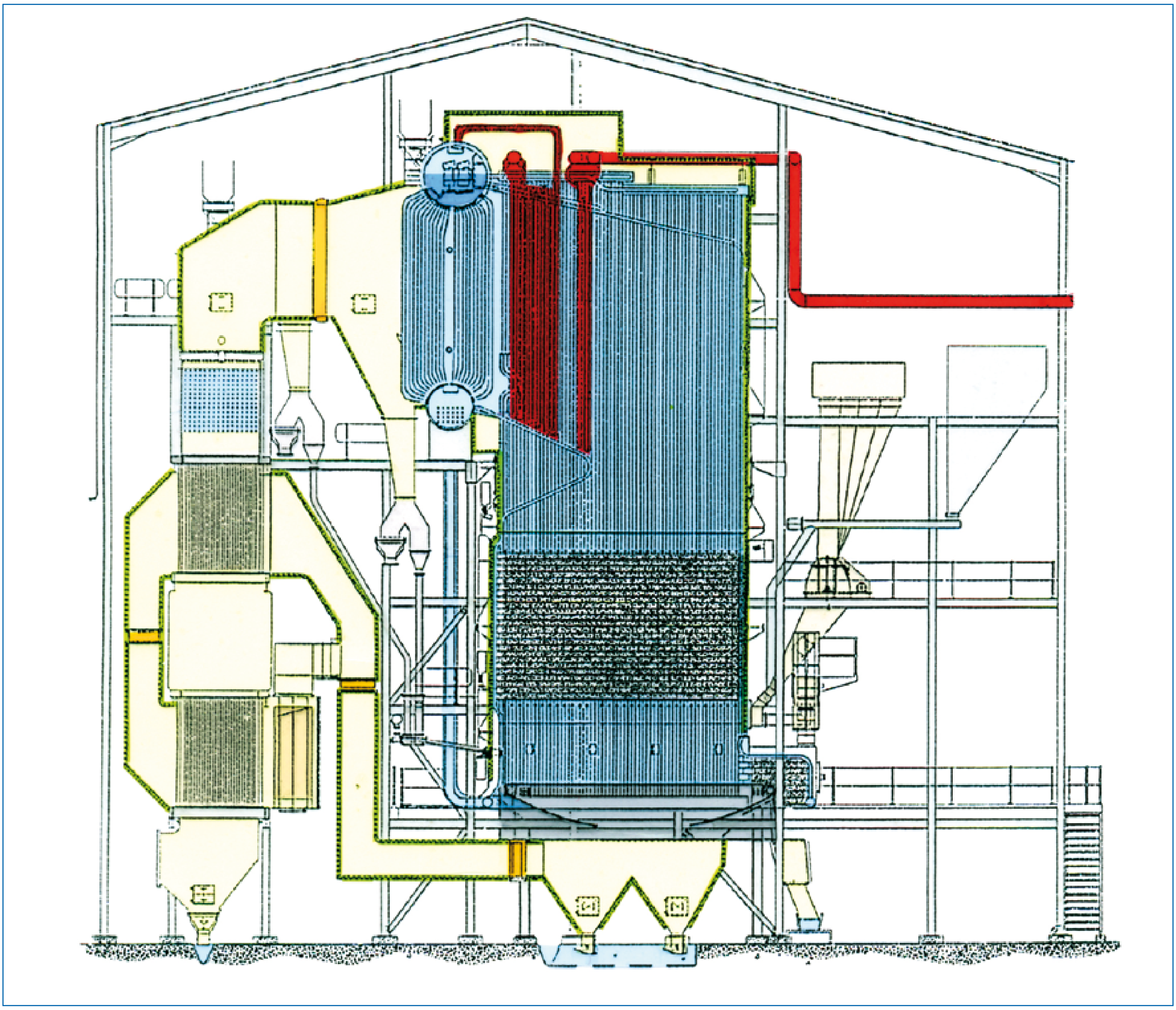


Features

- Welded wall/sandwich wall combustion chamber
- Single pass mainbank
- 2-Stage controlled superheater with mud drum attemperator
- Girth support
- Zoned CAD stoker
- Pneumatic coal & bagasse spreading
- Grit refiring on coal for optimum efficiency
- Extended surface economiser
- 2-Stage counterflow airheater
- Feedwater heater
- Irrigated sieve plate wet gas scrubber

Design Data

Design Data		Bagasse	Coal
Evaporation	t/h	100	80
Steam Pressure	kPa	4 500	4 500
Steam Temperature	°C	440	440
Feedwater Temperature	°C	105	130
Final Gas Temperature	°C	162	132
GCV Efficiency	%	69,0	86,5
NCV Efficiency	%	87,3	90,2

Fuel (As Fired)

Fuel (As Fired)		Bagasse	Coal
Moisture	%	52,0	9,0
Ash	%	3,5	16,0
Brix	%	1,2	N/A
Volatiles	%	38,3	20,5
Fixed Carbon	%	6,2	54,4
GCV	kJ/kg	9 170	25 200
NCV	kJ/kg	7 249	24 160

CASE STUDY No.25
100 t/h Single-pass Bagasse- / Coal-fired Boiler for Power Generation

john thompson

ACTOM

JOHN THOMPSON
100 t/h Single-pass Bagasse- / Coal-fired Boiler for Power Generation

Background

In 1997, Flacq United Estates, Mauritius placed an order with John Thompson for the supply and delivery of boiler plant and ancillary equipment as part of a project to increase the steam and power generation capacity of the mill. The project, commissioned in 1999 incorporated a new 100 t/h boiler and a new 18,5 MW extraction/condensing turbo alternator, supplied by ABB Germany. Forges Tardieu of Port Louis carried out erection of the boiler plant under the supervision of John Thompson.

The new power plant was designed to provide process steam and power to the factory and to export excess power to the National Grid (CEB), burning bagasse during the mill crushing campaign and coal during the off crop. The design criteria for the project required a 45 bar Watertube Boiler capable of generating 100 t/h of steam firing bagasse or 80 t/h steam on coal whilst maintaining a steam temperature of 440 °C within the load range of zero to 110% of the boiler MCR on each fuel.

The Boiler

The boiler is of the single pass, panel walled girth support design.

The girth support design incorporates a combustion chamber support plane just below the mud drum level. All vertical expansions occur above and below the support plane. The mud drum is supported directly off the boiler steelwork and the upper combustion chamber thus expands at the same rate as the generating bank. The stoker is supported from ground level and the boiler is girth supported at mud drum level. The boiler expands downwards towards the grate where a combination of mechanical and fabric seals complete the enclosure.

The combustion chamber incorporates a "sandwich wall" construction. This feature comprises a band of refractory tiles located between alternative rows of tubes in the combustion zone. The refractories provide sufficient thermal inertia to ensure stable combustion of wet bagasse while the widely spaced tubes in this area reduce the hot-face temperature of the refractory so that the risk of slagging is reduced when burning coal. This unique construction has been incorporated in a number of dual fuel fired John Thompson boilers in the field.

Secondary air is introduced into the furnace at strategic levels to promote turbulence and ensure complete burnout. The "furnace nose" provides further turbulence in the upper areas of the combustion chamber.

Combustion Equipment

Zoned CAD Stoker

The unit incorporates a Continuous Ash Discharge (CAD) zoned stoker in order to achieve a high combustion efficiency when burning coal. The mat consists of a series of several bands of grate bars attached to pairs of chains. The bars are manufactured from high-grade heat resisting cast iron, substantially ribbed to provide rigidity as well as to provide a large surface area to maximise the cooling effects from the undergrate air. Undergrate zoning is incorporated to facilitate the control and distribution of primary air across the length of the stoker. This consists of a series of small self-cleaning hoppers, each fitted with a damper capable of being adjusted whilst the boiler is on line.

Fuel Feeders and Spreaders

Bagasse is metered to the boiler through four 3-drum John Thompson biomass feeders driven by AC inverter drives. Coal is fed through four robust metering screws, also driven by AC inverter drives, and dischargers into the undersides of the bagasse feeders from where it is distributed into the combustion chamber.

Dual fuel pneumatic distributors, incorporating trajectory control plates, distribute the bagasse and coal evenly over the surface of the stoker.

Superheater

In order to accommodate the stringent final steam requirement on both fuels over a wide load range, the superheater is designed as a two-stage pendant unit. The final steam temperature is controlled by means of a mud drum attemperator.

Convection Bank

Gas velocities are limited to 14 m/s to reduce erosion in the single-pass generating bank. Tubing is swaged to improve drum ligament efficiencies whilst optimizing the heating surface.

A collecting hopper is positioned directly behind the generating bank to collect the fly ash, grit and sand carried over from the furnace. When firing coal the solids collected in this hopper are re-injected into the combustion chamber. When firing bagasse the solids are wet sluiced to the ash handling plant.

Primary Grit Collector

A coarse grit collector, situated behind the generating bank, provides a dual function of protecting the heat recovery equipment from erosion when firing bagasse and collecting carbon-rich grits for re-injection when firing coal.

Grit Reinjection

In order to maximize the thermal efficiency of the boiler, grits collected in the mud drum hopper and primary grit collector hopper are re-injected into the combustion chamber when firing coal.

Heat Recovery Equipment

Econ3omiser

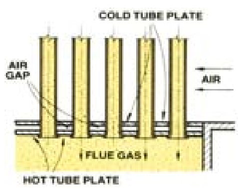
The economiser is arranged as a counter-flow extended surface unit with transverse fin pitching of 25 mm. It is fitted with a rake type soot blower.

When firing coal the incoming feed water is preheated to 135 °C by means of a feed water heater, which ensures that economiser metal temperatures are kept above the acid dew point, thus minimising dew point corrosion. The feed water utilizes bleed steam from the turbo-alternator at steam conditions of 4,2 bar and 167 °C in order to optimize the overall cycle efficiency.

Airheater

The airheater is a two-stage counter flow unit designed for an outlet air temperature of 175 °C when firing bagasse and 145 °C when burning coal. The design of the airheater obviates the need for a bypass system, which would otherwise be necessary to restrict the undergrate air temperature to the maximum recommended figure of 150 °C when burning coal. The cost effective heat recovery arrangement of economiser followed by a counter flow airheater results in a very high thermal efficiency. However the penalty for this benefit is one of accelerated corrosion of the lower bank of airheater tubes since the cold end of the airheater operates below the acid dew point over most of its operating range when burning coal. For this reason, the airheater, which would otherwise have been installed as a single bank of tubes with two air passes, was installed as two separate banks. A regular re-tube of the lower bank is envisaged, the costs for which can easily be accounted for by virtue of the considerably higher efficiency.

In order to provide protection from corrosion on the lower tube plate, a "double skin" lower tube plate arrangement is incorporated. This ensures that the corrosion-product laden flue gas does not come into contact with a tube plate cooled by the cold incoming air.



Ancillary Equipment

Draught Plant

A 132 kW single inlet radial vane controlled forced draught fan delivers combustion air through the air heater to the stoker plenum chamber. A discharge damper controlled 90 kW, direct driven, radial tipped, secondary air fan feeds cold high-pressure air to the secondary air nozzles and the fuel distributors.

Flue gas is exhausted from the boiler by a 630 kW inverter controlled variable speed electric driven ID fan. The impeller is of the backward curved blade design. The fan is located after the wet gas scrubber, which protects the fan from erosion. The exhaust gases discharged to atmosphere through a 40-metre high stack, manufactured from Corten.

Gas Clean Up Equipment

An irrigated sieve plate wet gas scrubber of the Tongaat-Hulett design cleans up the exhaust gases. Emission from the plant is below 150 mg/m^3 at STP and 12% CO_2 on both fuels.

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