%	29 000	29 000
26	Submersible mixer for receiving tank	1	24 000	0%	24 000	24 000
G	Construction	1	1 100 000	0%	1 100 000	1 100 000
H	Storage of solid fertilizer 800 m3	1	60 000	0%	60 000	60 000
J	Filtrate storage lagoon	1	100 000	0%	100 000	100 000
K	Weight control (truck scale)	1	20 000	0%	20 000	20 000
			TOTAL, EUR			3 608 200

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Project documentation	50%			50%											
Approvals and permits															
Equipment supply					30%		20%	20%	30%						
Cogeneration power plant					30%				70%						
Construction															
Supervision					25%			25%		25%		25%			
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

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