ZORG BIOGAS

Proposal

BioCNG plant 10 tpd using Napier grass

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OVERVIEW

We offer a solution to process napier grass into biogas in the single high-load reactor (HLR). The proposed HLR technology is superior to the conventional CSTR . HLR is 3 times smaller and cheaper than CSTR. For 10 tonnes methane a day capacity just 1 HLR is enough.

Zorg makes the detailed engineering, supplies equipment and provides supervision during construction as well as training and start-up.

The construction and installation are done by Customer under Zorg'

The amount of Napier grass and the volume of the reactor depends on the quality of the grass and the harvesting age.

For a grass with 33% total solid, that is harvested in 120 days, it's enough 120 tonnes grass a day and reactor V=4245 m3.

For the grass 27% TS, harvested in 80 days, the amount of grass is 146 tonnes a day and a reactor V=5281 m3 is required.

If you are not sure about the quality of the grass you may chose bigger reactor V=5281 m3

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Raw material potential from the Napier grass 33% total solid (ca. 120 day-harvest)

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	TS content: (%)	VS content (%)	TS quantity (tonne s/ day)	VS quantity (tonnes / day	Biogas yield (m^3 / tonneVS)	Biogas (m^3 /day)	Methane content (%)	Biomethane (m^3 /day)
Napier grass	120	43 800	33	96	39.6	38.02	690	26 231	52	13 723

Raw material potential from the Napier grass 27% total solid (ca. 80 day-harvest)

Substrate	Quantity (tonnes/day)	Quantity (tonnes/year)	TS content: (%)	VS content (%)	TS quantity (tonne s/ day)	VS quantity (tonnes / day	Biogas yield (m^3 / tonneVS)	Biogas (m^3 /day)	Methane content (%)	Biomethane (m^3 /day)
Napier grass	146,6	53 535	27	96	39.6	38.02	690	26 231	52	13 723

Biogas plant characteristics

Characteristics	Values	Figures
Number of reactors	units	1
Reactor the Napier grass 33% total solid		
a) volume:		
Work	m^3	3979
Overall	m^3	4245
b) Organic load	kgODM/ m^3	9.55
c) Hydraulic retention time (gross)	days	35/33
d) Overall dimensions of the reactor (diameter / height)	m	26.0/8.0
e) Temperature	^{0}	+52
Reactor the Napier grass 27% total solid		
a) volume:		
Work	m^3	4951
Overall	m^3	5281
b) Organic load	kgODM/ m^3	7,68
c) Hydraulic retention time (gross)	days	36/34
d) Overall dimensions of the reactor (diameter / height)	m	29.0/8.0
e) Temperature	^{0}	+52
Gasholder		
a) Volume	m^3	870
b) Number of gasholders	units	1
c) Dimensions of the gasholder (diameter / height)	m	12.5/9.3

Number of personnel

	Shift 1	Shift 2	Shift 3
Operator	1	1	1
Electrician	1	-	-
Mechanic	1	-	-



Biogas plant working principle

The technology is based on the biochemical conversion of organic materials from high molecular weight compounds to low

stage of this process is hydrolysis. Hydrolysis produces organic acids and alcohols.

2 5 7 2 -
CO3.
Further conversion of obtained dissolved compounds like organic acids and alcohols
5 7 2 3) 4 2
5 7 2 3 2 4 2 4
Biological process of consecutive (phasic) conversion of organic compounds take place in anaerobic environment i.e. in oxygen-free tank (biological reactor). At

hydrolysis take place under acidogenic

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

A and B type the character which depends on caused by different bacteria type. These two types of bacteria convert the com-
-
ond 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

Napier grass is transported to a biogas plant area and discharged into loaders. The loaders input substrates by portion to reactors using augers. In the reactors 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 reactors operating regime is thermophilic. The heated substrate in the digesters is blended periodically. Mixing is performed by vertical agitators. The average time of processing in the reactors is 32 days. After the reactors, 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

directed to a liquid residue storage tank. Biogas goes up under overlap and delivered into an external gas holder through pipeline.

protects the gasholder from precipitation and damage by foreign objects. The

by a special system. To protect the gasholder 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 biogs 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 compres-

2)

plant where raw biogas treats through the removal of CO2 and other soluble gases to produce primarily methane gas (~99%) which is clean and dry.

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

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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:	6.7 m
Width:	3.6 m
Height	3.4 m
Volume:	30 m³
Quantity:	1 pcs.



Reactor (RT-01)

Reactor 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 reactor there is a column with chapiter. Overlap of reactor 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 consumption, the reactor walls, overlap and bottom are insulated outside with 100 mm slabs of extruded polystyrene foam. Over the heater, the substructure walls and bot-

Superstructure and substructure heat insulation is protected by shaped sheet from the outside mechanical damages and rodents. The reactor`s bottom has a slope 1%.

Specifications for the Napier grass 33% total solid

Height :	8,0 m
Diameter :	26,0 m
The total volume :	4245 m³
The substrate volume :	3979 m³
Quantity:	1 pcs

Specifications for the Napier grass 27% total solid

Height :	8,0 m
Diameter :	29,0 m
The total volume :	5284 m³
The substrate volume :	4951 m³
Quantity:	1 pcs



Reactor vertical agitator (AG-01 ... AG-07)

use gear units and motors from respected European manufacturers. This guarantees the

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 Napier grass 33% total solid

Engine power:	N=15 kW
Quantity per digester:	5 pcs
Quantity total:	5 pcs

Specifications Napier grass 27% total solid

Engine power:	N=15 kW
Quantity per digester:	7 pcs
Quantity total:	7 pcs

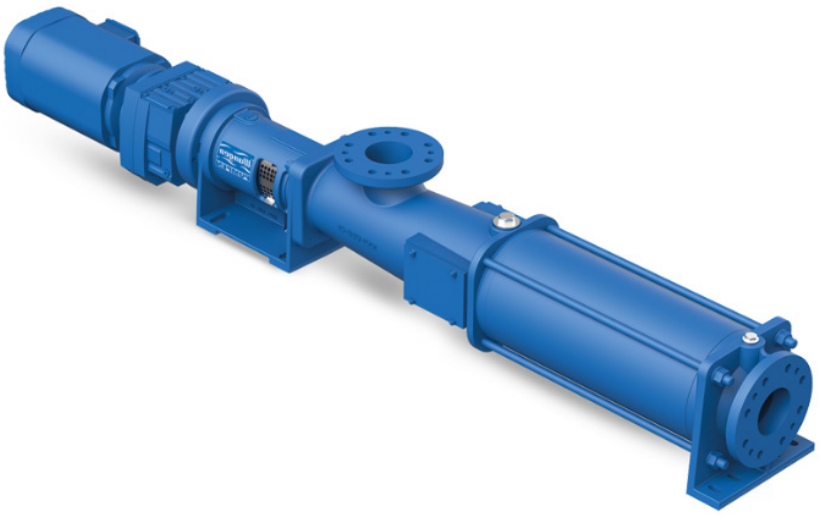


Window with spotlight (SG-01)

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-03)

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

the pumping chamber, wear-protected, robust universal joint with feeding screw, robust bearing pedestal with close-coupled drive and self-centering of the drive

Specifications

Substrate pump to separator (PU-01)	
Flow rate:	30 m3/hour
Engine power:	7.5 kW
Pressure:	4 bar
Quantity:	2 pcs
Liquid substrate pump (PU-02)	
Flow rate:	30 m3/hour
Engine power:	7,5 kW
Pressure:	4 bar
Quantity:	1 pcs
Filtrate 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

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

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	**5-10 m³ / h**
Quantity	**1 pcs**
Equipment	
Frame	
Screw	
Sieve for the filtration	
Counterweights	
The design of the protective room	

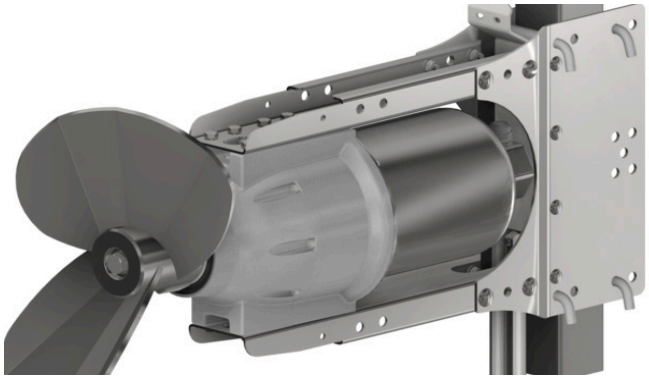


Receiving tank (RT-01) and Filtrate tank (FT-01)

Reinforced concrete tank for the storage of liquid raw materials. The tanks are equipped with level sensors and submersible agitators for mixing the substrate.

Specifications

Receiving tank (RT-01)	
Diameter:	6.0 m
Height	2.5 m
Total volume:	75 m³
Quantity:	1 pcs
Filtrate tank (FT-01)	
Diameter:	6.0 m
Height	2.5 m
Total volume:	75 m³
Quantity:	1 pcs



Submersible agitator (AG-06, AG-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

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ing the propeller. The conical shaft in the

by two angular roller bearings and sealed off from the agitating substrate with a mechanical seal.

Specifications

Submersible agitator of the receiving tank (AG-06)	
Nominal power	N=3.0 kW
Quantity:	1 pcs
Submersible agitator of the filtrate tank (AG-07)	
Nominal power	N=3.0 kW
Quantity:	1 pcs



Gasholder (GH-01)

The gasholder provides for biogas storage and for equalizing pressure and biogas composition. The gasholder system has a two-layer construction. The external

of PVC-coated polyester fabrics with UV

external N/5cm, internal membrane PELD (gasholder) membrane.
The gasholder has a methane permeation maximum of 260 cm3/m2 * 1 bar biogas

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ture range allows operation from -30°C to +60°C.

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mal 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 :	9.3 m
Diameter :	12.5 m
The total/working volume :	870 m³
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; inspec-

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ADMerkblätter and factory pressure test.

Specifications

Gas volume flow	1.200 Nm³/h
Gas inlet temperature	50
Gas outlet temperature	10
Cooling power	150 kW
Engine power	42 kW



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 (biogas upgrading plant in our case).

Specifications

Flow rate:	1.200 Nm³/h
Pressure:	150 mbar
Engine power:	16 kW
Quantity:	2 pcs



Desulphurization system

The desulphurization system is a 3-step system. Stage 1 is adding Ferrum Hydrooxide. Stage 2 - biological. Adding a certain portion of air to the fermenter. Air by special bacteria, converting H2S into S. After 1 and 2 steps the sulphur contcentration is 80

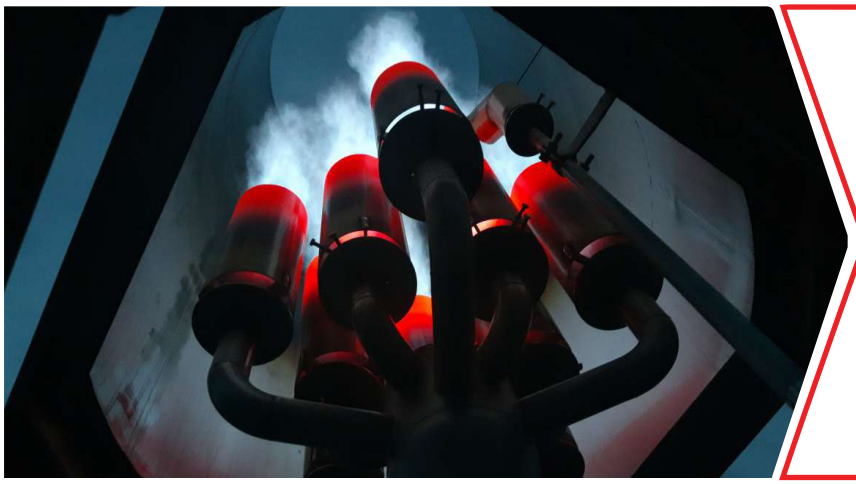
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is re-duced to 0 ppm.

Specifications

Charcoal filter (CF-01)

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



Flare (BF-01)

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 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 con-

Specifications

Flow rate	1.200 Nm³/h
Quantity:	1 pcs

Water supplying and sewerage system

Water supplying system provides biogas plant feed water, water for network circuits,

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

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 using 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

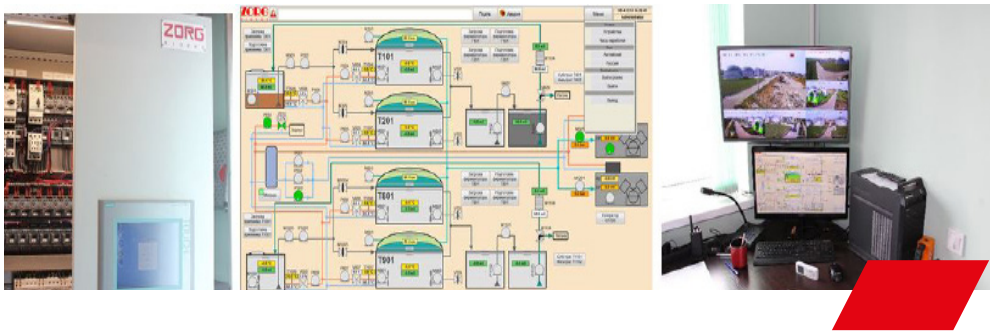


Dry cooler (cooling substrate system)

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 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 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

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sess 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,

Equipment

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

EQUIPMENT SPECIFICATION LIST



№	Equipment	Characteristic	Quantity
1	**Loader**	**V=30 m³**	**1**
1.1	Container bunker		1
1.2	Feeding screws	set.	1
2	**Submersible agitator**	**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	**Reactor vertical agitator**	**N=15 kW**	**5,7**
3.1	Airtight motor gearbox		5,7
3.2	Hydraulic screw (wear-resistant steel)		5,7
3.3	Shaft (adapted to the height of the fermenter)		5,7
3.4	Blade		5,7
3.5	Frequency converter		5,7
3.6	Mounting bracket to bottom of the mixer		5,7
4	**Safety valve of reactor**		**1**
5	**Window with a searchlight**	**set**	**1**
5.1	Inspection window RD300 (mounts and sealant included)	Ø300	2
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**

№	Equipment	Characteristic	Quantity
7	**Separator**	**N=5.5kW, Q=5-10m³/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			1
8	**Filtrate pump**	**30 m3/hour N=7,5 kW**	**1**
9	**Liquid substrate pump**	**30 m3/hour N=7,5 kW**	**1**
10	**Submersible agitator**	**N=3.0 kW**	**1**
11	**PVC gas holder**	**860m³**	**1**
11.1		Ø12.5m	1
11.2	max.260 cm3/m2*d*1 bar, 650 N/5cm bio-gas resistant		1
11.3	Air blower	16A, 0,5kW	1
11.4	Excess and minimum pressure valve		1
11.5	Dome level sensor		1
11.6	Mounting system		1
11.7	Accessories		1
11.8	Safety valve		1
12	**Biogas Cooling System**	**1.200 Nm³/h**	**1**
12.1	Chiller		1
12.2	Heat exchanger		1
12.3	Polypropylene glycol tank		1
13	**Desulphurization system**		**1**

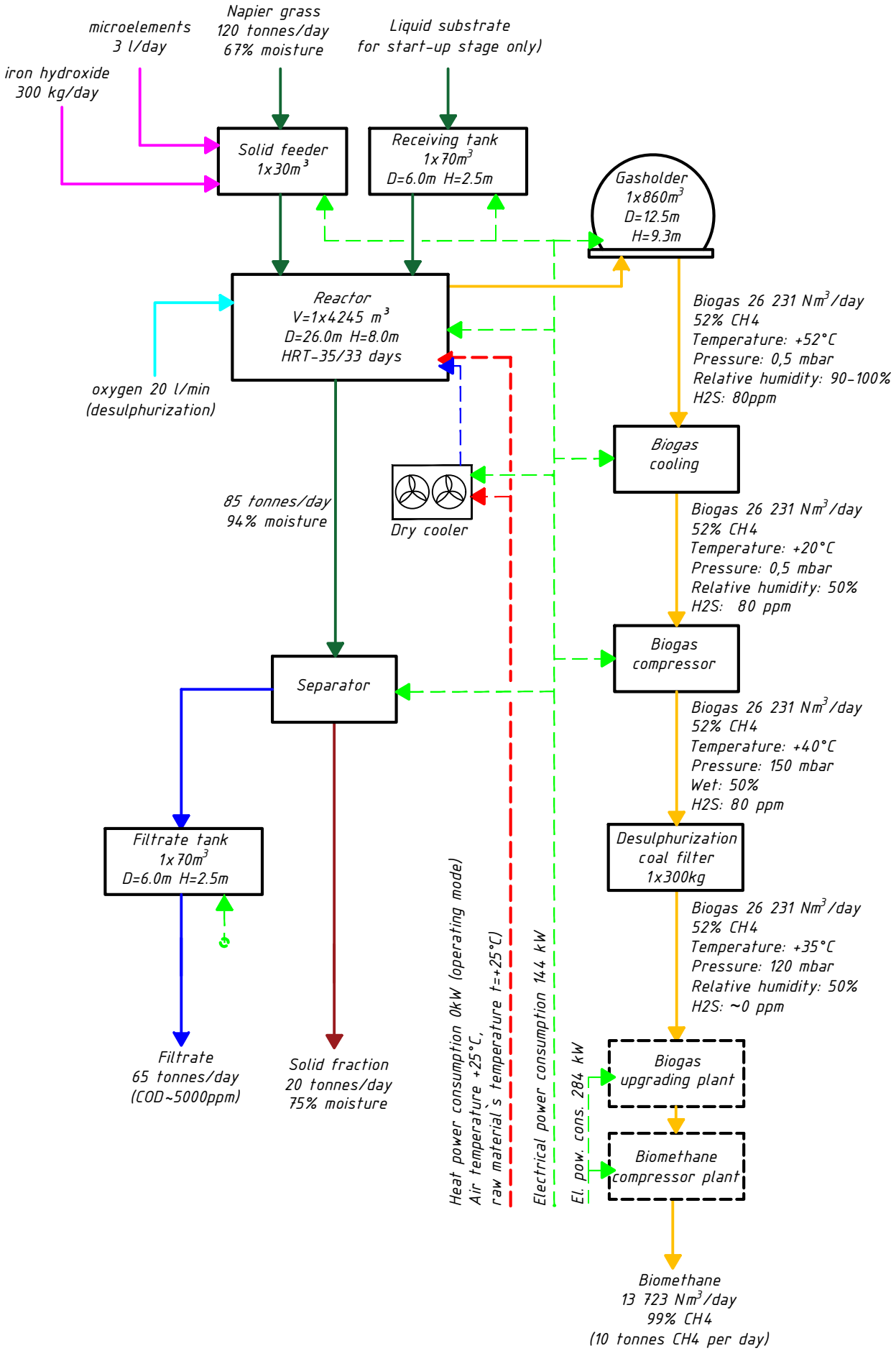
№	Equipment	Characteristic	Quantity
14	**Biogas compressor**	**Q=1.200 Nm³/h H=150mBar N=16kW**	**2**
15	**Electromagnetic flow meter**		**1**
16	**Flare**	**1.200 Nm³/h**	**1**
17	**Gas equipment included**	**set**	**1**
17.1		DN=50 Q=1m³/h H=13 m	2
18	**The heat supply system**	**set**	**1**
18.1	Diaphragm expansion tank	V=1000 l 6 120	1
18.2	Circulating pump for supplying heat carrier	Q=30 m³/h H=1bar	
18.3	Propylene glycol feed pump station heating systems	Q=1,0 m³/h, 4	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		2
21.2	Gas pressure sensor 0,4Bar		2
21.3	Pressure sensor(substrate level) 1,0Bar		2
21.4	Pressure sensor (substrate pressure) 2,5bar		2

№	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		2
21.10	Conductometric sensor of water level		2
21.11	Dome position sensor		1
21.12	Coolant pressure sensor	SEN 3276 B065 G1/2 6Bar	2
21.13	Humidity and gas temperature sensor	ESFTF-I	2
22	**Dry cooler 100kW heat pow.**		**1**
23	**Laboratory**		**1**

APPENDICES

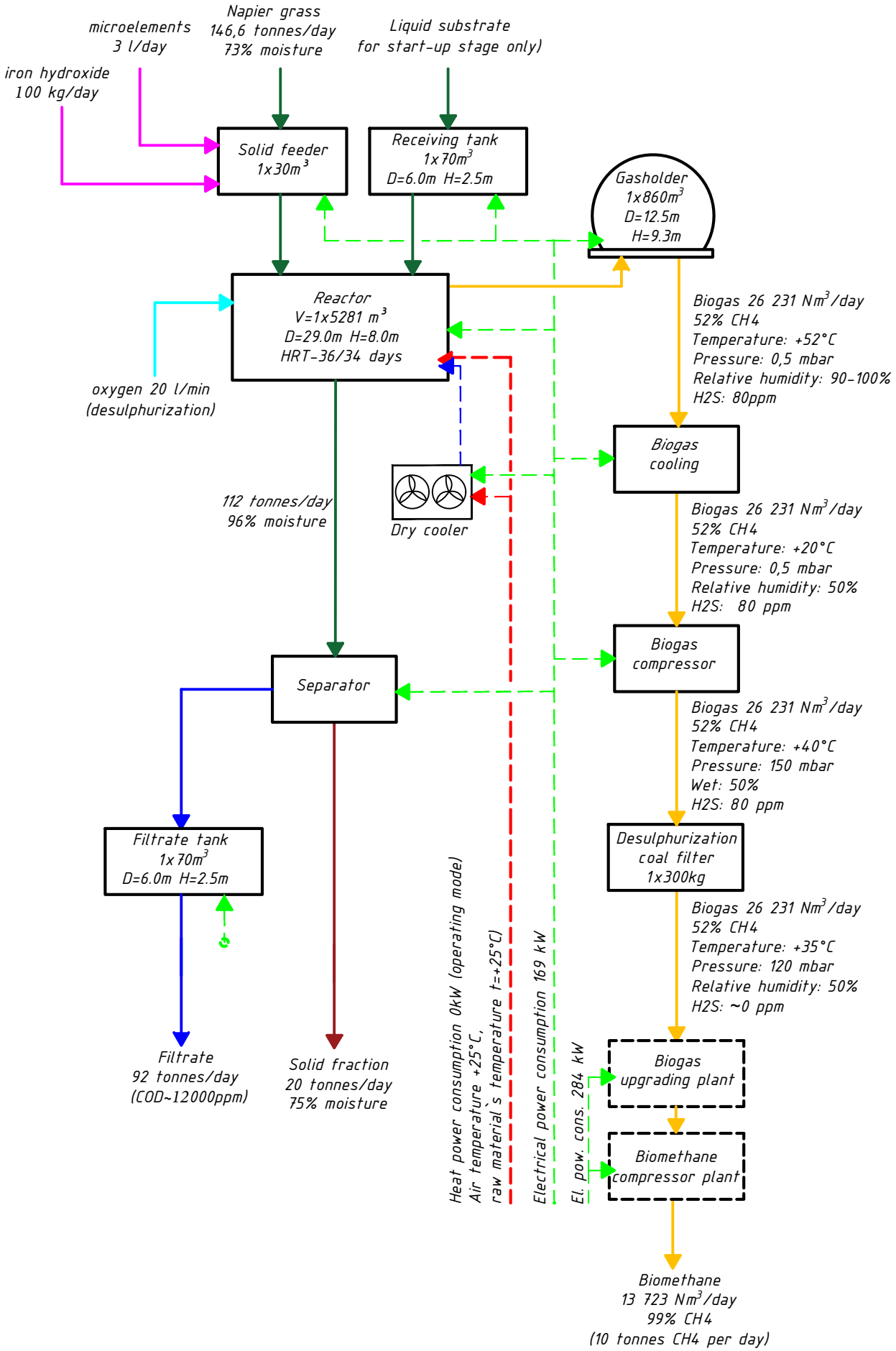


Material flow diagram (Napier gras 33% TS)



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Material flow diagram (Napier gras 27% TS)



ZORG BIOGAS

Appendix 2

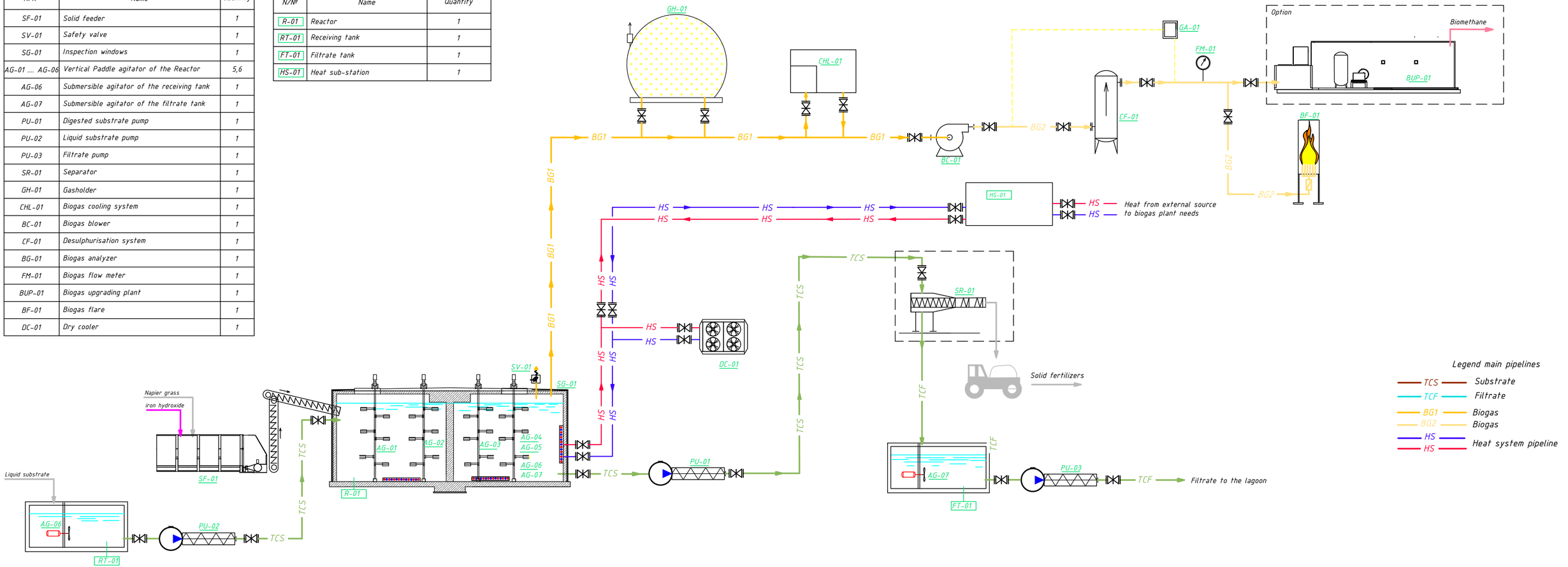
Explication

N/№	Name	Quantity
SF-01	Solid feeder	1
SV-01	Safety valve	1
SG-01	Inspection windows	1
AG-01 .... AG-06	Vertical Paddle agitator of the Reactor	5,6
AG-06	Submersible agitator of the receiving tank	1
AG-07	Submersible agitator of the filtrate tank	1
PU-01	Digested substrate pump	1
PU-02	Liquid substrate pump	1
PU-03	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
BUP-01	Biogas upgrading plant	1
BF-01	Biogas flare	1
DC-01	Dry cooler	1

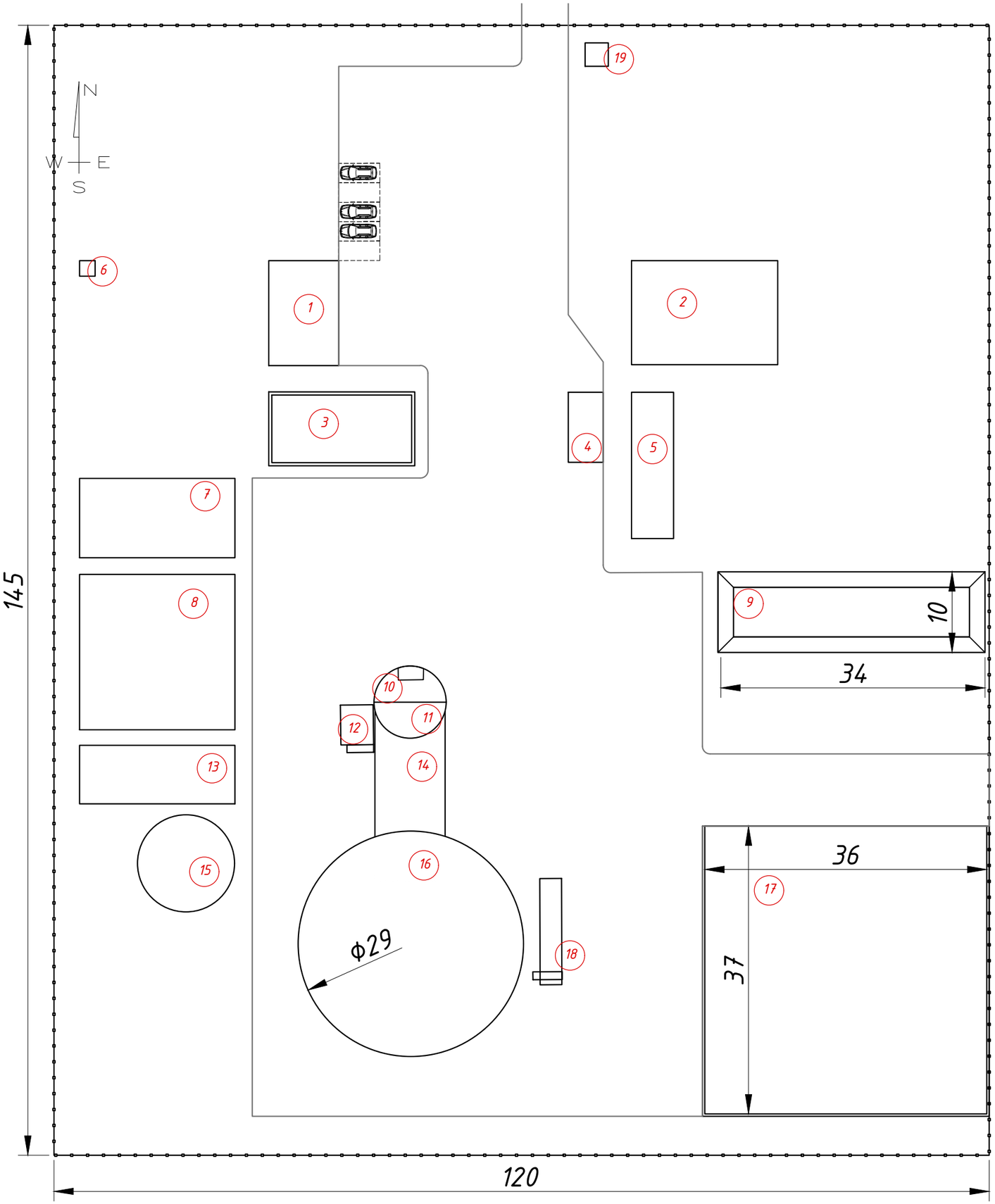
Structure

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

Basic diagram



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Explication

N/№	Name	Note
1	Warehouse	
2	Fire tank	
3	Operators room	
4	Weigh bridge	
5	Rainwater treatment	
6	Biogas flare	
7	Methane filling station	
8	Biomethane module	
9	Lagoon	
10	Receiving tank	
11	Filtrate tank	
12	Separator area	
13	Gas preparation	
14	Technological room	
15	Gasholder	
16	Reactor	
17	Storage of raw materials	
18	Solid loader	
19	Security	

S=1,7 ha

Appendix 4.1

Biogas plant (Napier grass 33% total solid)					
Name equipment	**Instal. Pow. (kW)**	**Quantity (pcs)**	**Total installed power (kW)**	**Working hours per day**	**Consumption kWh per day**
Loader V=30 m^3	20,0	1	20,0	8,0	160,0
Screw set.	18,5	1	18,5	8,0	148,0
Reactor Vertical agitator	15,0	5	75,0	18,0	1350,0
Submersible agitator in receiving tank	3,0	1	3,0	12,0	36,0
Submersible agitator in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	42,0	1	42,0	24,0	1008,0
Biogas compressor	16,0	2	32,0	12,0	384,0
Separator	5,5	1	8,0	8,0	64,0
Substrate pump to separator	7,5	1	8,0	8,0	64,0
Filtrate pump	7,5	1	2,0	4,0	8,0
Liquid substrate pump	7,5	1	2,0	4,0	8,0
Air compressor for gasholder lock	1,5	1	1,5	1,0	1,5
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
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			**226**		
Total consumed electric energy, kWh per day					**3464**
Total consumed power, kW					**144**

Biogas upgrading plant					
Name equipment	**Instal. Pow. (kW)**	**Quantity (pcs)**	**Total installed power (kW)**	**Working hours per day**	**Consumption kWh per day**
Biogas upgrading plant	174,9	1	174,9	24,0	4197,0
Biomethane compressor plant	108,6	1	108,6	24,0	2607,3
Total installed power, kW			**174,9**		
Total consumed electric energy, kWh per day					**6804**
Average consumed electric power, kW					**284**

Total average consumed electric power, kW					**428**

Appendix 4.2

Biogas plant (Napier grass 27% total solid)					
Name equipment	**Instal. Pow. (kW)**	**Quantity (pcs)**	**Total installed power (kW)**	**Working hours per day**	**Consumption kWh per day**
Loader V=30 m^3	20,0	1	20,0	9,0	180,0
Screw set.	18,5	1	18,5	9,0	166,5
Reactor Vertical agitator	15,0	7	105,0	18,0	1890,0
Submersible agitator in receiving tank	3,0	1	3,0	12,0	36,0
Submersible agitator in filtrate tank	3,0	1	3,0	12,0	36,0
Biogas cooling system	42,0	1	42,0	24,0	1008,0
Biogas compressor	16,0	2	32,0	12,0	384,0
Separator	5,5	1	8,0	8,5	68,0
Substrate pump to separator	7,5	1	8,0	8,5	68,0
Filtrate pump	7,5	1	2,0	4,5	9,0
Liquid substrate pump	7,5	1	2,0	4,0	8,0
Air compressor for gasholder lock	1,5	1	1,5	1,0	1,5
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
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			**256**		
Total consumed electric energy, kWh per day					**4052**
Total consumed power, kW					**169**

Biogas upgrading plant					
Name equipment	**Instal. Pow. (kW)**	**Quantity (pcs)**	**Total installed power (kW)**	**Working hours per day**	**Consumption kWh per day**
Biogas upgrading plant	174,9	1	174,9	24,0	4197,0
Biomethane compressor plant	108,6	1	108,6	24,0	2607,3
Total installed power, kW			**174,9**		
Total consumed electric energy, kWh per day					**6804**
Average consumed electric power, kW					**284**

Total average consumed electric power, kW					**452**

ZORG BIOGAS

Prices for a 10 tpd bioCNG plant using 100% Napier grass

Pos	Name	Number	Unit price, EUR	Price sub-total, EUR
1	Project documention	1	55.200	55.200
2	Supervision	1	35.000	35.000
3	Startup and training	1	35.000	35.000
4	Living and travel expences	1	40.000	40.000
5	Delivery of the equipment to a port in India + packaging for sea transpotation	10	8.000	80.000
6	Laboratory	1	18.900	18.900
7	Solid feeder (dosing buffer machine)	1	105.000	105.000
8	Screw conveyor	1	114.000	114.000
9	Digester vertical agitator	5	37.800	189.000
10	Frame for Digester vertical agitator pos 3	5	4.900	24.500
11	Substrate pump	1	20.300	20.300
12	Digested substrate pump	1	20.300	20.300
13	Filtrate supply pump	1	20.300	20.300
14	Substrate separation unit	1	33.600	33.600
15	Submersible agitator for receiving tank	1	7.700	7.700
16	Submersible agitator with guiding unit for filtrate tank	1	7.700	7.700
17	Over- and under pressure safeguard	1	3.500	3.500
18	Windows with a projector	1	6.000	6.000
19	Water supply and canalization system	1	18.900	18.900
20	Heat supply station	1	25.900	25.900
21	Dry-cooler (Substrate cooling system)	1	25.200	25.200
22	Automation and electric cabinet	1	158.000	158.000
23	Sensors (set)	3	25.000	75.000
24	Gasholder	1	45.500	45.500
25	Biogas chiller (Biogas cooling system)	1	36.400	36.400
26	Biogas blower of the 1 stage	1	11.200	11.200
27	Desulphurization column with active coal	1	15.400	15.400
28	Biogas flare	1	33.600	33.600
29	Gas analyzer	1	18.900	18.900
30	Gas conditioning unit	1	25.200	25.200
32	Oxygen generator	1	50.000	50.000
33	Biomethane upgrading plant	1	900.000	900.000
34	Biomethane compressor plant	1	250.000	250.000
	Total by Zorg, EUR			**2.505.200**
	equivalent in crores			**28**
	Client' responsibility			
36	Construction and installation	1	600.000	600.000
37	Filtrate Storage 2000 m3	1	20.000	20.000
38	Grass storage 8000m3	1	60.000	60.000
	Total by Client, EUR			**680.000**
	equivalent in crores			**7**

Total Zorg+ Client, crores **35**

Implementation terms and payment

Year													
Months	1	2	3	4	5	6	7	8	9	10	11	12	01
Project documentation	25%	25%	40%	10%									
Approvals and permits													
Equipment				30%		25%	25%	20%					
Delivery						25%	25%	25%	25%				
Construction													
Supervision				50%			50%						
Biogas plant start-up											50%	50%	

Contracts

Project implementation is executed simultaneously under several contracts

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

List of exclusions for a 10 tpd bioCNG plant:

1) Import taxes and local duties. The importer needs to apply the Ministry of Economy o get waiving of the import duties. Biogas plant is a plant for renewables.
2) Project report, civil permits and authorizations, adaptation of the project documentation by a licensed local engineering organisation for the permit purposes. Namely the organisation puts their stamp and acts act the face of the project. The design documentation is not changed in fact. 10 000 – 15 000 EUR
3) Topographic and geological surveys 3000-7000 EUR
4) Electric transformer and the external electric line 150 kW for start-up, for construction period and 450 kW for normal operation.
5) External roads,
6) Temporary water supply during the construction and the hydraulic test of reactors at least 500 m3 water per day. It can be a technical quality water from a river, lake, well. Not salty.
7) Bacterial seed for the start-up. It can be biomass from another biogas plant. Possibley also cow manure, any kind of manure, sludge from city sewage treatment plant. Customer needs to bring the seed one-time during a 1-2 week period 15-20% of the reactor volume 600-800 3 6 above.
8) Machinery to transport Napier grass to and from silage storage to the solid feeders (a truck, a frontal loader, a tractor)
9) Machinery to transport filtrate and the digested mass from the biogas plant to the agricultural fields (a truck, a frontal loader, a tractor)
10) Activated carbon 0,3 tonne per 2 year x 1800 EUR/tonne
11) Fe(OH)3, Fe(OH)2 – 38 tonnes per year x 800 EUR/tonne
12) Anti-foam reagent 2 tonnes annually (all kinds of vegetable oil, for example, palm oil or rapeseed oil)
13) Microelements 950 per year total x 25 EUR/l= 23 750 EUR
14) PVC foil for the silage storage to cover grass 700 m2
15) Demineralized water to the heating system 1,5 tonne.
16) Spare parts for two years -110 000 EUR

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