

China's first straw based biomass power plant



Shan Xian power plant, Shandong Province

First Straw based biomass power plant of China

Description/ About the Plant

China's first mixed fuel based biomass power plant in Shan Xian Shandong Province was developed by DP CleanTech. The plant is one of the best examples of a mixed fuel biomass power plant in China. The plant was designed for 30 MWe load or capacity.

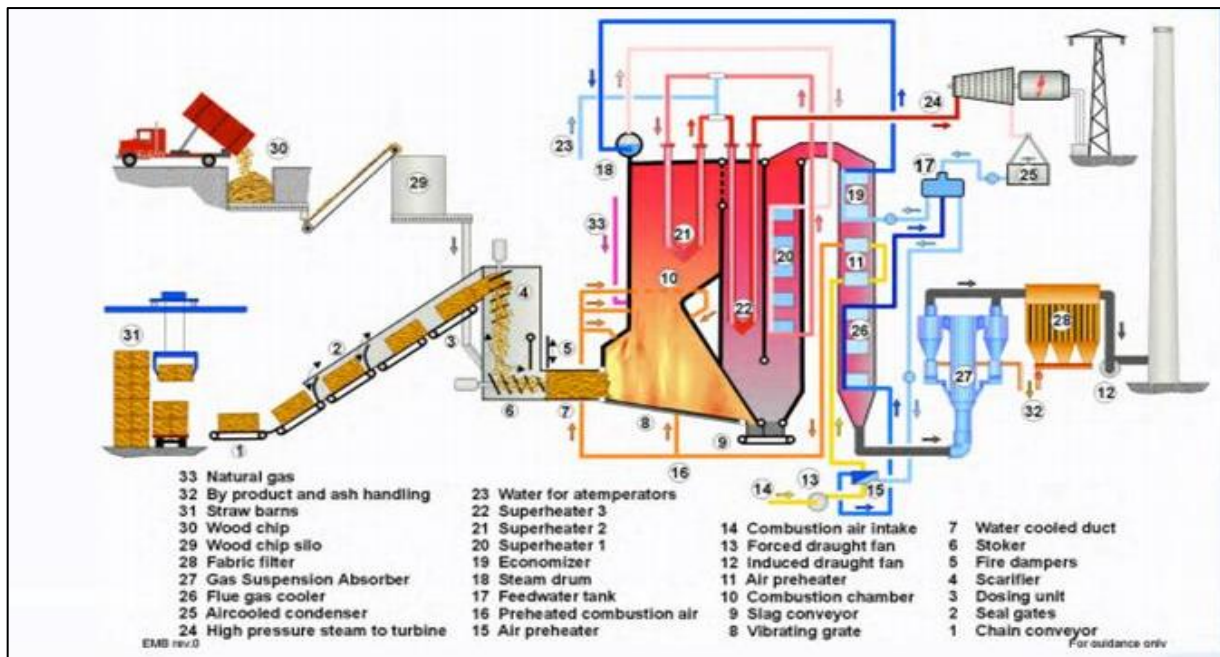
Biomass Supply Chain

The plant mainly use wood chips as raw material. The other fuel resources are corn cob, eucalyptus bark and peanut shells depending on the availability of the biomass. The plant consumes approximately 170,000 tons of wood per year. The wood is supplied locally from a pool of around 50,000 farmers who own less than 1 acre of land each. They deliver the fuel to 8 logistics stations located within a 30 km radius to the plant site where the fuel is shredded. The wood chips arrive at the plant on trucks which deliver the fuel to the storage area. The boiler buffer silo has a capacity of approximately one hour of operation. From the silo, the fuel is led to the spreader stokers via dosing screw conveyors. The wood chips are then fed into the boiler at the required flow rate under carefully controlled conditions.

PROJECT AT A GLANCE	
Capacity	30 MWe
Technology	Combustion
Feedstock	Mixed fuel (wood chip, bark, straw, husk)
Yearly fuel consumption:	Around 170,000 tons of wood chips with average of 25 tons per hour (tph)
Steam flow	130 tons per hour
Steam pressure	92 bar
Steam temperature	540 °C
Boiler efficiency	91%
Plant efficiency	33%

Technology of the plant

The technology used in the plant is based on an advanced biomass-fired, vibrating grate, high temperature, high pressure steam boiler. The typical biomass boiler is a natural circulation, single drum, single furnace, balanced draft, solid bottom ash removing, bottom supported boiler. Such boilers are well suited to indoor or outdoor installation. They can be fuelled as required with hard straw (e.g. cotton straw, wood chips or other selected forestry residues), soft straw (e.g. wheat, corn, rice or sorghum), rice husks, corn cores, peanut shells, and many other types of biomass. They can also handle moisturized fuels. The steam/water system uses natural circulation with a centralized downcomer located outside the furnace. The boilers have an M-type arrangement, and fully enclosed membrane water wall structure is used for the furnace and the back pass in order to ensure adequate sealing. Four-stage superheating and three-stage water de-superheating systems ensure that the temperature of the superheated steam can be flexibly adjusted. The rear pass incorporates an economizer and a flue gas cooler. An air preheater is located outside the boiler. The air is preheated by boiler feedwater in order to prevent the low temperature corrosion of heat exchangers inside the rear pass that can occur if air is heated by flue gas (as in most other typical designs). Light diesel is used for ignition via a start up burner at the side wall of furnace.



The biomass plant has several unique features the details of which are provided below.

- Combustion process** - In the power plant as shown in Figure 1, spreaders blow the wood chips into the furnace and whilst suspended in the air, the combustion of the fuel particles begins. The main combustion process takes place on the water-cooled vibrating grate; the vibrating movements regulate the stages of combustion. Part of the combustion air is fed to the furnace from beneath the grate and further combustion air is led to the furnace through nozzles situated above the grate. The ignition zone of the grate is stabilized by means of a patented ignition air supply system. The vibrating motion occurs in cycles which alternate between 1.5 – 3 minutes for a period of 3 – 5 seconds at a time. The fuel ash and slag are transported down the grate to the slag fall, along with the final burn out of the fuel.
- Water Cooled Vibrating Grate** - Water-cooled vibrating grate was specially designed and developed by DP CleanTech's for the combustion of biomass fuels. The vibrating grate is one of few grates able to effectively accommodate mixtures of woody and herbaceous biomass fuel. The key advantage of vibration grates is inhibition of the formation of large slag particles, which are common in straw and waste wood fuels. This makes the grate suitable for burning fuels with high slagging and sintering characteristics.
- High Temperature, High Pressure Boiler** - The steam boiler is a water tube boiler with hanging superheaters, which produce 130 tons of steam per hour at 92 bar and 540°C. The boiler design has been specially developed to work with the high temperature and high pressure. The unique and well proven design together with the right selection of materials and advanced temperature control counteracts the fouling and corrosive effects of the fuel. The steam produced is used in a conventional steam cycle turbine. The plant supplies approximately 200,000 MWh of electricity to the national grid annually. The flue gas, having been cooled in the boiler, is cleaned in a fabric filter before being discharged through the stack.
- Flue Gas Cleaning** - Gaseous emissions are low due to advanced combustion techniques. The steam boiler is provided with a fabric filter for removal of particulate matters. All plant emissions are well below regulatory standards.