

THE WORLD RESOURCE FOUNDATION

TWR-Biomass Gasification Plant 500 kWh



TWR - 500 KWh Fluidized Bed Biomass Gasification Station Process Design

1. Introduction

1.1. Project Name

Project name: 500 KWh biomass gasification plant.

1.2. Design Standard

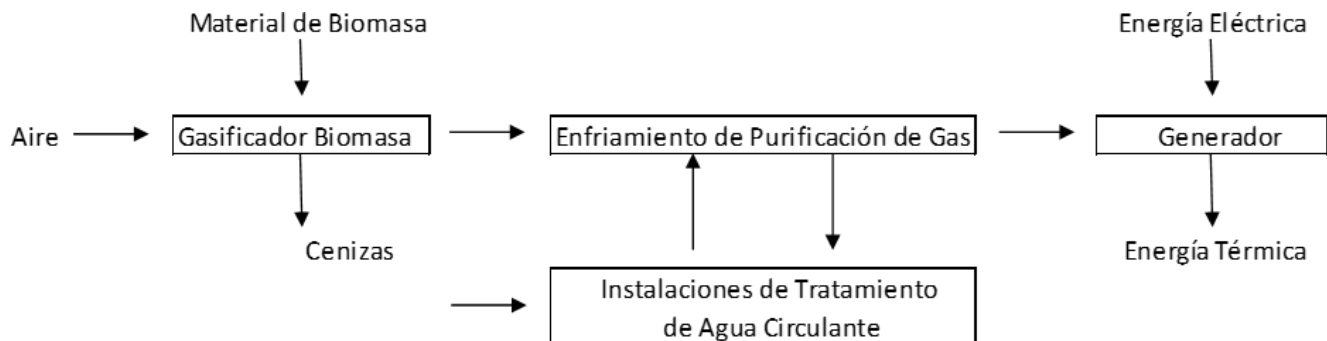
1. Regulations on environmental protection management of construction projects.
2. Acceptance standards and precondition for crop stalk gasification. NY/T443-2001.
3. Industrial enterprise gas safety standards. GB6222-2005.

1.3. Design Principles

1. Strictly in accordance with the standards and discipline of the gasification system specifications and the accepted standard required by the organizations to design work.
2. For easy operation, short construction period, stable operation and performance thereafter. installation, we choose high quality technical parts, advanced technology and design.
3. Seriously implement the "five objectives" design principles (plant design integration, outdoor production plant, light structure socialization, public works, equipment location technologies), we must adjust to local natural conditions.

2. Technological Scheme

Basic flow diagram of the gasification electrical system.



2.1. Basic Data for TWR Technology Scheme (rice stalks as sample)

2.1.1. Biomass Gasifier Quality Indicators

The project requires the owners to provide the actual feedstock (fuel) used to collect the correct sample or industrial analysis. According to the industrial analysis of rice stalks in our company, the rice stalk biomass feedstock is very suitable for gasification use. The actual project also proved this point, the gas quality and flow rate is high when.

our product is used. Therefore, we recommend the use of a fluidized bed gasifier, TWRBGL-500 as the gasification equipment for this project. The industrial analysis of crop stalks is as follows: (sample)

****The composition and calorific value are different for different biomass fuels.**

| Content % Content | Water | Ashes | Volatile Matter | Fixed Carbon | C | H | O | N | S | Minimum heating value |
|-------------------|-------|-------|-----------------|--------------|------|------|-------|------|------|-----------------------|
| Percentage | 10.0 | 10.39 | 60.7 | 5.86 | 39.1 | 5.02 | 35.28 | 0.58 | 0.04 | 12,330MJ/kg |

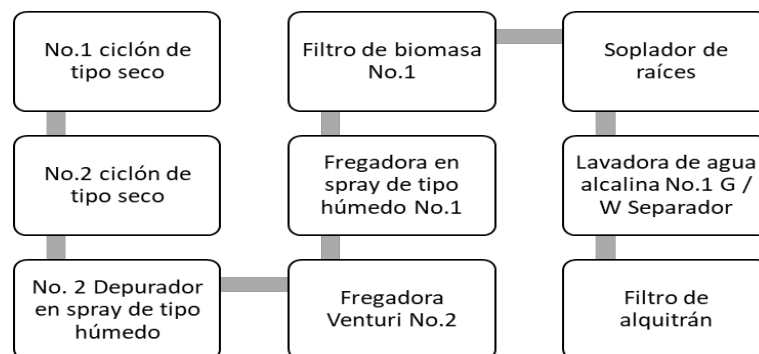
2.1.2. Gasification Rate of the 500 kW Biomass Power Plant

(Fuel parameters as sample for reference)

| Raw Materials | Crop stems |
|---|--|
| Gasification intensity | 300 ~ 450 kg/m ² h |
| Dry gasification combustion | 1.4 ~ 1.8 m ³ /kg |
| Gasification efficiency | ≥70% |
| Air consumption | 1000 Nm ³ ~1200 Nm ³ |
| Raw material consumption | 0.9 ~ 1.1 ton/h |
| Gas outlet | 1900 ~ 2100 Nm ³ /h |
| Gasification reactor outlet gas temperature | 700 - 800°C |
| Outlet gas temperature after cleaning and cooling | < 45°C |
| Low calorific value gas | 5000 ~ 6300 kJ/Nm ³ |
| Power output | 500 kW/h (according to consumption 16 MJ/kW) |
| Floor space | 2200 m ² |
| Gross weight of gasification reactor | 31 ton |
| Ash disposal method | Dry type, by means of collection and discharge by screw conveyor |

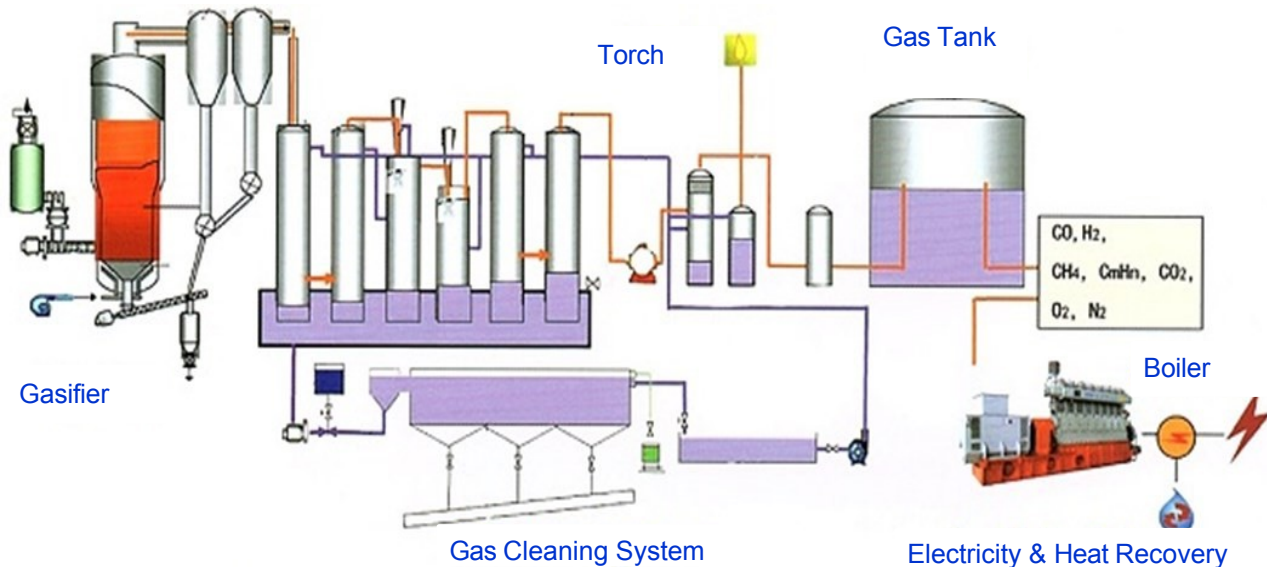
2.2. Technology Profile

2.2.1. Syngas Purification Process



After this dedusting and purification, the ash and tar content can be reduced within 50 mg / Nm³.

2.2.1.1. Flow Diagram



Dust & Tar Removal, Dehydration & Desulfurization

2.2.2. Strength and Advantage

The company's patented technology, a fluidized bed gasifier with an inner loop design, prolongs the residence time of material in the reactor and greatly increases gasification efficiency. Meanwhile, it is also specially equipped with dust purification and tar removal equipment designed outside the reactor. Purifying the gas strictly in various ways. The reactor has perfect operation of parameter monitors, centralized control, remote operation, which meets the requirements of the internal combustion engine of gas fuel quality. The entire filling station, water seal water (sewage) to implement an independent circulation system, recycling within the station, no sewage discharge.

2.2.3. Preliminary Provision as follows; see the file in this folder

2.3. Technical Performance of Major Equipment

The biomass gasifier belongs to the gasification equipment, the service station configured a biomass gasifier unit with fluidized bed type: TWRBGL-500.

In order to reduce the intensity of operators, biomass gasifier should be automatically controlled. In the technology, it should take the advantages of fluidized bed, large-scale and automation, at the same time, it can attract dry distillation. It can get the high quality gas and form a continuous semi-dry gasifier of the new technology. It can also make the gasification system work more reasonable, more energy saving and consumption reduction. Fluidized bed reactor as internal circulating fluidized bed, can increase the residence time of fuel in the reactor and further reduce fuel consumption to increase energy conversion efficiency, increase the calorific value of synthetic fuel gas.

2.3.1. 500 kW Biomass Gasifier with Fluidized bed main Technical Characteristics and basic parameters

| No. | Name | Parameters | Value |
|-----|--|-------------------------|-------------|
| 1 | Oven inside | mm | 1800 |
| 2 | Furnace basal zone | m ² | 2.2 |
| 4 | Applicable fuel | Wood Chips / Sawdust | |
| 5 | Fuel particle size | ≤10mm | |
| 6 | Fuel consumption | Kg/h | 900 ~ 1100 |
| 7 | Gasification agent | Air | |
| 8 | Air consumption | m ³ /kg fuel | 1000 ~ 1200 |
| 10 | Gas production | Nm ³ /h | 1900 ~ 2100 |
| 11 | Calorific value of gas | kJ/Nm ³ | ≥5000 |
| 12 | Gas outlet pressure | Pa | -200~200 |
| 13 | Gas outlet temperature | °C | 700 |
| 14 | The higher explosion pressure of the bottom. | kPa | 8 |

2.3.2. Dry Powder

Its main function is gas for dust removal. This gasifier matches with No.1 inertial precipitator + No.2 cyclone precipitator. The inertial precipitator can reduce the powder velocity and inertia with impact, by gravity powder. The cyclone precipitator is made of steel plate welding. Using the centrifugal force of powder rotation to realize the powder removal. The main technical indicators are listed below.

Inertial Precipitators Principal Technical Indicators

| No. | Name | Parameters | Value |
|-----|-------------------------------|--------------------|-------------------|
| 1 | Diameter of equipment housing | mm | 2000 x 680 x 2500 |
| 2 | Gas quantity processing | Nm ³ /h | 2400 ~ 3000 |
| 3 | Dust removal efficiency | % | 50 ~ 60 |
| 4 | Working gas temperature | °C | 600 ~ 700 |

Main Technical Indicators of Cyclone Precipitators No.1

| No. | Name | Parameters | Value |
|-----|-------------------------------|--------------------|-------------|
| 1 | Diameter of equipment housing | mm | Φ1000 |
| 2 | Gas quantity processing | Nm ³ /h | 2400 ~ 3000 |
| 3 | Dust removal efficiency | % | 70 ~ 80 |
| 4 | Working gas temperature | °C | 550 ~ 600 |

Main Technical Indicators of Cyclone Precipitators No. 2

| No. | Name | Parameters | Value |
|-----|-------------------------------|--------------------|-------------|
| 1 | Diameter of equipment housing | mm | Φ960 |
| 2 | Gas quantity processing | Nm ³ /h | 2400 ~ 3000 |
| 3 | Dust removal efficiency | % | 70 ~ 80 |
| 4 | Working gas temperature | °C | 500 ~ 550 |

2.3.3. Combination Spray Tower

Its main function is to clean the dust, remove the tar and reduce the temperature, etc. The combination of spray tower is made of welding steel plate, through water with No.2 wet type spray washer + No.2 venturi washer + No.1 wet type spray washer + No.1 biomass filter, the main technical indicators in the list below.

Combination Spray Tower, Main Technical Indicators

| No. | Name | Parameters | Value |
|-----|-------------------------------|--------------------|-------------|
| 1 | Diameter of equipment housing | mm | Φ1300 |
| 2 | Gas quantity processing | Nm ³ /h | 2400 ~ 3000 |
| 3 | Gas inlet temperature | °C | 400 ~ 550 |
| 4 | Gas outlet temperature | °C | ≤40 |
| 5 | Dust removal efficiency | % | 90% |
| 6 | Oil removal efficiency | % | 80% |

2.3.4. Alkaline water washer, separator G / W

Its main function is to capture the inside of the small dust and tar from the gas. It can put the water and gas separator in the biomass gasifier, remove the free water in the gas.

| No. | Name | Parameters | Value |
|-----|-------------------------|--------------------|--------------------|
| 1 | L * A * A | mm | 2100 × 1000 × 5000 |
| 2 | Gas quantity processing | Nm ³ /h | 2400 ~ 3000 |
| 6 | Dust removal efficiency | % | 90% |
| 7 | Oil removal efficiency | % | 90% |

2.3.5. Tar Filter

Its function is to capture tar, the effect of tar filter is good, the equipment can release tar and keep working.

| No. | Name | Parameters | Value |
|-----|-------------------------|--------------------|--------------------|
| 1 | L * A * A | mm | 4200 × 2100 × 8982 |
| 2 | Gas quantity processing | Nm ³ /h | 2400 ~ 3000 |
| 5 | Oil removal efficiency | % | 80% |

2.3.6. Roots Ventilator System

- According to the amount of fuel gas, the type of root force draft fan is L63LD, air pressure is 9.8 KPa, flow rate is 82.1 Nm³/min. And the motor type is Y280M-6.
- According to the amount of fuel gas, the type of root induced fan is L73WD, air pressure of 19.6 KPa, flow rate of 101 Nm³/min. And the motor type is Y180L-4.

2.4. Fuel Gas Power Plant Internal Piping

The power plant is equipped with air pipeline, fuel gas pipeline and pipeline for internal water circulation, etc. In order to avoid heat loss during the process and antifreeze consideration in winter, the protection measure should be taken for water, gas, pipeline. To avoid erosion of the pipeline, the anti-corrosion measure should be taken for the pipeline.

2.5. Analysis and testing

In accordance with the manufacturing technology requirement of the entire plant, the testing laboratory must be configured to test the analysis of the fuel gas components.

2.6. Civil Works (User Made)

The medium produced by this plant is flammable and explosive material, the fire hazard is classified as B class. And the general arrangement drawing is strictly in accordance with the relevant stipulations, such as:

- Standard design of the gasification plant.
- Design standard for general design drawings for industrial companies.
- Fire protection standard for architectural design.

Please pay attention to the separation distance between buildings and smooth lane. And according to the local weather conditions, make reasonable arrangements for the plant. Under the condition of meeting the requirement of manufacturing technology, try to use less land.

According to the actual condition of the project site, our company can make a design drawing for the whole gasification workshop, which can be sent to the customer for audit and modification in terms of the actual condition of the project site.

2.7. Automatic Control Technical Proposal

2.7.1. Automatic Control System Overview

The whole control system consists of PLC, IPC and intelligent digital meter, this DCS control system can monitor and measure the system equipment and make on-site indication of temperature, pressure and liquid level of the main technical measuring points, sound, light alarm, intelligent instrument control and real-time monitoring for upper computer; And it can realize automatic control operation for gasification system, it can display and store the main technical parameters and curve, which can provide reliable guarantee for the safe and stable operation of biomass power plant.

2.7.2. Screw Feeder for Biomass Feeding

The screw feeder is controlled by frequency converter, according to the standard signal of 4~20m. Through the pressure converter and the thermal torque in the reactor, judging the relationship between the reactor internal pressure, temperature and gas volume, the PLC can automatically adjust the RPM of the screw feeder to make the balance of the reactor operation and make it not disturb the transition of manual / automatic mode.

2.7.3. Screw Ash Remover

The inverter control of the screw ash remover, according to the speed signal of the spiral feeder, automatically adjusts the frequency of the feeder speed, so that the balance of the reactor conditions, and allows manual / automatic control without disturbance.

2.7.4. Temperature and Pressure Control Inside the Reactor

The PLC can automatically balance the temperature and pressure inside the reactor to make the gas production uniform, and will not waste the fuel, which can generate the balance between gas production and gas usage.

2.7.5. Control for root draught fan

Root force draft fan is controlled by frequency converter. According to the standard signal of 4 ~ 20 m. Through the pressure converter and the thermal torque in the reactor, judging the relationship between the reactor internal pressure, temperature and gas volume, the PLC can automatically adjust the RPM of the screw feeder to make the balance of the reactor operation and make it not disturbed Transition of manual / automatic mode.

2.7.6. Root Induced Fan Control

The root draught fan is controlled by a frequency converter. According to the standard signal of 4 ~ 20 m. Through the pressure converter and the thermal torque in the reactor, judging the relationship between the reactor internal pressure, temperature and gas volume, the PLC can automatically adjust the RPM of the screw feeder to make the balance of the reactor operation and make it not disturbed Transition of manual / automatic mode.

2.7.7. Interlocking between Forced Draft Fan and Induction Fan

Single-acting, linking and interlocking functions are installed in the system. In case of interlock, such as stopping the induced fan, the forced draft fan cannot be started. In case of forced draft fan stop, the induced fan will be delayed to shut down.

2.8. Safety, Environmental Protection and Fire Control Measures

2.8.1. Security

- Facilities for thunder prevention and ground discharge for electrostatic discharges are installed in the piping and fuel gas equipment.
- The ladders, platform and safety barrier are designed for all the equipment, which needs to be serviced and maintained.
- The safe pressure release water seal is installed in different parts of the entire system.
- In case of maintenance, specialized steam blowing and safe distribution systems are available.
- To establish a strict management system and perfect operation instruction.
- Fences, entrance guards are arranged in the power plant area for strict management.

2.8.2. Environmental Protection

The wastewater treatment of the entire power plant is an independent circulating system, which is distributed throughout the system and no wastewater discharge occurs.

2.8.3. Fire Requirements

The power plant is an explosive area, to ensure a safe production, follow the requirements to continued during design, construction and acceptance inspection.

- The main building of the power plant plant, the cooling and cleaning system and the pressure addition area belong to explosive and hazardous areas with grade B, the grade of fire resistant buildings is more than grade 2.
- The power plant is equipped with a fire rail and a fire hydrant and fire extinguisher are installed on each floor.
- It is necessary for the power plant to have strict rules and regulations for fire fighting and explosion protection. The management of the power plant should be improved and the specially assigned person should be in charge of it.
- The lightning protection device is complete, all the power plant equipment will be under the lightning protection area. The distribution for motive power and lighting can meet the requirement of anti-explosion.
- Ground for all equipment and piping are in good condition, resistance for ground is less than 40Ω.

- The one-way valve (check valve) is installed in the air blower pipeline, so that the biomass fuel cannot flow back to the air pipeline to form explosive gas. And the anti-explosion membrane is installed at the end of the main pipeline.
- The pressure lock is designed between the root induced fan, root force draft fan and fuel gas main pipe. In case of no operation of the root-induced fan, the root-induced fan cannot start; In case of stopping the operation of the root-induced fan, the root force fan will stop automatically.
- Pay attention to cooling by ventilation at the power plant site, especially avoid spontaneous combustion of biomass fuel in summer.

2.8.4. Ash treatment

The ash can be used as fertilizer, mechanical carbon, activated carbon, carbon black, it can also be used for road pavement or brick making material, which can be sold to the domestic and international market.

3. Main Technical Parameters of the Fuel Gas after Purification

3.1. Fuel Gas Components (e.g., take powdered peat):

| | |
|----------------------------------|--|
| Calorific value | ≥ 5 MJ/ Nm ³ |
| H ₂ | $\leq 10\%$ |
| Biomass fuel gas temperature | $\leq 40^{\circ}\text{C}$ |
| Biomass fuel gas outlet pressure | 3 kPa ~ 10 kPa (according to motor) |
| Pressure change rate | ≤ 1 kPa/min (normal operating conditions) |
| NH ₃ | ≤ 20 mg/N m ³ |
| Tar and dust content | ≤ 40 mg/N m ³ |
| Size of impurities | $\leq 5\mu\text{m}$ |

4. Workers Required

It is suggested that the number of power plant personnel should be 4.

| No. | Oficio | Shift 1 | Shift 2 | Shift 3 | Total |
|-----|-----------------|---------|---------|--------------|----------|
| 1 | Workers | 1 | 1 | 1 | 3 |
| 2 | Station Manager | 1 | | | 1 |
| | | | | Total | 4 |

5. Equipment components

List of main components of the 500 kW biomass gasifier.

| | |
|--|---------|
| Biomass fuel hopper (welding at project site) | 1 unit |
| Screw feed unit | 1 unit |
| Biomass gasification reactor | 1 unit |
| Inertial Precipitator | 1 unit |
| Dry type cyclone precipitator No.1 | 1 unit |
| No. 2 dry type cyclone precipitator | 1 unit |
| No.1 wet type spray scrubber No.1 | 1 unit |
| Wet type spray scrubber No.2 | 1 unit |
| Venturi Scrubber No.1 | 1 unit |
| Venturi Scrubber No.2 | 1 unit |
| No.1 wet type spray scrubber No.1 | 1 unit |
| Aerosol Spray Tower | 1 unit |
| Low temperature tar removal spray tower. | 1 unit |
| Biomass tar filter No.1 | 1 unit |
| Adjustable pressure wet-type gas tank (locally manufactured on site) | Drawing |
| Overpressure safety water seal | 1 unit |
| Surplus gas burner | 1 unit |
| Screw ash conveyor unit | 1 unit |
| Motor-driven rotary block valve | 3 Units |
| Piping and fittings between towers and scrubbers. | 1 unit |
| Forced draft fan unit | 1 unit |
| High-pressure biomass gas blower | 1 unit |
| Water supply pump | 2 Units |
| Circulation return water pump | 2 Units |
| Gasification control table (computer monitor control) | 1 unit |
| Circulating water filtration equipment | 1 unit |

6. Does not include

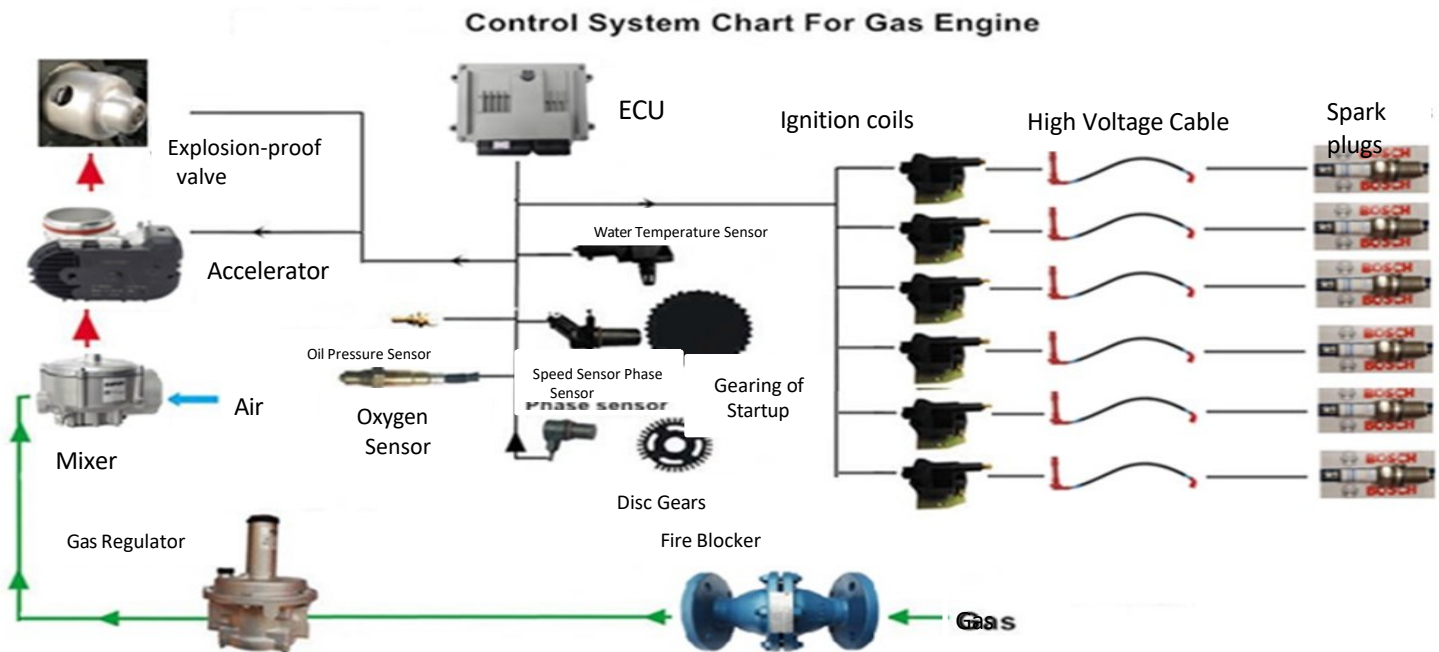
- Gas pipeline transporting gas out of the power plant.
- Equipment transportation costs in the user's country.
- Unloading of equipment on site, installation costs, such as cranes, etc.
- Factory engineer assignment (depending on installation time).
- The user must also be responsible for foundations, civil works, including lighting, lightning protection, earth and fire protection, etc.
- The user must be responsible for transporting water and electricity to the power plant.

7. 500 kW Biomass Gas Generator.

7.1. Generator Parameters

| | | |
|--------------------------|--------------------------|---|
| Biomass generator | Generator model | TWR-TM500GF-G |
| | Main power | 500 Kw |
| | Electrical parameters | 3-phase, 50HZ, 230/400V, PF= 0.8 |
| | Packing size | 4700 * 1800 * 2000 mm |
| | Gross weight | 7500 kgs |
| Gas engine | Model | TWR-YC6TD525N-D30 |
| | Continuous power / speed | 600 kw/1500 rpm |
| | Diameter and stroke | 200 * 210 mm |
| | Displacement | 39.6 L |
| | Cylinder number | 6 cylinders in line |
| | Cooling method | Water-cooled and air-cooled |
| | Start-up method | 24V DC starter |
| | Gas consumption | 2.5-3 m ³ /kwh |
| | Exhaust air temperature | 500-550 °C |
| Alternator | first power | 500 kw/1500 rpm |
| | Parameters | 3-phase, 4-wire, 50 Hz, 230/400 V, PF = 0.8 |
| | Flexible method | Brushless |
| | Protection | IP23 |
| | Insulation class | H |
| | Voltage stability | ≤±2% |
| | Transient voltage | ≤±1% |
| Certification | CE & ISO9001 | |

7.1.1 Gas engine control system (standard)



7.1.2. The supply details of the previous system

| Main article | Quantity |
|--------------------------|----------|
| Motor control unit | 1 unit |
| Wiring harness | 2 sets |
| Ignition coils | 6 units |
| High voltage wire | 6 units |
| Spark plugs | 6 units |
| Electronic accelerator | 1 unit |
| Venturi Mixer | 1 unit |
| Zero pressure valve | 1 unit |
| Fire blocker | 1 unit |
| Anti-explosion valve | 1 unit |
| Speed sensor | 1 unit |
| Phase sensor | 1 unit |
| Water temperature sensor | 1 unit |
| Oil pressure sensor | 1 unit |
| Oxygen sensor | 1 unit |

7.1.3. Generator control panel (standard)

1. 7310 offshore controller: displays all operating parameters of the engine and alternator, engine protection when there is high water temperature, low oil pressure, high speed, phase failure, large current, etc., with RS485 telecommunication protocol.
2. The famous Schneider switches and Omron relay increase durability.
3. The 2.5 mm thick wire rails reduce the vibration of the switches and the relay, in case of loosening of the joints.
4. Beautiful workmanship, powder coated workmanship for oxidation.



7.1.4. Total supply list

| Items | Quantity |
|---|----------|
| Gas engine (corrugated pipe, muffler, radiator, with gas engine control system) | 1 unit |
| Alternator (air switch, AVR) | 1 unit |
| Steel base with high efficiency shock absorbers. | 1 set |
| Control cabinet (with 7310 offshore controller) | 1 unit |
| Maintenance-free battery (including connection cables) (lead-acid) | 2 pcs |

7.2. Heat recovery system (optional)

1. The heat recovery system uses the heat from the spent gas to raise the temperature of the water in it, the exhaust gas temperature can reach 500-600 degrees when in operation, which is suitable for heating water.
2. Water temperature can be raised to over 90°C by means of the recovery system of heat.
3. The heat recovery system is with a needle type structure, which can absorb the gas temperature at most.
4. The system is made of carbon steel material.

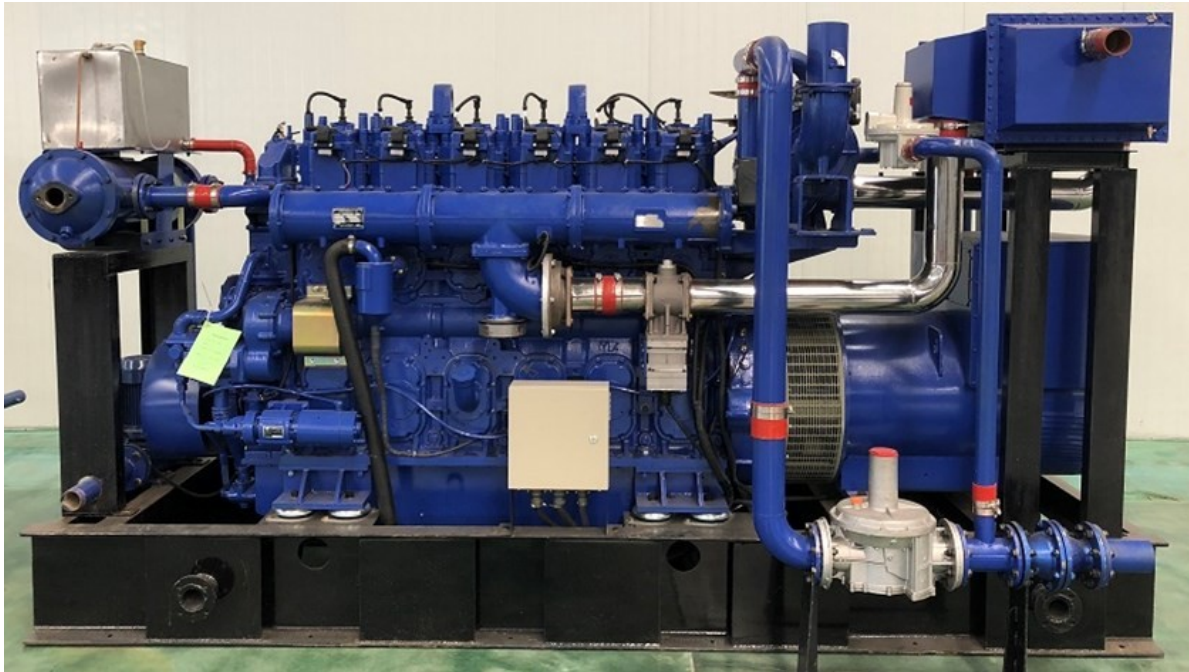


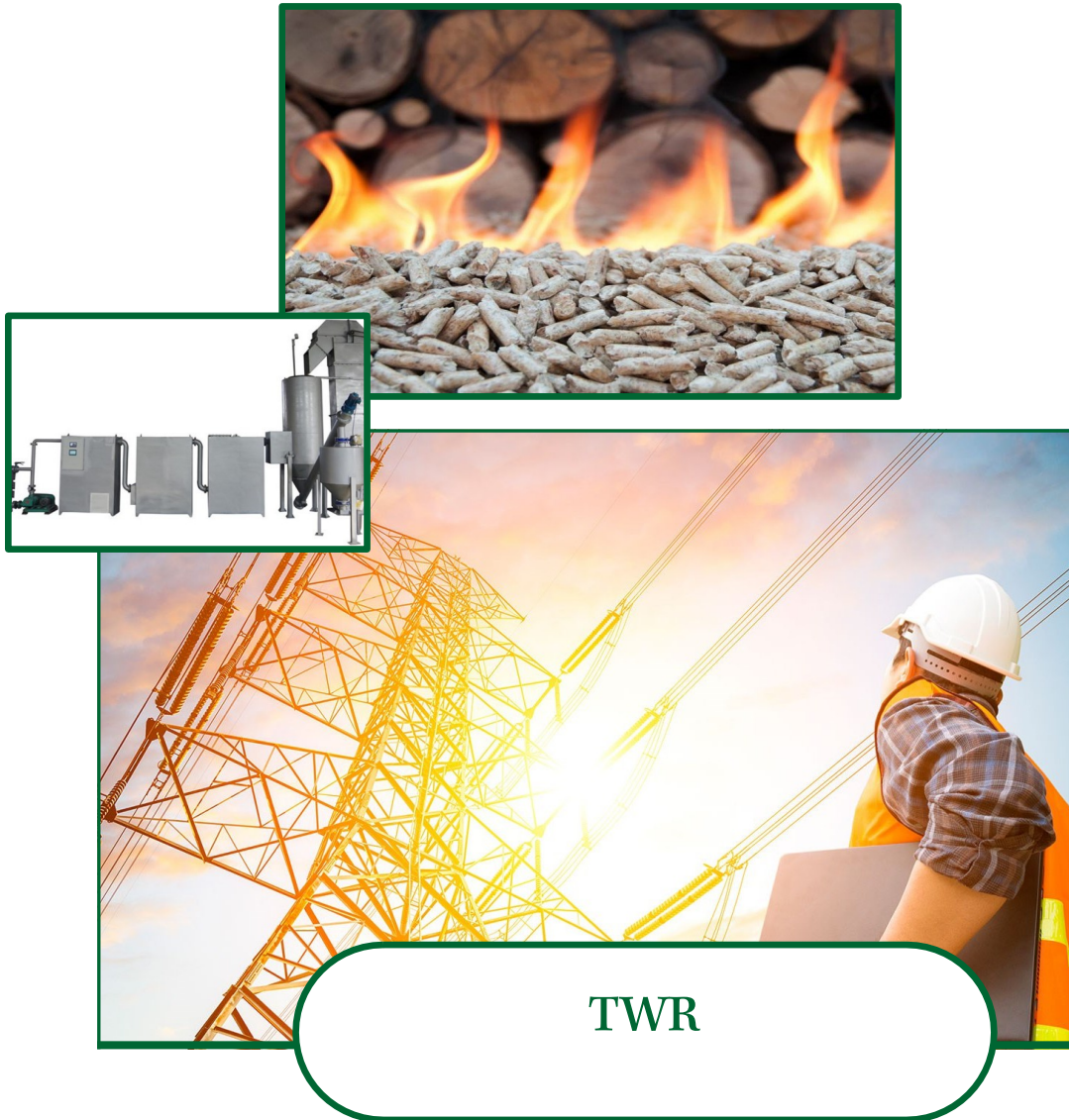
7.3. Self-parallel system with grid (optional)

If you choose this system, the above controller will be Smartgen 9510 series, and its function includes the functions of Smartgen 6110, the system adopts Smartgen 9510 series controller, Europe Legrand brand electric switch, when the system detects the voltage, HZ, phase, Like the grid, it will parallel the generator with the grid automatically.



7.4. Generator and Gasifier Images





It is committed to make every effort to make this project possible, the commitment is based on our principle,

"People Helping People"

Thank you for your valuable time