



Advanced straw-fired power plant

Liaoyuan Jilin Province, China





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Introduction

Liaoyuan power plant is one of 36 biomass power plants to have been installed by DP CleanTech in China between 2006 and 2013. DP CleanTech delivered the complete 30 MWe straw-fired biomass power plant to National Bio Energy (NBE) in 2007. The complete solution included the fuel handling system, steam boiler and flue gas cleaning system to National Bio Energy (NBE). DP CleanTech custom designed the plant to handle auxiliary fuels such as wheat straw, peanut shell and husk in order to help NBE secure fuel availability. Since 2006, DP CleanTech has delivered over 1000 MW of installed capacity to NBE who own and operate their plants in partnership with the China State National Grid, making them the largest biomass power generation company in the world.

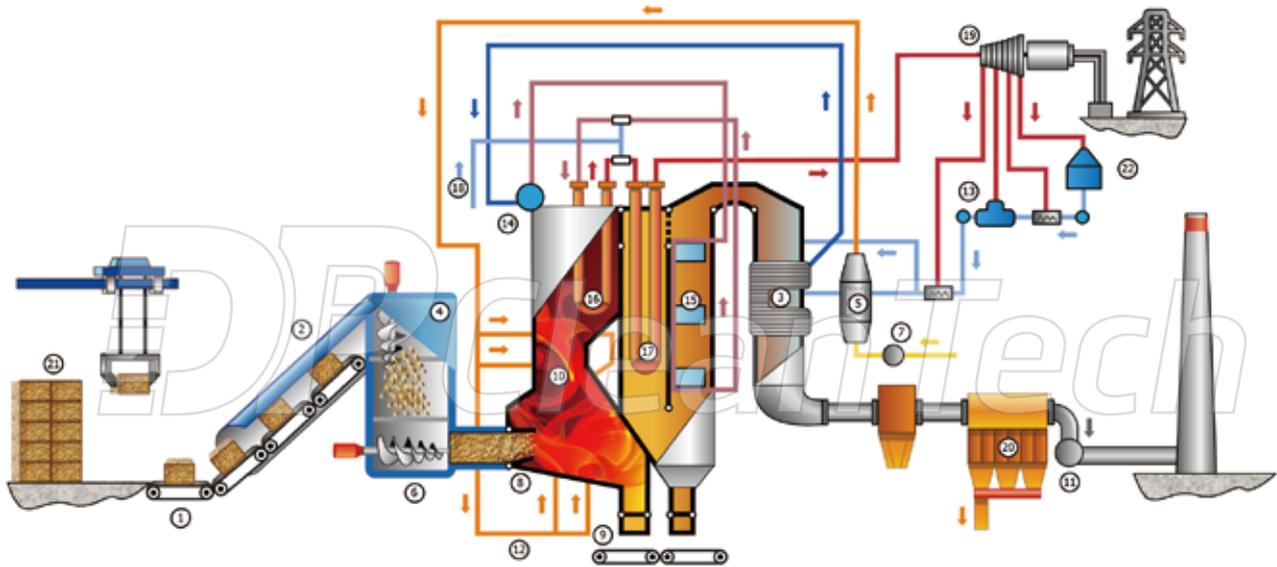


Plant Performance

The plant has an installed capacity of 30MWe. It runs on locally sourced fuels mainly from agriculture residues such as corn straw. The straw boiler is designed to handle hard fuels such as wood chips, which can be fed via the auxiliary silo contributing up to 35% of total fuel input. The plant consumes more than 160,000 tons of straw per year and reaches an availability of 7800h/y. The straw-fired steam boiler operates with high steam parameters at 92 bar and 540°C resulting in a net overall plant efficiency of more than 32% and boiler efficiency of over 93%.

Fuel	Corn Straw
Straw consumption	25tph
Power output	30MWe
Steam flow	130 tph
Steam pressure	92 bar
Steam temperature	540 °C
Boiler efficiency	93.1 %
Plant efficiency	32%
Availability	7800 h/y

Straw-Fired Boiler



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|-------------------|------------------------------|----------------------------|--------------------------|
| 1. Chain conveyor | 7. FD fan | 13. Deaerator | 19. Turbine |
| 2. Seal gates | 8. Vibrating grate | 14. Steam drum | 20. Bag filter |
| 3. Economizer | 9. Slag conveyor | 15. Superheater 1 | 21. Straw barns |
| 4. Scarifier | 10. Combustion chamber | 16. Superheater 2 | 22. Air-cooled condenser |
| 5. Air preheater | 11. ID fan | 17. Superheater 3 | |
| 6. Stoker | 12. Preheated combustion air | 18. Water for atemperators | |

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Combustion

The straw is led to the boiler through a stoker and is then combusted on a water-cooled vibrating grate under carefully controlled conditions; the vibrating movements regulate the stages of combustion. The vibrating motion occurs in cycles which alternate between 1.5 – 3 minutes for a period of 3 – 5 seconds at a time. 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 first section of the grate into which the straw is fed, is subject to high turbulence in order to help the straw in releasing its volatile matter, this corresponds to 50 - 60% of the straw's energy. The fuel ash and slag are transported by the vibrating movement down the grate to the slag fall along with the final burn out of the fuel.



Water-Cooled Vibrating Grate

DP CleanTech's water-cooled vibrating grate was designed and developed specifically 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 water-cooled vibrating grate is one of the most reliable combustion grates in the world. The vibration inhibits 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 propensities. In addition, a vibrating grate requires less maintenance than a moving grate because it has fewer moving parts.



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Fuel Handling

The fuel handling system deals with large or small square straw bales and has auxiliary systems to handle other fuels. The straw storage of the plant is designed for a capacity of more than 7 days. The plant consumes approximately 160,000 tons of straw per year. The straw is supplied by local farmers growing crops within a 50 km radius of the plant site. The bales of straw arrive at the plant on trucks which deliver the fuel to the straw barn storage area. The straw bales are fed onto automatic conveyors which transport the fuel to the boiler. When the bales arrive at the feeding system, a scarifier cuts the twines to loosen the bales, then they are sliced before being fed into the boiler at the required and controlled flow rate.



High Pressure, High Temperature 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. DP CleanTech's unique and well proven design together with the proper 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 200,000MWh 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 DP CleanTech's 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.