ZORG BIOGAS

Proposal

Biogas plant 57 tonnes spent grain/day

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OVERVIEW

Zorg Biogas offers a solution to process spent grains from beer brewery 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 will process 57 tonnes spent grains a day. The produced biogas will replace 4000 m3/day natural gas (41 MWh thermal energy a day or 141 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)
Spent grain	57	17100	21,8	95,8	12,42	11,9	580	6904	58	2071314

Biogas plant technical performances

Characteristics	Values	Figures
Number of digester	units	1
Digester volume Work Overall	m^3	 1600 1794
Organic load	kgODM/ m^3	6,6
Hydraulic retention time (gross)	days	31
Temperature in the digester	^0C	52
Overall dimensions of the digester (diameter / height)	m	11.95/16.00
Number of gasholder	units	1
Gasholder volume	m^3	218
Overall dimensions of the gasholder (diameter / height)	m	8/5

Number of personnel

Personnel is "0" people.
Biogas plant is fully automated and remotely controlled from a smartphone or a notebook.

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

The spent grain is transported to the territory of the biogas plant to the loading conveyor auger. The conveyor auger feeds the spent grain in equal portions into the upper part of the digester under the working level of the substrate. In the digester, the substrate is fermented at temperature of + 52 C. Thus, a constant temperature is maintained in the digester throughout the entire fermentation process. Heating and maintaining the temperature is provided by an external heat exchanger and the reactor cooling system. The substrate is mixed with a vertical mixer. The average fermentation time is 31 days. Biogas rises and collects under the conical roof of the digester. To prevent excess pressure above acceptable, the digester 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 + 10C, condensate formed is removed from the cooling system. After cooling, the biogas is heated to + 25 ° 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 to a boiler room.

The digested substrate is fed to the separator by pump. The separator separates the digested substrate into digestate and clarified wastewaters. Digestat is unloaded onto a site or a trailer, larified wastewaters enter a buffer tank, from where they are pumped out for further use or treatment.

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

MAIN EQUIPMENT

Digester

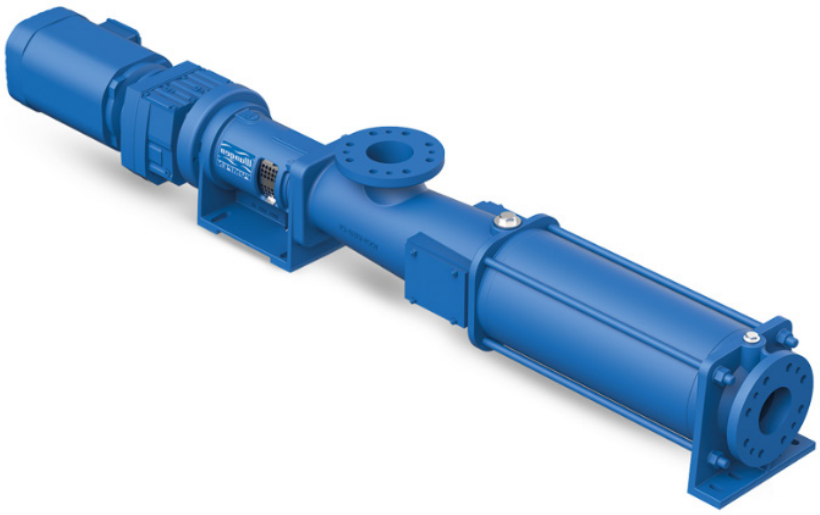
Digester is an important part of a biogas plant made of enameled sheet metal. The metal digester is installed on a concrete basis. A layer of enamel protects the surface of the entire metal structure. The enamel is vitreous and very resistant to aggressive pH and mechanical damage. Enameled digester 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 :	16.00 m
Diameter :	11.95 m
The total volume :	1794 m^3
Quantity:	1 pcs.



Pump equipment

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

Clarified wastewater pump

Flow rate:	**20 m3/hour**
Pressure:	**4Bar**
Quantity:	**1 pcs**

Heat exchanger supply pump

Flow rate:	**20 m3/hour**
Pressure:	**4Bar**
Quantity:	**1 pcs**

Separator supply pump

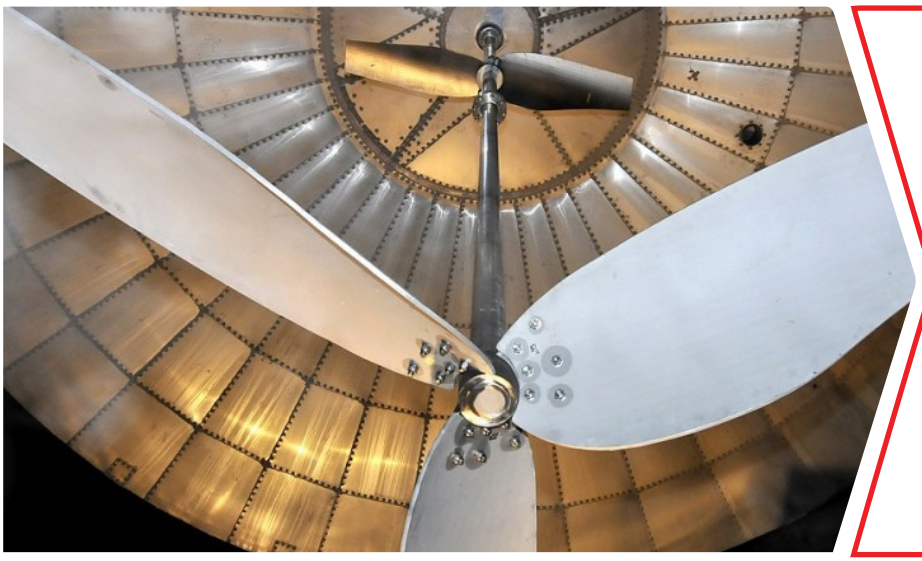
Flow rate:	**20 m3/hour**
Pressure:	**4Bar**
Quantity:	**1 pcs**

Buffer tank

Reservoir for reception of liquid kinds of raw materials. Tank is equipped conical roof, relief valves and level control systems (visual and electronic)

Specifications

Diameter:	4.4 m
Height	4.27 m
Total volume:	61 m^3
Working volume:	55 m^3
Quantity:	1 psc



Digester central agitator

The agitator is fixed to the center of the rigid overlap of the fermenter. Mixer blades are designed in different directions. This design of the blades helps to create a lifting force that lifts the substrate from the bottom of the digester to the top of the tank. The upper blades rotate distributing the substrate along the digester, directing the flow downward. The agitator works constantly, mixing the substrate in the digester all the time.

Specifications

Engine power:	N=17 kW
Quantity (per digester):	1pcs

Spiral Heat Exchanger

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 from Temperature	5 to 30 m³ / h up to 90 ° C;
Working pressure	at 4 bar
Capacity of the heat exchanger	50 kW
Quantity	1 pcs

Window with spotlight

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

Separator

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	**3,0kW**
Flow rate	**10-20 m3 / h**
Quantity	**1 pcs.**
Equipment	
Frame	
Screw	
Sieve for the filtration	
Counterweights	
The design of the protective room	

Gasholder

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 :	5.0 m
Diameter :	8.1 m
The total volume :	210 m^3
Quantity:	1pcs

Biogas dryer and cooling

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	290 m^3/ h
Gas inlet temperature	+52 C
Gas outlet temperature	+10 C
Engine power	19 kW
Quantity:	1 pcs

Biogas compressor

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 (co-generation power plant in our case)

Specifications

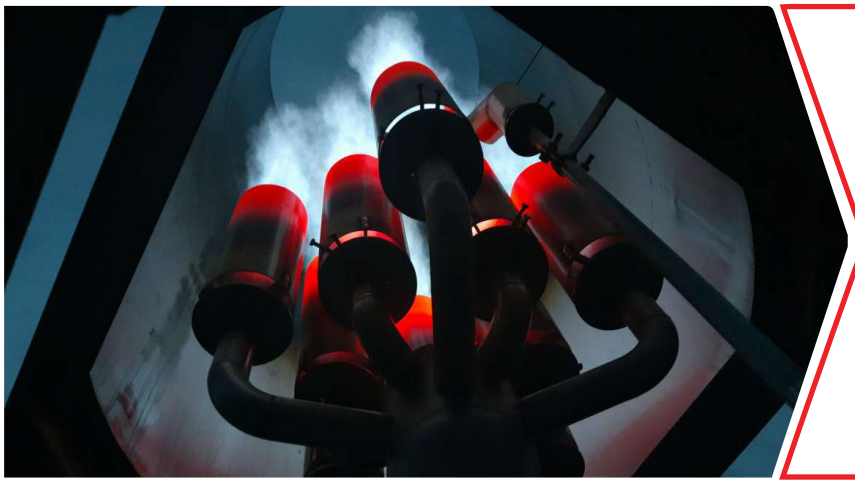
Flow rate	290 m^3/h
Pressure	150 mbar
Engine	3.0 kW
Quantity	1 pcs

Desulphurization system

The desulphurization system is a one-step purification of biogas to remove sulfur. The system cleans biogas of sulfur using activated charcoal filtration, as activated charcoal has the capability to absorb sulfur. After passing through activated charcoal filters, the sulfur concentration is reduced to 0 ppm.

Specifications

The volume of charcoal	500 kg
Numbers of charcoal columns	1 pcs



Flare

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	290 m^3/h

Dry cooler (digester cooling)

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:	30kW
Engine power:	0.5 kW
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

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

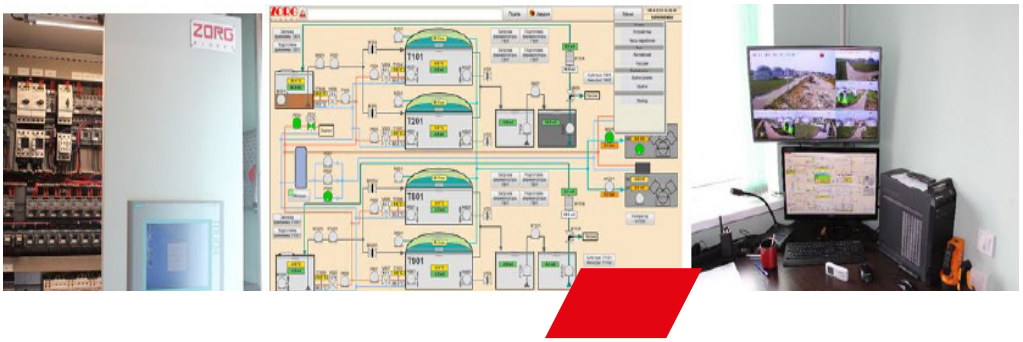
Equipment
Pump case control
Stove-base
gauges
Check valves
Float switches
Brackets
Valves

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



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 digesters, the volume 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

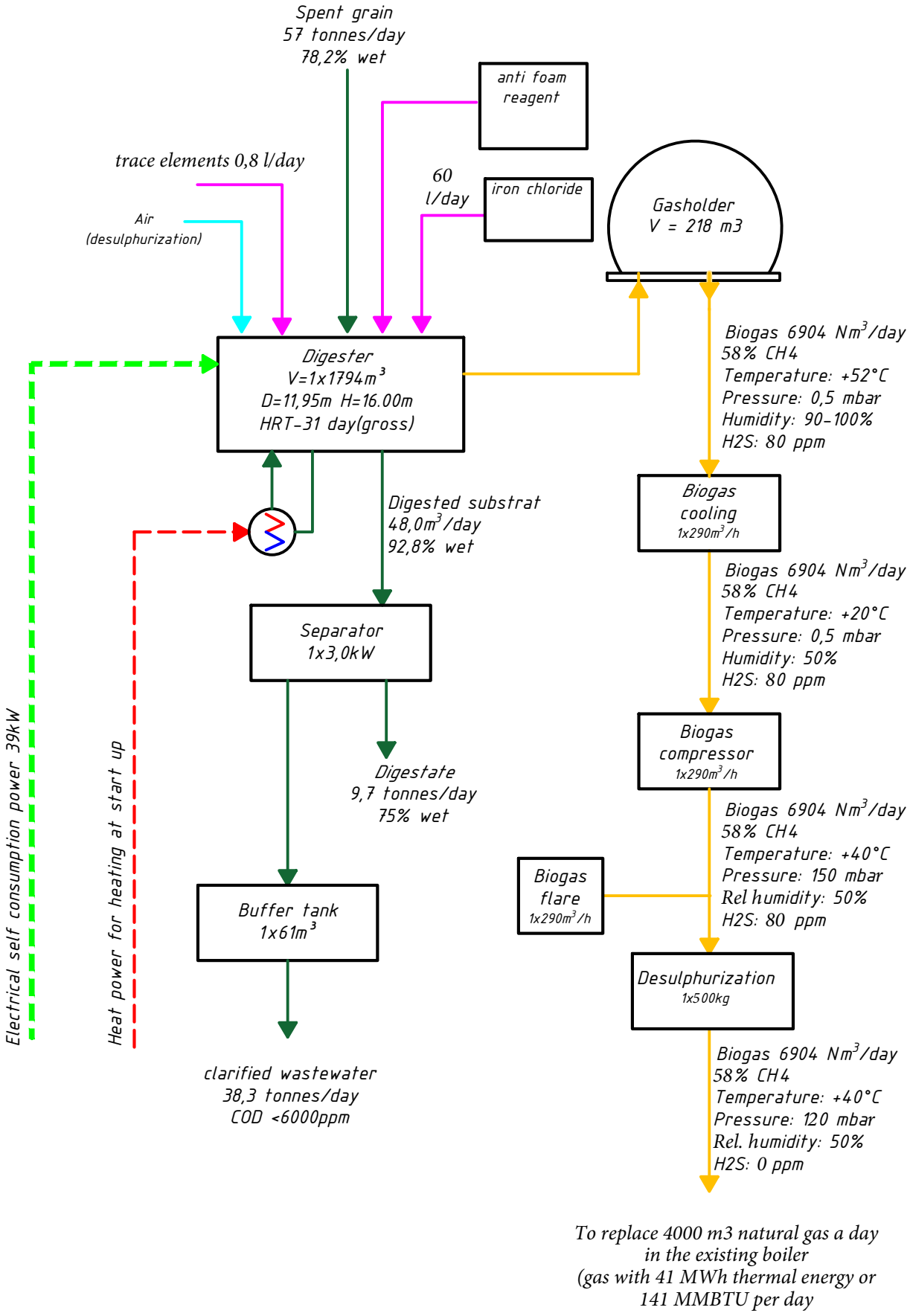
№	Equipment	Characteristic	Q-ty
1	**Digester (steel enamel tank)**	**V=1794 m³**	**1**
1.1	Windows with spotlight, complete, disas-sembled	set	1
1.2	Flanges to connection engineering communication	set	1
1.3	Service sites (for mixers gear, valves and connections)	set	1
1.4	Fixing for engineering communication	set	1
2	**Buffer tank (steel enamel tank)**	**V=61 m³**	
2.1	Manholes	set	
2.2	Flanges to connection engineering communication	set	
2.3	Service sites (for mixers gear, valves and connections)	set	
2.4	Fixing for engineering communication	set	
3	**Digester vertical agitator**	**N=17 kW**	**1**
3.1	Airtight motor gearbox		1
3.2	Hydraulic screw (wear-resistant steel)		1
3.3	Shaft (adapted to the height of the fer-menter)		1
3.4	Frequency converter		1
4	**Clarified wastewater pump**	**Q= 20 m³/h N=5.5 kW**	**1**
5	**Separator**	**N=3.0 kW**	**1**
5.1	Frame		1
5.2	Screw		1
5.3	Sieve for the filtration		1
5.5	Counterweights		1
5.2	**Separator supply pump**	**Q= 20 m³/h N=5.5 kW**	**1**
6	**Circulation substrate pump**	**Q= 20 m³/h N=5.5 kW**	**1**
7	**External heat exchanger**	**50 kW (heat power)**	**1**

№	Equipment	Characteristic	Q-ty
8	**Dry cooler**	**40kw**	**1**
9	**PVC external gas holder**	**Ø8.0 m**	**1**
9.1	Weather protection film	Ø8.0 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**		**1**
11	**Biogas compressor**	**Q=290m³/h N=3.0 kW**	**1**
12	**Biogas Cooling System**	**290 m³/h**	**1**
12.1	Chiller		1
12.2	Heat exchanger		1
12.3	Polypropylene glycol tank		1
13	**Desulphurisation system**		**1**
13.1	Filter with activated charcoal	500 kg	1
14	**Biogas analyzer (CH4 , CO2 , H2S)**		**set**
15	**Electromagnetic flow meter**		**1**
16	**Flare**	**290m³/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

№	Equipment	Characteristic	Q-ty
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 m^3/h N=3,5 kW	1
17.3	Circulation pump for supplying heating water to the office building	N=0,165 kW	1
18	**Electric boiler for start up**		**1**
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**
20.1	Conductivity sensor	31SCM50	3
20.2	Pressure / level sensor	SEN-3251 B025 G1 1Bar	2
20.3	Ultrasonic sensor	SPA-380-08	2
20.4	Gas pressure sensor	G1/2 0,4Bar	2
20.5	Thermal converter		2
20.6	Thermowells for thermocouples	TR10-B	2
20.7	Thermal converter heating circuit	TR3	2
20.8	Substrate pressure sensor	G1 4Bar	2
19.9	Substrate pressure sensor	G1 2,5Bar	2
19.10	Coolant pressure sensor	G1/2 6Bar	2
19.11	Immersion level sensor	LS-10 0,6Bar 4-20 mA	2
20.12	Humidity and gas temperature sensor	ESFTF-I	2

APPENDIXES

Material flow diagram



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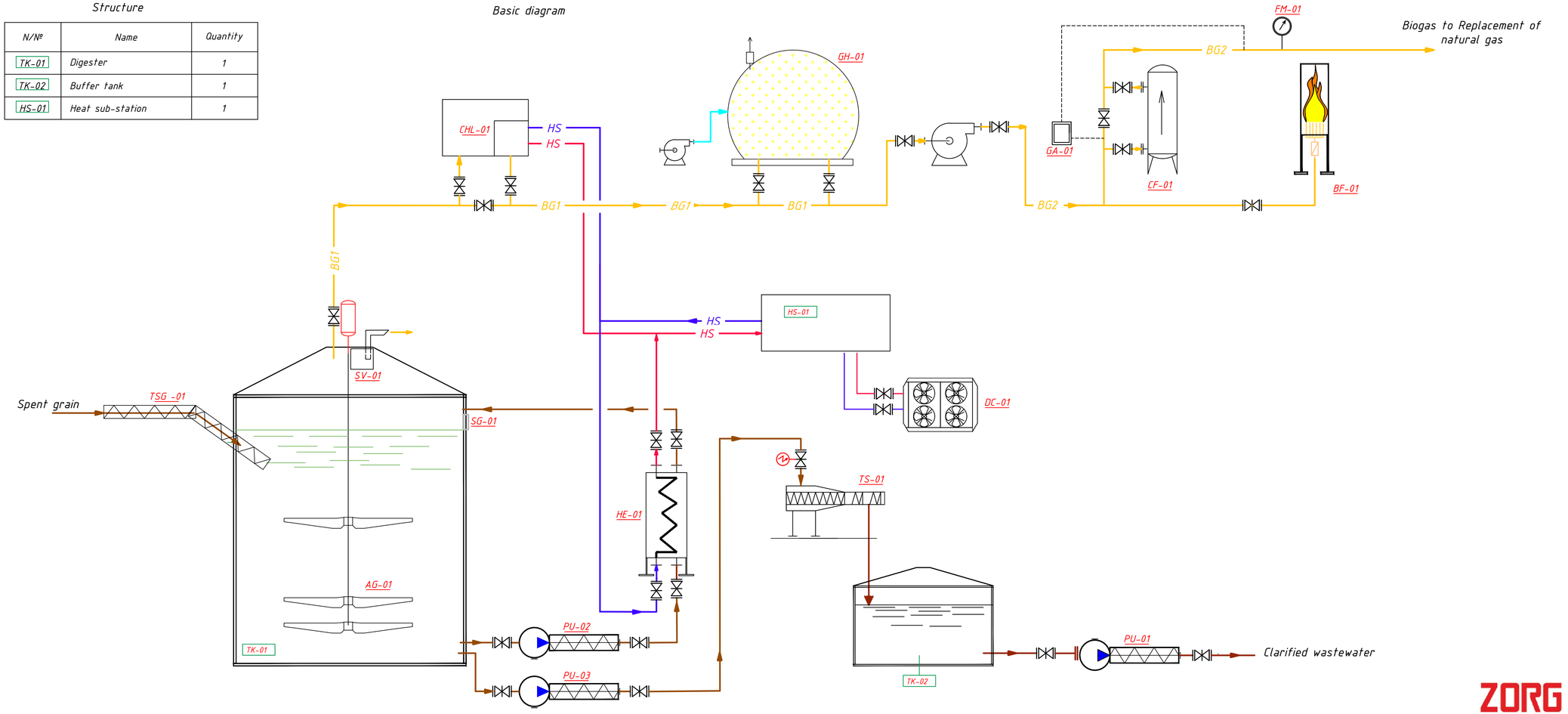
Specification

N/№	Name	Quantity
AG-01	Digester central agitator	1
SV-01	Safety valve	1
SG-01	Inspection windows	1
PU-02	Substrate circularion pump	1
PU-01	Clarified wastewater pump	1
PU-03	Separator supply pump	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
DC-01	Dry cooler	1
TS-01	Separator	1
TSG-01	Loading auger with spent grain	1

Structure

N/№	Name	Quantity
TK-01	Digester	1
TK-02	Buffer tank	1
HS-01	Heat sub-station	1

Basic diagram

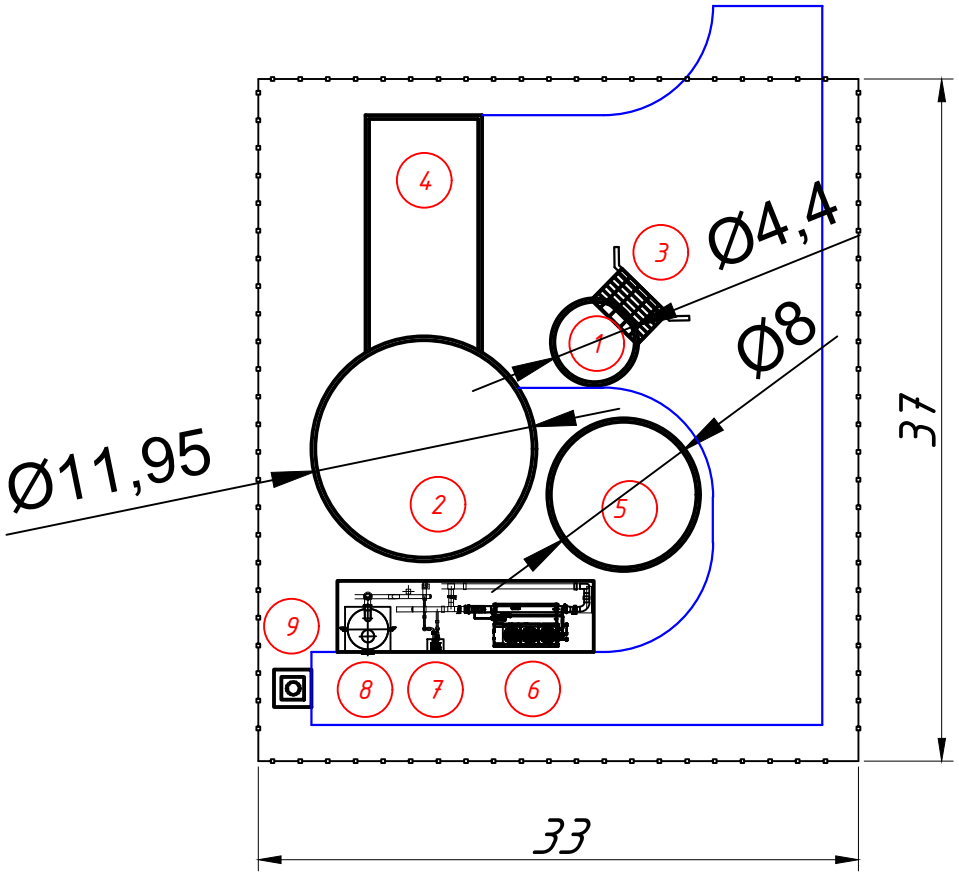


Legend main pipelines

- TCS — Substrate
- BG1 — Biogas
- BG2 — Biogas
- HS — Heat system pipeline
- HS

ZORG BIOGAS

Plan



Explication

N/№	Name	Note
1	Filtrate tank	
2	Digester	
3	Separator	
4	Technical room	
5	External gasholder	
6	Biogas cooling system	
7	Biogas compressor	
8	Carbon filter (desulphurization)	
9	Biogas flare	

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Average consumed electric power

Name equipment	Pow.instal (kW)	Q-y (pcs)	Total installed power (kW)	Working hours per day	Consumption kWh per day
Digester central agitator	9,5	1	9,5	16,0	152,0
Loading auger with spent grain (set)	17,0	1	17,0	4,0	68,0
Separator supply pump	5,5	1	5,5	3,0	16,5
Substrate circulation pump	5,5	1	5,5	6,0	33,0
Biogas compressor	3,0	1	3,0	24,0	72,0
Circulation pump for supplying heat carrier	0,5	1	0,5	12,0	6,0
Circulation pump for supplying heat carrierr to digester	1,0	1	1,0	24,0	24,0
Biogas cooling system	19,0	1	19,0	24,0	456,0
Circulating pump feeding network water at technical building	0,5	1	0,5	24,0	12,0
Circulating pump feeding hot water at technical building	0,1	1	0,1	only ambiant temp +10°C	
Propylene glycol pump station	0,5	1	0,5	0,5	0,3
Water circulation pump	0,5	1	0,5	2,0	1,0
Dry cooler (temperature control of digester)	0,5	1	0,5	24,0	12,0
Air compressor for gasholder lock	1,0	1	1,0	1,0	1,0
Air blower for duble membrane	1,0	1	1,0	24,0	24,0
Separator	3,0	1	3,0	12,0	36,0
Drinage pump	0,7	1	0,7	0,5	0,4
Biogas analyzer	1,0	1	1,0	24,0	24,0
Total installed power, kW			**69,8**		
Total consumed electric energy, kWh per day					**938,1**
Average consumed electric power, kW					**39**

Equipment price

Pos.	Description	Quantity	Unit Price, EUR	Total Price, EUR
1	Separator 3,0kW	1	36 000,00	36 000,00
2	External Gas-Holder D=8,0m V=218m³	1	57 000,00	57 000,00
3	Over- and underpressure safeguard	1	6 820,00	6 820,00
4	Sight glasses/viewing windows with projector	1	4 290,00	4 290,00
5	Digester central agitator 17kW	1	95 000,00	95 000,00
6	Separator supply pump N=5,5kW	1	16 000,00	16 000,00
7	Digested substrate pump N=5,5kW	1	16 000,00	16 000,00
8	Substrate circulation pump N=5,5kW	1	16 000,00	16 000,00
9	External heat exchanger	1	57 000,00	57 000,00
10	Biogas cooling system 290m3/hour	1	65 000,00	65 000,00
11	Biogas blower 290m3/hour	1	4 900,00	4 900,00
12	Desulfurization system (with activated carbon 500 kg)	1	33 000,00	33 000,00
13	Gas analyzer	1	27 000,00	27 000,00
14	Gas conditioning unit 290m3/hour	1	15 400,00	15 400,00
15	Biogas burner 290 m3/hour	1	51 000,00	51 000,00
16	Heat supply station, as a unit, knocked-down.	1	16 390,00	16 390,00
17	Dry cooler (digester cooling) 40 kW	1	18 000,00	18 000,00
18	Automatic with electric equipment, as a unit	1	137 000,00	137 000,00
19	Sensors (set)	1	27 390,00	27 390,00
20	Water supply and canalization system, as a unit.	1	13 310,00	13 310,00
21	Loading auger with spent grain (set: 1x horizontal, 1x inclined)	1	115 500,00	115 500,00
22	Steel enamel tank (buffer tank V=61m3)	1	115 500,00	115 500,00
23	Steel enamel tank (Digester) V=1794m3)	1	339 500,00	339 500,00
24	Accessories to the digester (ladders, manholes, platform, gas relief valve, foam relief valve, flanges, profiles for thermal insulation support)	1	145 500,00	145 500,00
	TOTAL (EXW, Memmingen, Germany), Euro			**1 428 500,00**

Price

Name	Price (EXW, Memmingen)
Project documentation	76 000 Euro
Supervision	20 000 Euro
Start-up, training	20 000 Euro
Equipment	1 428 500 Euro
Laboratory	31 000 Euro
Delivery to any port worldwide (8 containers x 12000Euro)	96 000 Euro
Sub total	1 671 500 Euro
Construction and instalation*	500 000 EUR
Total	2 171 500 Euro

* - Construction and installation includes excavation, concrete foundations, control and power cables, lighting, pipes, thermal insulation of the reactor and pipes, technical building, construction machinery and instrument rent, reactor assembly, equipment montage, hydraulic and dry testing

Implementation terms and payment

Months	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Project documentation	50%		50%													
Permissions and approvals																
Equipment supply		50%		50%			30%			20%						
Construction		30%		20%		30%		10%	10%							
Supervision		50%				50%										
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

ZORG
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