DP CleanTech
Clean energy, natural solutions

Advanced straw-fired CHP power plant

Maribo-Sakskøbing Rudkøbing, Denmark

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Introduction

Maribo-Sakskøbing Combined Heat and Power (CHP) plant was completed in 1999 and began producing energy for district heating and electricity. The heat produced is delivered to Maribo and Sakskøbing, two cities in the southern part of Denmark. Bioener (acquired by DP CleanTech in 2009) delivered the complete straw-fired boiler island to SK Power, as the tenth in a series of plants installed by SK Power. The operation and maintenance of the plant is carried out by the staff at the Kyndby Power Station located approximately 120 km away.

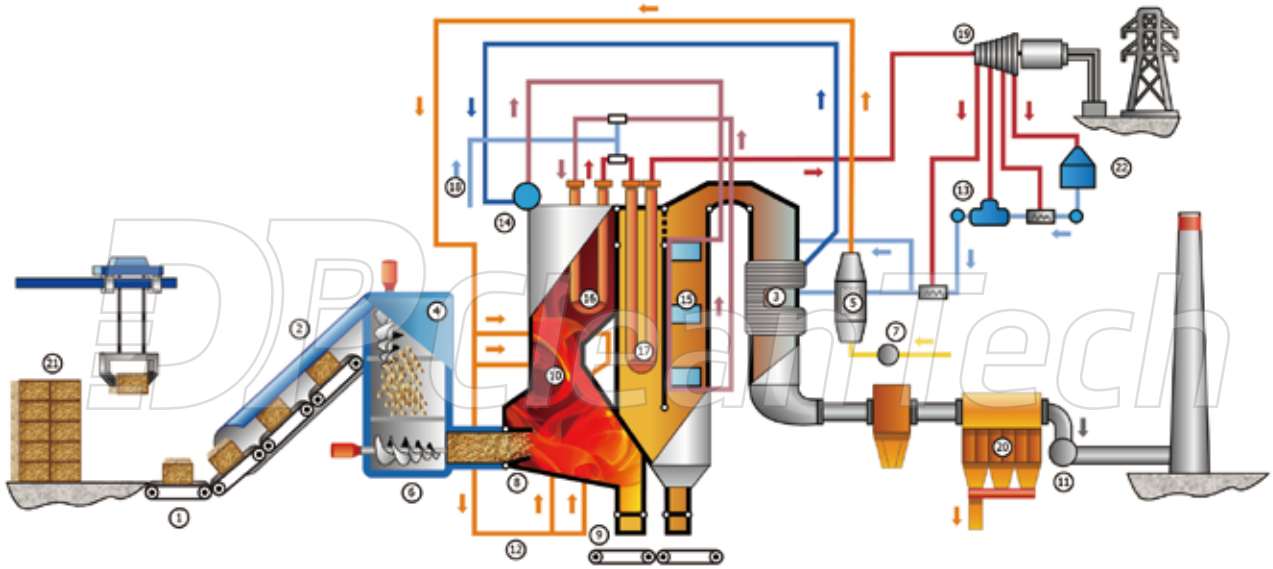
Plant Performance

This straw-fired CHP plant produces 9.7MWe net output which supplies electricity to approximately 10,000 households. The plant also produces 20 MW of heat which covers 90% of the two cities' heating requirements.

The plant has a total efficiency of 89% whereby 29% is for electricity production and 60% is for heat production. The straw-fired boiler has been specially designed to operate at high steam parameters 92 bar and 542°C, and this is reflected in the plant's high efficiency level.

Fuel	Wheat straw
Fuel consumption	8.1 tph
Power output	9.7 MWe
Thermal output	20 MW
Steam flow	43.2 tph
Steam pressure	92 bar
Steam temperature	542 °C
Boiler efficiency	92%
Plant efficiency	89%

Straw-Fired Boiler



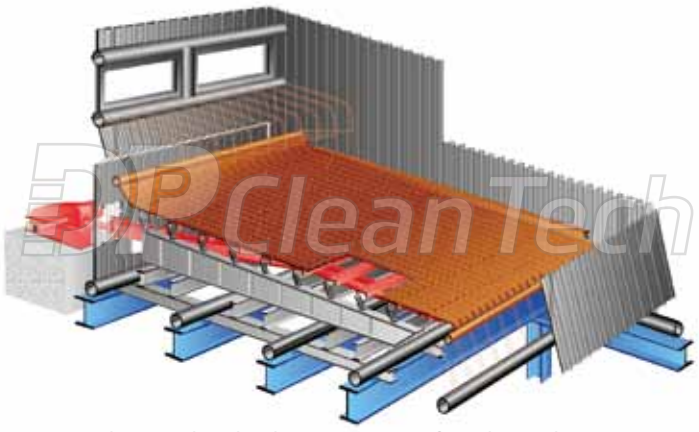
1. Chain conveyor
2. Seal gates
3. Economizer
4. Scarifier
5. Air preheater
6. Stoker
7. FD fan
8. Vibrating grate
9. Slag conveyor
10. Combustion chamber
11. ID fan
12. Preheated combustion air
13. Deaerator
14. Steam drum
15. Superheater 1
16. Superheater 2
17. Superheater 3
18. Water for atemperators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

Combustion

The straw is combusted on a water-cooled vibrating grate under carefully controlled conditions; the vibrating movements regulate the stages of combustion. This vibrating motion is done 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 stability of the ignition zone of the grate is secured by means of a patented ignition air supply system. The first section of the grate into which the straw is fed, is subject to a high turbulence in order to assist the straw in releasing its volatile matter, this corresponds to 50 - 60% of the straw's energy. The fuel ash and slag are transported down the grate to the slag fall along with the final burn out of the fuel by the vibrating movement.

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 predominantly utilizes wheat straw. The fuel is supplied to the plant by nearby farmers who also receive the ash and slag from the combustion process for use as fertilizer on their fields. The straw barn storage area has a capacity of 900 tons which corresponds to 4 days of consumption at full load.

The plant is composed of four main components; the straw handling and feeding systems, the boiler island, the turbine and generator, and the district heating heat exchanger. The bales of straw arrive at the plant on trucks which deliver the fuel to the straw barn storage area where the humidity and weight of the bales are measured in order to determine the fuel's value. The cranes in the barn place the straw bales on the automatic conveyor which transports it to the boiler, here the straw bales are loosened and ignited in the combustion chamber.

High Pressure, High Temperature Boiler

DP CleanTech's steam boiler is a water tube boiler with hanging superheaters which produce 43 tons of steam per hour at 92 bar and 542 °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. After the steam passes the turbine, it is led into two heat exchangers and is then condensed into water. The flue gas, after having been cooled in the boiler, is cleaned in a fabric filter for removal of particulate matters 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.