

**01**

version

# Proposal

**Biogas plant 300 tonnes stillage/day**



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## 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 0,1°C. 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 will process 300 tonnes stillage a day. The produced biogas will replace 11162 m<sup>3</sup>/day natural gas or any other fuel with 114 MWh thermal energy a day or 393 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 <sup>3</sup> / tonneDDM)	Biogas (m <sup>3</sup> / day)	Methane content (%)	Biogas (m <sup>3</sup> / year)
Distillery spent wash (stillage)	300	109 500	10	92	30	20,76	670	18 492	60	6 749 580

## Biogas plant technical performances

Characteristics	Values	Figures
Number of digesters	units	1
Digester volume	m <sup>3</sup>	7924
Work Overall		8200
Organic load	kgODM/ m <sup>3</sup>	3,51
Hydraulic retention time	days	27
Temperature in the digester	°C	52
Overall dimensions of the digester (diameter / height)	m	23,05/19,67
Number of gasholder	units	1
Gasholder volume	m <sup>3</sup>	700
Overall dimensions of the gasholder (diameter / height)	m	12,0/9,3



# 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 + H<sub>2</sub>O → C<sub>5</sub>H<sub>7</sub>N<sub>0</sub>2 + H-CO<sub>3</sub>.

Further conversion of obtained dissolved compounds like organic acids and alcohols (C<sub>5</sub>H<sub>7</sub>N<sub>0</sub>2, HCO<sub>3</sub>) into gases - CH<sub>4</sub>, CO<sub>2</sub>. C<sub>5</sub>H<sub>7</sub>N<sub>0</sub>2 + HCO<sub>3</sub> + H<sub>2</sub>O → CH<sub>4</sub> + CO<sub>2</sub> + NH<sub>4</sub>.

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 C<sub>1</sub> 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 CH<sub>4</sub>, water H<sub>2</sub>O and carbon dioxide CO<sub>2</sub>. 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 into a digester by pump. In the digesters, 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 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 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 digester enters the external gasholder. In a 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 + 20C, condensate formed is removed from the cooling system. After cooling, the biogas is heated to + 40 ° C to reduce the relative humidity of the biogas.

After cooling biogas flows through the pipeline to the compressor, where its pres-

sure rises to 80-150 mbar for supplying to purification from hydrogen sulphide in activated carbon columns and then to a existing boiler plant to replace natural gas.

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







## 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 smooth-

ness 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 :** 19.87 m

**The total volume :** 8200 m<sup>3</sup>

**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

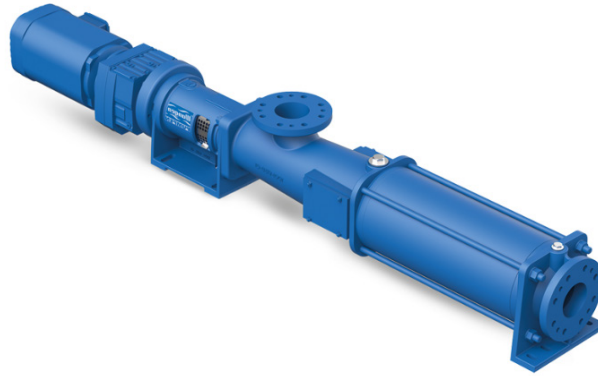
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Engine power:

N=35 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

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#### Substrate circulation pump (PU-01)

<b>Flow rate:</b>	50 m <sup>3</sup> /hour
<b>Engine power:</b>	15 kW
<b>Quantity:</b>	1 pcs

#### Digested substrate pump (PU-02)

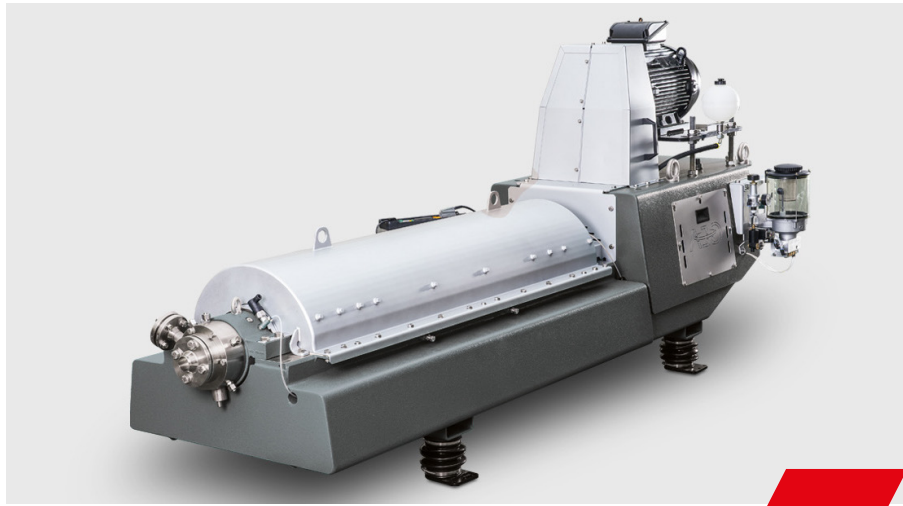
<b>Flow rate:</b>	40 m <sup>3</sup> /hour
<b>Engine power:</b>	11 kW
<b>Quantity:</b>	1 pcs

#### Filtrate pump (PU-03)

<b>Flow rate:</b>	50 m <sup>3</sup> /hour
<b>Engine power:</b>	15 kW
<b>Quantity:</b>	1 pcs

#### Substrate feed pump (PU-04)

<b>Flow rate:</b>	
<b>Engine power:</b>	50 m <sup>3</sup> /hour
<b>Quantity:</b>	15 kW
	1 pcs



## Decanter

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 centrifugal 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

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<b>Flow rate:</b>	15-30 m <sup>3</sup> /hour
<b>Engine power:</b>	30.0 kW
<b>Quantity:</b>	1 pcs



## Filtrate tank (FT-01)

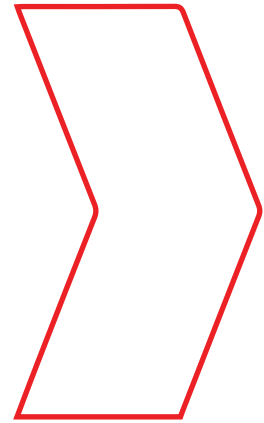
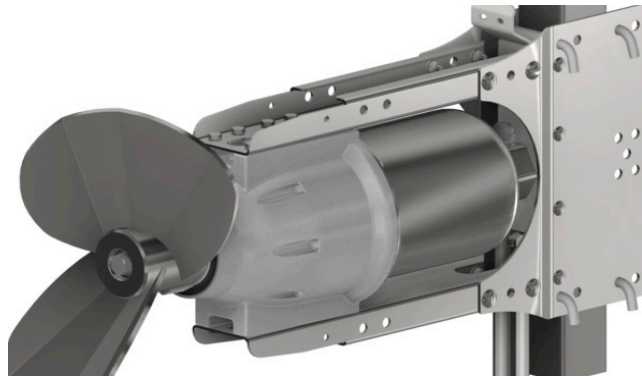
Reinforced concrete reservoir for reception of liquid kinds of raw materials. The reservoirs are equipped with level sensors and submersible agitators for mixing substrate.

### Specifications

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#### Filtrate tank (FT-01)

<b>Diameter:</b>	8,0 m
<b>Height</b>	3,0 m
<b>Total volume:</b>	150 m <sup>3</sup>
<b>Quantity:</b>	1 pcs



## Submersible mixer (AG-02)

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

**Nominal power**

N=11,0kW

**Quantity:**

1 pcs



## 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 non-corrosive alloy. A number of left-handed and right-handed components, one on top of the other, form 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

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

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Inspection windows Ø300  
Spotlight VISULUX UL50 -G -H  
230V, 50W, IP65  
Quantity: 3 pcs





## Reagent tanks

Reservoirs 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  $-40^{\circ}\text{C}$  to over  $+100^{\circ}\text{C}$ . 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

<b>Diameter:</b>	1,6 m
<b>Height</b>	3,0 m
<b>Total volume:</b>	6 m <sup>3</sup>
<b>Quantity:</b>	1 pcs.

### Anti-foam reagent tank

<b>Diameter:</b>	3.7 m
<b>Height</b>	4.9 m
<b>Total volume:</b>	40 m <sup>3</sup>
<b>Quantity:</b>	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  $260 \text{ cm}^3/\text{m}^2 \cdot 1 \text{ bar}$  biogas resistance. The gasholder film temperature range allows operation from  $-30^\circ\text{C}$  to  $+60^\circ\text{C}$ .

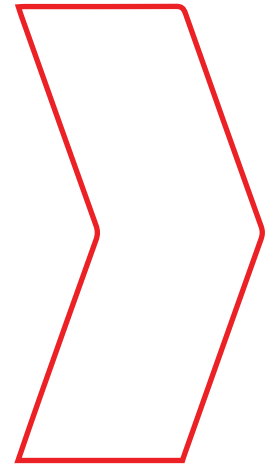
The internal film is stretched under normal biogas pressure. Air is blown into the space between the external and internal membranes to pressurize the internal membrane and form the shape of the external membrane.

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

<b>Height :</b>	9,3 m
<b>Diameter :</b>	12,0 m
<b>The total volume :</b>	700 m <sup>3</sup>
<b>Quantity:</b>	1pcs



## 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 (CHL-01...CHL-06)

<b>Gas volume flow</b>	770 m <sup>3</sup> / h
<b>Gas inlet temperature</b>	+55 C
<b>Gas outlet temperature</b>	+10C
<b>Engine power</b>	46 kW
<b>Quantity:</b>	1 pcs



## Biogas compressor (BC-01, BC-02)

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

### Specifications

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Flow rate	900 m <sup>3</sup> /h
Pressure	150 mbar
Engine	12 kW
Quantity	2 pcs



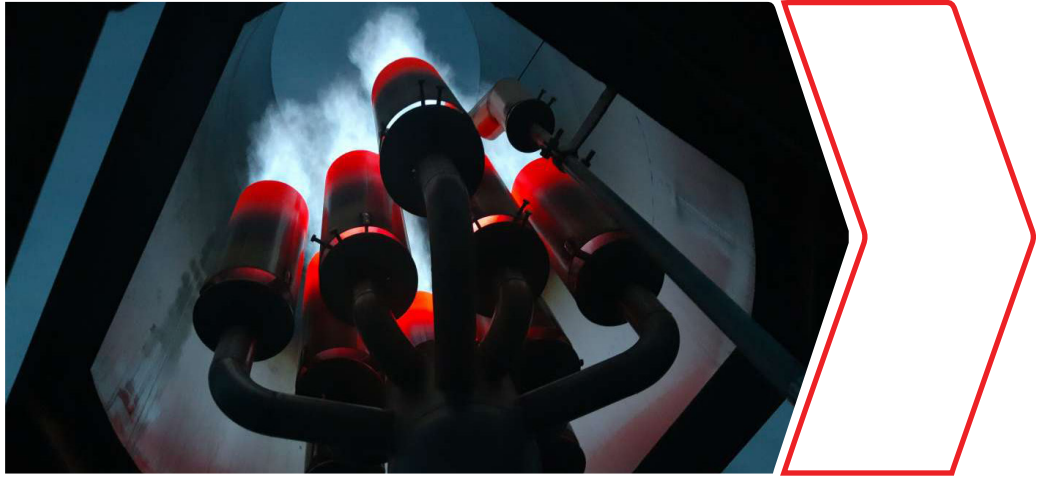
## Desulphurization system (CF-01)

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

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The volume of charcoal	500 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

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**Flow rate**

770 m<sup>3</sup>/h

**Quantity**

1 pcs





## Gas analyzer (CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S, O<sub>2</sub>) (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

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#### Set includes

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

Defined gases methane % (CH<sub>4</sub>), carbon dioxide % (CO<sub>2</sub>), hydrogen sulfide ppm (H<sub>2</sub>S)



## Dry cooler (DC-01)

The device is designed to cool the heat-carrier 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

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<b>Power (cooling)</b>	100 kW
<b>Engine power:</b>	4,0 kW
<b>Quantity:</b>	1 pcs





## Heating system

The heating equipment is used 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 the 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 temperatures in the fermenter are 60°C and 40°C respectively.

## Specifications

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Circulating pump feeding heat carrier  
Flow 12 m<sup>3</sup> / h;  
Pressure 1.1 bar  
Engine 3.5 kW

Circulating pump feeding heat carrier  
Flow 0.6 m<sup>3</sup> / h;  
Pressure 1 bar,  
Engine 0.165 kW

The pumping station feeding propylene glycol  
Flow 1,0 m<sup>3</sup> / 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

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### Water supply pump

Pressure	2.5 bar
Flow	25 m <sup>3</sup> /h
Engine	3.0 kW

### Submersible pump

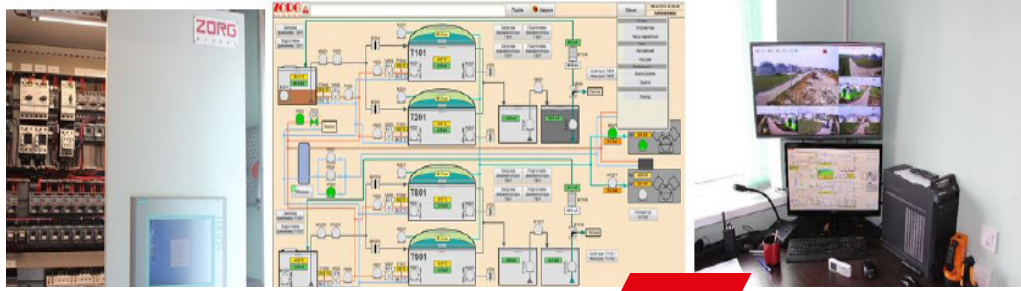
Pressure	1.1 bar
Flow	15 m <sup>3</sup> / h
Engine	3,5 kW

### 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 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

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**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

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**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

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

# SPECIFICATION LIST



Nº	Equipment	Characteristic	Quantity
<b>1</b>	<b>Digester (steel enamel tank)</b>	<b>V=8200 m<sup>3</sup></b>	<b>1</b>
1.1	Windows with spotlight, complete, disassembled	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
<b>2</b>	<b>Digester vertical agitator</b>	<b>N=35kW</b>	<b>1</b>
2.1	Airtight motor gearbox		1
2.2	Hydraulic screw (wear-resistant steel)		1
2.3	Shaft (adapted to the height of the fermenter)		1
2.5	Frequency converter		1
<b>3</b>	<b>Circulation substrate pump</b>	<b>Q=50 m<sup>3</sup>/h</b>	<b>1</b>
<b>4</b>	<b>External heat exchanger</b>	<b>300 kW</b>	<b>1</b>
<b>5</b>	<b>Digested substrate pump</b>	<b>Q=40 m<sup>3</sup>/h</b>	<b>1</b>
<b>6</b>	<b>Filtrate pump</b>	<b>Q=50 m<sup>3</sup>/h</b>	<b>1</b>
<b>7</b>	<b>PVC external gas holder</b>	<b>Ø12,0 m</b>	<b>1</b>
7.1	Weather protection film	Ø12,0 m	1
7.2	Gasholder film PELD methane permeation max.260 cm <sup>3</sup> /m <sup>2</sup> *d*1 bar, 650 N/5cm biogas resistant		1
7.3	Air blower	16A, 0,5kW	1
7.5	Excess and minimum pressure valve		1
7.6	Dome level sensor		1
7.7	Mounting system		1
7.8	Accessories	set	1
<b>8</b>	<b>Digester safety valve</b>		<b>1</b>
<b>9</b>	<b>Biogas compressor</b>	<b>Q=900 m<sup>3</sup>/h N=12,0 kW</b>	<b>2</b>

Nº	Equipment	Characteristic	Quantity
<b>10</b>	<b>Biogas Cooling System</b>	<b>770 m<sup>3</sup>/h</b>	<b>1</b>
10.1	Chiller		1
10.2	Heat exchanger		1
10.3	Polypropylene glycol tank		1
<b>11</b>	<b>Desulphurisation system</b>		<b>set</b>
11.1	Filter with activated charcoal	500 kg	1
<b>12</b>	<b>Biogas analyzer (CH<sub>4</sub> , CO<sub>2</sub> , H<sub>2</sub>S )</b>		<b>set</b>
<b>13</b>	<b>Electromagnetic flow meter</b>		<b>1</b>
<b>14</b>	<b>Flare</b>	<b>770 m<sup>3</sup>/h</b>	<b>1</b>
14.1	Compressor		1
14.2	Manual locking element		1
14.3	Deflagration fuse		1
14.4	On-site control cabinet		1
14.5	Auto ignition system		1
14.6	Auto Main Gas Solenoid Valve		1
<b>15</b>	<b>The heat supply system</b>		<b>1</b>
15.1	Diaphragm expansion tank	V=1000 l P=6Bar	1
15.2	Circulating pump for supplying heat carrier	T=120°C Q=12 m <sup>3</sup> /h N=3,5 kW	1
15.3	Circulation pump for supplying heating water to the office building	N=0,165 kW	1
<b>16</b>	<b>Dry cooler</b>	<b>100 kw heat pow.</b>	<b>1</b>
<b>17</b>	<b>Automation with electrical equipment complete, disassembled</b>		<b>1</b>
17.1	Incoming distribution cabinet with a set of automation DB-1		1
17.2	Incoming distribution cabinet with a set of automation DB-2		1
17.3	Incoming distribution cabinet with a set of automation DB-3		1

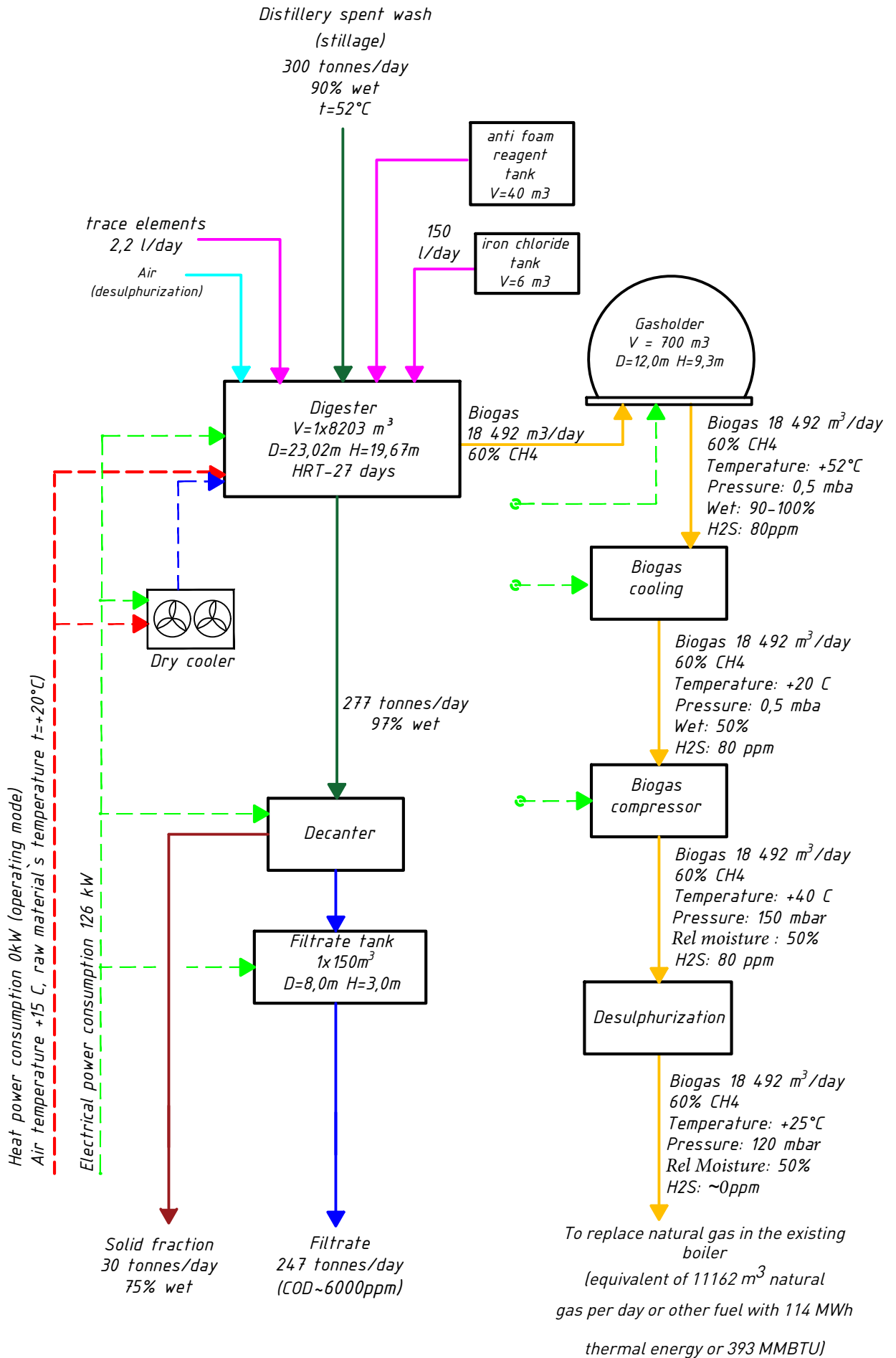


Nº	Equipment	Characteristic	Quantity
<b>18</b>	<b>Sensor set</b>		<b>1</b>
18.1	Conductivity sensor	31SCM50	2
18.2	Pressure / level sensor	SEN-3251 B025 G1 1Bar	3
18.3	Ultrasonic sensor	SPA-380-08	2
18.4	Gas pressure sensor	G1/2 0,4Bar	4
18.5	Thermal converter		4
18.6	Thermowells for thermocouples	TR10-B	2
18.7	Thermal converter heating circuit	TR3	2
18.8	Substrate pressure sensor	G1 4Bar	3
18.9	Substrate pressure sensor	G1 2,5Bar	3
18.10	Coolant pressure sensor	G1/2 6Bar	2
18.11	Immersion level sensor	LS-10 0,6Bar 4-20 mA	4
18.12	Humidity and gas temperature sensor	ESFTF-I	2
<b>19</b>	<b>Laboratory set</b>		<b>1</b>

# APPENDIXES



# Material flow diagram



Specification

N/Nº	Name	Quantity
AG-01	Digester central agitator	1
AG-02	Submersible agitator	1
SV-01	Safety valve	1
SG-01	Inspection windows	1
PU-01	Substrate circulation 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
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
BF-01	Biogas flare	1

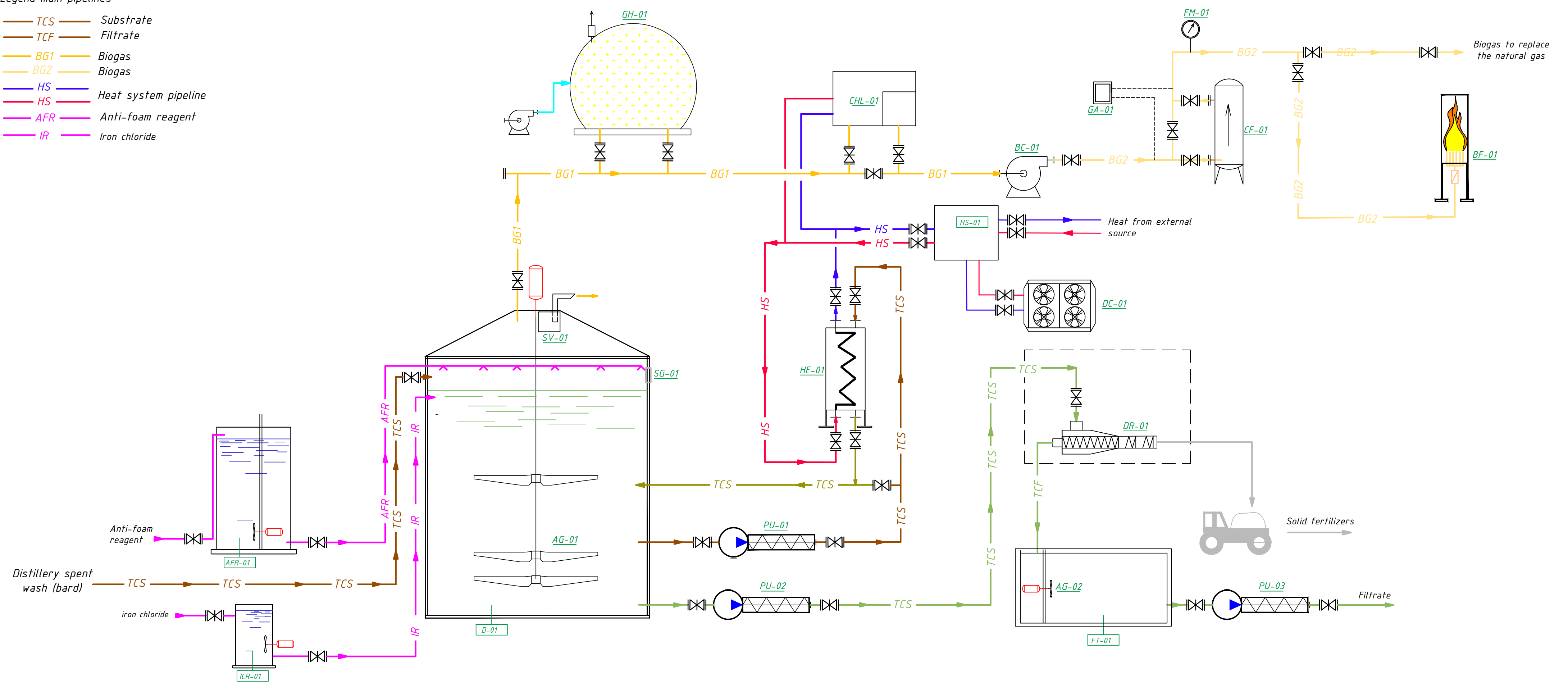
Structure

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

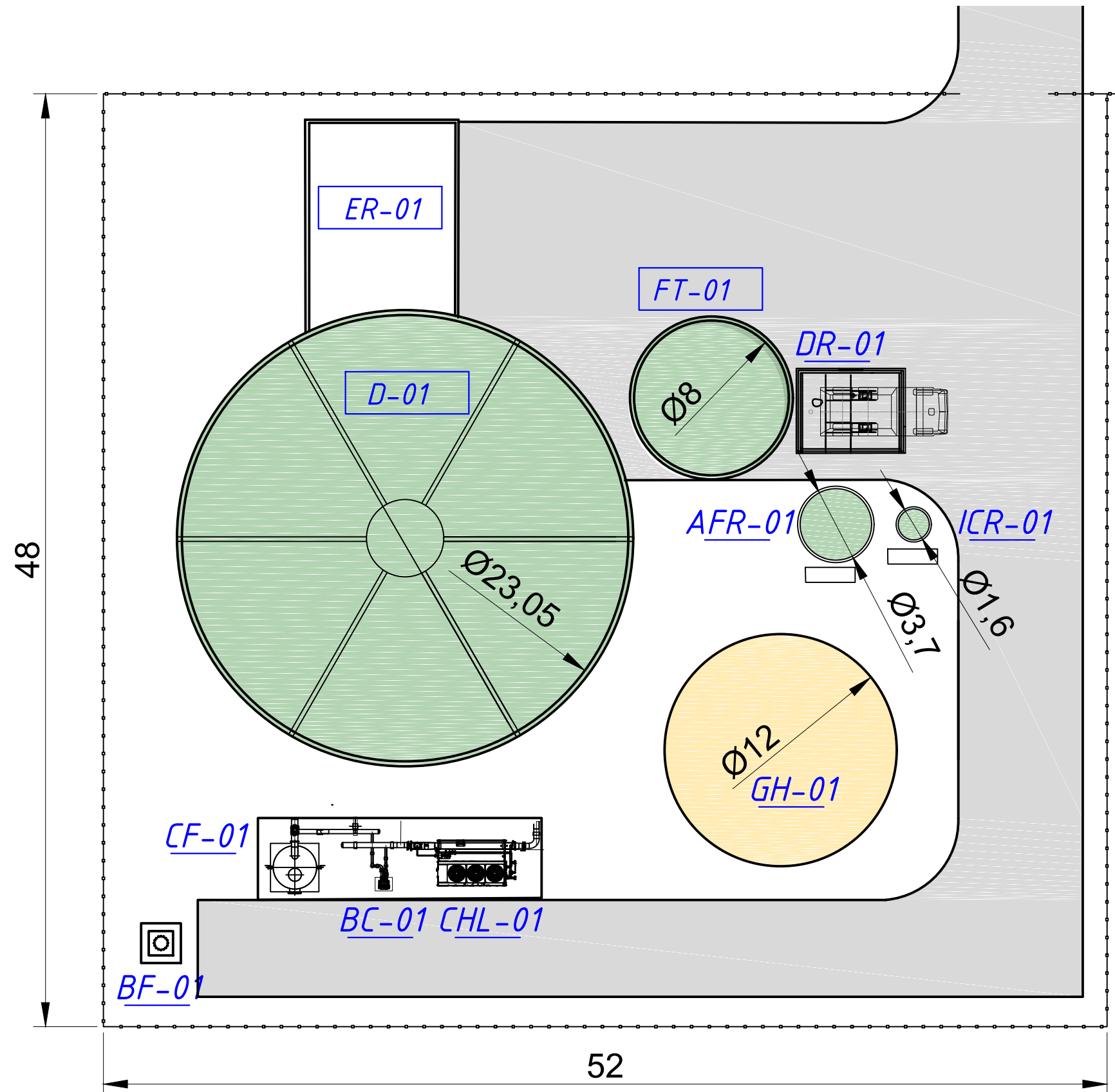
Legend main pipelines

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

Basic diagram



Preliminary layout proposal



Explication

N/Nº	Name	Note
RT-01	Receiving tank	
D-01	Digester	
FT-01	Filtrat tank	
DR-01	Decanter platform	
GH-01	Gasholder	
CHL-01	Biogas cooling system	
BC-01	Biogas compressor	
CF-01	Carbon filter (desulphurization)	
BF-01	Biogas burner	
ER-01	Equipment room	
AFR-01	Anti-foam reagent tank	
ICR-01	Iron chloride tank	

#### Appendix 4

Name equipment	Instal. Pow. (kW)	Quantity (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Digester Vertical agitator	37,0	1	37,0	16,0	592,0
Submersible mixer in filtrate tank	11,0	1	11,0	8,0	88,0
Substrate feed pump to digester	15,0	1	15,0	6,0	90,0
Substrate pump to decanter	11,0	1	11,0	9,0	99,0
Substrate circulation pump	15,0	1	15,0	12,0	180,0
Filtrate pump	15,0	1	15,0	5,0	75,0
Decanter	30,0	1	30,0	9,0	270,0
Anti-foam pump	2,5	1	2,5	1,0	2,5
Iron-ichloride pump	1,2	1	1,2	1,5	1,8
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	46,0	1	46,0	24,0	1104,0
Biogas compressor	12,0	2	24,0	12,0	288,0
Dry cooler (Digester cooling system)	4,0	1	4,0	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	1	0,8	24,0	18,0
Circulating pump feeding hot water at technical building	0,1	1	0,1	only ambient temp +15°C	
Circulation pump for supplying network water to the digester cooling system	2,0	1	2,0	24,0	48,0
Propylene glycol pump station	0,8	1	0,8	0,5	0,4
Desulphurization system compressor	1,5	1	1,5	24,0	36,0
Drinage pump	1,0	2	2,0	0,5	1,0
Lighting of the biogas plant territory	1,0	1	1,0	8,0	8,0
Spot light for digesters inspection windows	0,1	1	0,1	0,5	0,0
Working lighting of switchboard	0,1	1	0,1	0,5	0,1
Total installed power, kW			<b>226</b>		
Total consumed electric energy, kWh per day					<b>3015</b>
Total consumed power, kW					<b>126</b>

## Equipment price

Pos.	Description	Quantity	Unit Price, EUR	Total Price, EUR
1	Gasholder external (set) 700 m <sup>3</sup>	1	83 000,00	83 000,00
2	Over- and underpressure safeguard	1	4 200,00	4 200,00
3	Sight glasses/viewing windows with projector	1	4 900,00	4 900,00
4	Digester central agitator 35kW	1	135 000,00	135 000,00
5	Substrate circulation pump N=15 kW	1	21 000,00	21 000,00
6	Digested substrate pump N=18,5 kW	1	23 000,00	23 000,00
7	Filtrate pump N=18,5kW	1	23 000,00	23 000,00
8	Decanter N=30,0 kW	1	95 000,00	95 000,00
9	Submersible agitator 11 kW (Filtrate tank)	1	13 000,00	13 000,00
10	Biogas cooling system 770 m <sup>3</sup> /hour	1	105 000,00	105 000,00
11	Biogas blower 900 m <sup>3</sup> /hour	2	18 700,00	37 400,00
12	Desulfurization system 500 kg	1	48 000,00	48 000,00
13	Gas analyzer	1	25 700,00	25 700,00
14	Gas conditioning unit 770 m <sup>3</sup> /hour	1	13 500,00	13 500,00
15	Biogas burner 770 m <sup>3</sup> /hour	1	56 000,00	56 000,00
16	Heat supply station, as a unit, knocked-down.	1	87 000,00	87 000,00
17	Automatic with electric equipment, as a unit	1	195 000,00	195 000,00
18	Sensors (set)	1	50 000,00	50 000,00
19	Water supply and canalization system, as a unit.	1	55 700,00	55 700,00
20	Digester dry-cooler 100 kW	1	26 100,00	26 100,00
21	Digester Enameled steel tank V=8200 m <sup>3</sup> (including servise stairs, platforms, manholes, pipe flanges, suppotrs, fixing etc.)	1	870 000,00	870 000,00
22	Iron chloride reagent tank 6m <sup>3</sup> system, as a unit.	1	15 500,00	15 500,00
23	Anti-foam reagent tank 40m <sup>3</sup> system, as a unit.	1	105 000,00	105 000,00
<b>TOTAL (EXW, Memmingen, Germany): Two million ninety-two thousand Euro</b>				<b>2 092 000,00</b>

## Price

Name	Price (EXW, Memmingen)
» Project documentation	82 000 Euro
» Supervision	40 000 Euro
» Start-up, training	40 000 Euro
» Living and travel expenses	40 000 Euro
» Equipment	2 092 000 Euro
» Laboratory	35 000 Euro
» Delivery in Germany (17 trucks x2 000Euro)	34 000 Euro
» Construction and instalation	1 000 000* Euro
<b>Total</b>	<b>3 363 000 Euro</b>

\* 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%					
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

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