Project Pirdop
1 MW Thermal Gasification Plant

Short description of the project

The Sponsors have constructed a thermal gasification installation for the production of electrical and thermal energy from a renewable energy source – biomass. The installation has an installed capacity of 1000 kW and will use waste wood from lumber manufacturing and forestry activities as a resource. The synthesis gas (syngas) produced by installation is cooled and cleaned from tars and resins is fed into an internal combustion engine with a generator for the production of electrical and thermal energy. The electrical energy will be fed into the local grid, managed by CEZ and sold at tariffs set each year by the State Energy and Water Regulatory Commission (SEWRC). The thermal energy could be (a) sold locally to lumber manufacturers for wood drying, or (b) used by the installation operator to dry the wood chips fed into the reactor.

I. The installation for producing electrical energy from dry biomass is comprised by the following sections

First and foremost the wood resourced must be prepared for usage by chipping and/or forming burning blocks in the appropriate size, and then dried (if necessary).

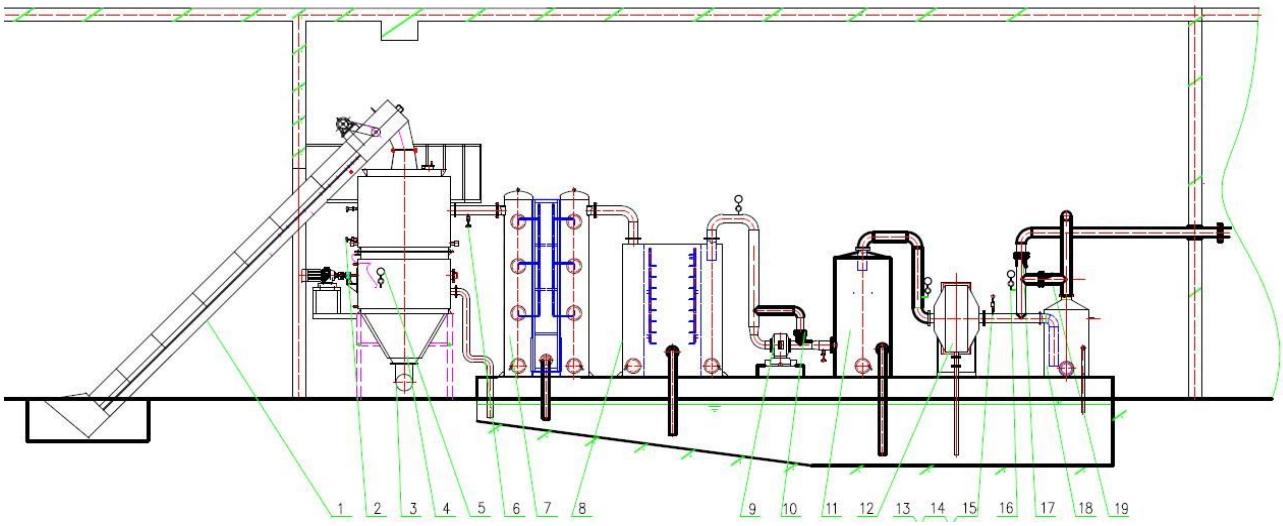
I. 1 Gasification and gas generation reactor

Gasification of dry biomass is a process of incomplete incineration, which forms three zones in the reactor – drying, oxidation, reduction zones. No matter what the humidity of the resources they always go into a drying zone of the reactor first. In the oxidation zone the wood is incinerated by oxygen or oxygen-steam mix. The oxygen in this zone must be injected in a balanced and careful matter in order to achieve an even burning zone. The product of the process are carbon-dioxide CO_2 and water H_2O with temperatures of 1000-1200^{o}C. The process in the reduction zone breaks down the gases to carbon monoxide and carbon in the following reaction: $CO_2 + C = 2CO$; $H_2O + C = CO + H_2$. The products of the pyrolysis incineration are gases that contain tars and resins, which contain organic acids, phenols. In a two-staged downdraft gasification process, which we use, the tars that fall into the reduction zone are almost completely decomposed, through oxidation and cracking. Therefore the proper engineering and construction of the reduction camera is essential in minimizing the volume of tars in the produced syngas. This in turn provides for seamless operation of the installation, as well as extends the life of the equipment.

I.2 Cleaning and cooling of the produced syngas

Cleaning of the produced gas is essential, especially when fed into internal combustion engines or gas turbines. The primal rough cleaning from ashes is performed in a cyclone battery, where the gas is fed directly from the reactor and its temperature is about 300 to 500^{o}C. This prevents condensation of tars and water on the body of the cyclones. The cyclone batteries clean the gas from ashes to about 80% and partially cool it to 200-120^{o}C, which allows for the gas to be fed into the electro-static filter and/or scrubber battery. The electro-filter acts as dry filter for tars and ashes and where the tars can be collected and disposed of. Collected tars can also be mixed with fresh wood resources or fine sawdust to form briquettes, which can be fed into a reactor. In the electro-static filter the gas is cleaned up to 99% of the tars. In the scrubbers the gas is ran against a stream of fine water drops and later through a filer comprised of finely crushed coal and biomass. This additionally cools and dries the gas from the remaining ashes and tars. The gas temperature after the scrubber battery is about 20-30^{o}C, which allows it to go then go through a fine paper and textile filter for removal of any remaining moisture. They syngas can now be fed into the internal combustion engines.

Sample schematic of the thermal gasification installation



Items: 1. Automatic life for feeding biomass to reactor; 2. Thermal sensor monitoring the process in the reactor; 3. Ash removal valve; 4. Gasification Reactor; 5. Switch.; 6. Thermal sensor for monitoring produces syngas; 7. Cyclone battery; 8. Electro-Static Filter; 9. Fan; 10. System bypass with Valve; 11. Scrubber battery; 12.Condensation removal; 13. 14. 15. Thermal Sensors for cooling and cleaning; 16. Pressure; 17. Gas Pipe to Generators. 18. Filter; 19. Bypass for starting the gasification cycle and on/off switch for Generators

II. Installation

This section gives an overall description for just some of the general elements of the installation. All parts must be engineered and ordered for construction.

II.1 Installation - parts, engineering and construction

1. Reactor
2. Cooling-cleaning system
    a. Cyclone for rough cleaning battery
    b. High-temperature textile filter
    c. Scrubber Battery
3. Resource Preparation
    a. Gang-saw 10-20 m^3/h (2 pieces)
    b. Forklifts (2 pieces)
    c. Pallet and briquette presses (150 kg/h)
    d. Bunkers for wood treatment and preparation
4. Gas Generators for Syngas
5. Other
    a. Caballing, framing, fitting, integration of installation, drying cameras, etc.
6. Engineering and planning
    a. Engineering projects
    b. Technological project
7. Grid-connection
    a. Transformers
    b. Meters
    c. Communication boxes
    d. Grid connection line construction

II.2 Operation and Management

1. Staff Required
    a. 1 Chief Engineer
    b. 2 Head of shift-resource handler
    c. 2 Forklift operators
    d. 2 Lab engineers
    e. 2 Mechanics
    f. 6 General workers
2. Generator maintenance requirements
    a. Motor oil
    b. Spark

    c. Oil and air filters
3. Miscellaneous expenses
    a. Installation filters
    b. Cleaning
    c. Reactor parts, piping and other installation parts
    d. Insulation
4. Water consumption for cooling
5. Wood resources delivery and logistics