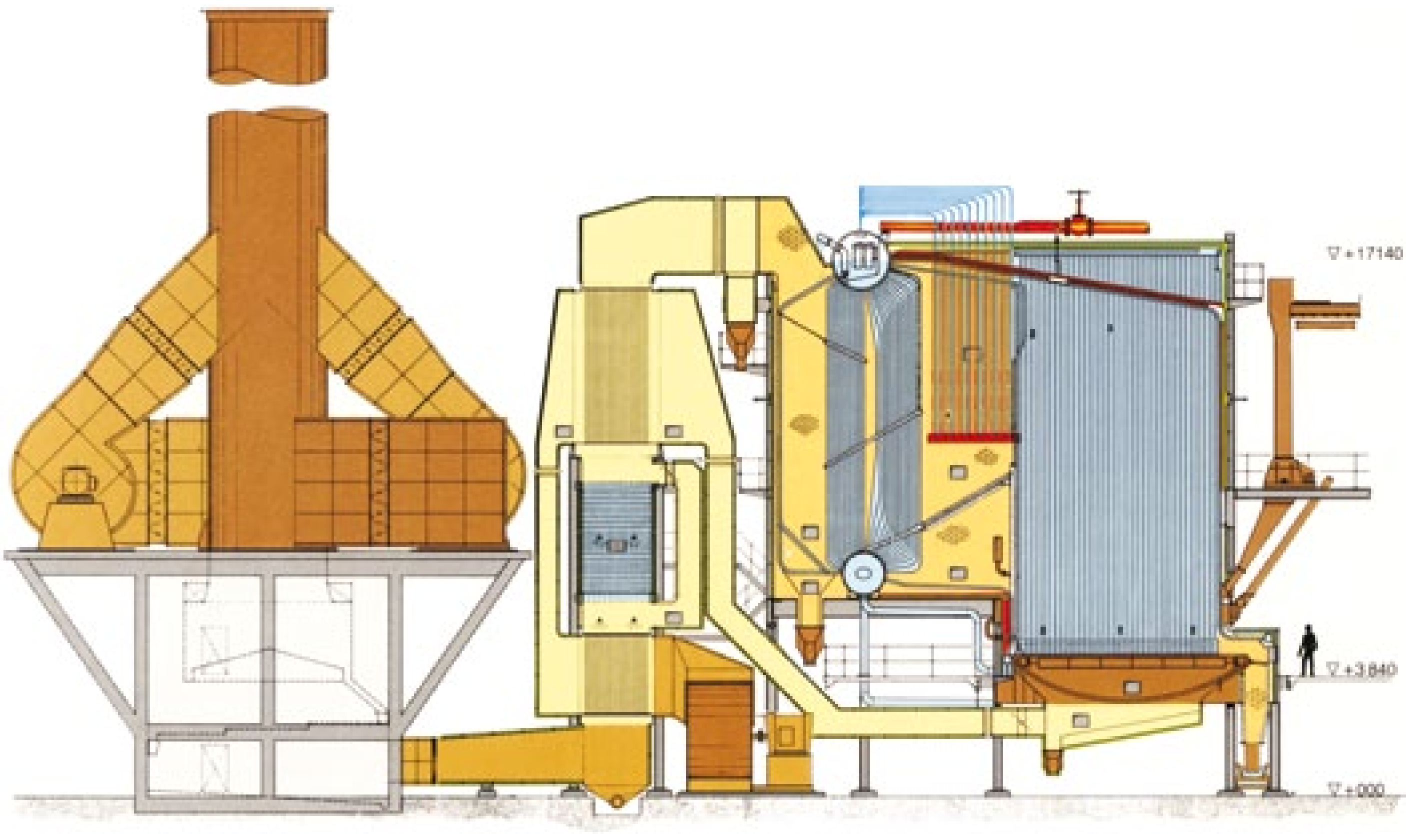


Features

- Low final gas temperature – high efficiency
- Novel back end arrangement – minimises acid dew point corrosion
- Large steam drum – enhanced water level stability
- All welded steel cased enclosure
- Erosion limiting features
- Dual fuel capability
- Bottom support

Design Data

Design Data		Bagasse		Coal
Moisture in Fuel	%	55	50	3,0
Evaporation	t/h	150	176	128
Steam Pressure	kPa	3 100	3 100	3 100
Steam Temperature	°C	402	410	386
Final Gas Temperature	°C	150	160	125
GCV Efficiency	%	66,6	69,8	86,8
NCV Efficiency	%	86,2	87,1	89,9
Installed Power	kW	1 720	1 720	1 720
Absorbed Power at MCR	kW	1 065	1 130	450

Fuel (as fired)

Fuel (as fired)		Bagasse		Coal
Moisture	%	50	55	3,0
Ash	%	1.7	1.5	16
Brix	%	1.6	1.5	N/A
Volatiles	%	N/A	N/A	27.5
Fixed carbon	%	N/A	N/A	53.5
GCV	kJ/kg	9 419	8 482	27 500
NCV	kJ/kg	7 566	6 569	26 520

CASE STUDY No.11
150 t/h Three-pass Bagasse- / Coal-fired Boiler

john thompson

ACTOM

JOHN THOMPSON
150 t/h Three-pass Bagasse- / Coal-fired Boiler

Background

Increased factory steam demand and deterioration of two old boilers prompted Tongaat-Hulett Sugar Limited's Maidstone Mill to order a new boiler from John Thompson in 1982. This boiler was commissioned in time for the 1984 crop.

The new boiler was designed to cater for:

- The mill running continuously for 7 days a week, 9 to 11 months a year.
- The fibre content of the cane varying from 14% to 17%.
- Bagasse moistures varying from 51% to 57%, and
- The simultaneous export from the 360 tons cane per hour factory of: 10 – 25 t/h bagasse, 10 – 20 t/h steam, and 4 – 8 MW of electricity.

Combustion Equipment

Bagasse is fed to six feed chutes from a rubber belt conveyor by means of Tongaat Hulett ploughs. Each chute is mounted on a John Thompson three drum fibrous fuel feeder driven by a 2.2 kW variable speed DC motor. Aircooled stainless steel pneumatic distributors spread the fuel into the furnace.

Coal stored in an overhead bunker gravitates through six separate chutes to John Thompson single drum coal feeders and mechanical spreaders which distribute the fuel into the furnace. The burning fuel bed is carried on twin John Thompson continuous ash discharge stokers. The catenary tensioned stokers are driven by hydraulically operated pawl and ratchet mechanisms and the burning fuel is transported from the rear to the front of the furnace. Coarse ash is deposited into a submerged belt conveyor.

The Boiler

The boiler is bottom supported. Galleries and ladders are cantilevered off torsionally rigid box girders which form part of the structural framework. The furnace tubing is open pitched with refractory tile and insulation backing. With this construction coal and bagasse can be fired either separately or together in the same furnace. The heat reserve provided by the refractory helps to stabilize combustion of wet bagasse, while the relatively cold furnace tubing reduces slagging when burning coal.

The unit is fitted with gas tight seal welded cold casings, which are paneled into the structural framework.

Superheater

Steam is dried in cyclone separators before flowing to a twin cross-flow drainable superheater, the high temperature elements of which are made of 1% Cr ½% Mo alloy tubing.

Towards the rear of the superheater pass, sand and dust are concentrated by centrifugal action. By leaving a clear passage in this zone, erosion is minimised. The superheater bends are shrouded.

Convection Bank

Gas velocities are kept below 15 m/s to reduce erosion in the cross baffled mainbank. No tubing is positioned at the baffle tips where erosion rates can be high. This gap also provides useful inspection and maintenance access.

Heat Recovery Equipment

To achieve the high efficiency required to meet the Mill's energy export demand, the unit is fitted with a novel heat recovery system. A mild steel bare tube economizer is interposed between two tubular airheaters. The high temperature airheater, which operates at a tube metal temperature above the acid dew point, heats combustion air to 230 °C when firing bagasse. To limit grate metal temperatures the airheaters are partly by-passed when burning coal. The low temperature airheater, which operates below the acid dew-point, is fitted with 430 stainless steel tubes. It is water washed every 8 hours to dilute and remove acid concentration. Figure 1 shows how the lower tube plate is protected. The boiler can be operated in an incineration mode by partly by-passing the heat recovery system on the air side.

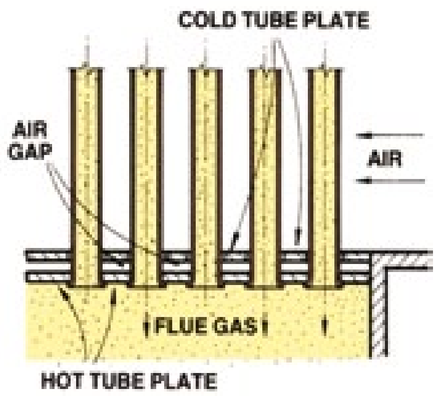


Figure 1: 'Double Skin" tube plates of cold airheater.

ANCILLARY EQUIPMENT

Flue Gas Cleaning

A John Thompson multi-cyclone primary grit collector, located between the boiler and the airheater, removes most of the coarse grits. A Tongaat Hulett perforated plate type wet scrubber located upstream of the ID fans cleans up the final exhaust gases. The scrubber is designed to reduced the particulate stack emission level to below 150 mg/m^3 at STP and 12% CO_2.

Draught Plant

A single damper controlled 180 kW direct driven backward bladed forced draught fan blows combustion air through the airheater to the stoker plenum chamber. A damper controlled 90 kW direct driven radially tipped secondary air fan feeds cold high pressure air to the secondary air nozzles, the bagasse distributors and the coal distributors. Gas is exhausted from the system by means of twin direct driven, forward curved, radially tipped, variable speed ID fans, each driven by 550 kW DC motors. As the fans are located after the wet scrubber the impellers are not exposed to any abrasive gas. The exhaust gases are discharged to atmosphere through a 3Cr12 self supporting stack.

Operating Characteristics

On test at MCR the boiler operated at an efficiency on NCV of 88.4% with 53% moisture bagasse. The exit gas temperature from the heat recovery equipment was 139 °C. The oxygen content of the flue gas averaged 3.7%. The signal from the 0_2 meter is used as feedback to close the combustion control loop. A typical 0_2 trace is shown in Figure 2.

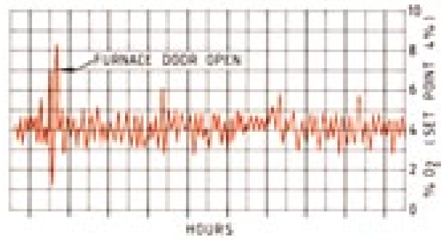
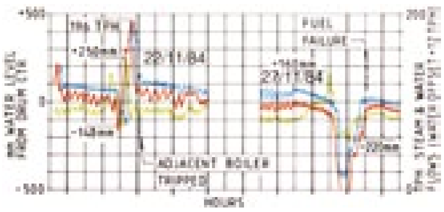


Figure 2: Typical 0_2 trace.

The NCV efficiency on coal firing was approximately 90%, with final gas temperatures in the region of 115 °C to 120 °C.

The large 1 900 mm diameter steam drum is a special feature of the unit and enables the boiler to carry large load swings as indicated in Figure 3.



- Steam flow
- Water flow
- Drum level

Figure 3: Chart illustrating drum level characteristics.

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