

Case Study No. 11

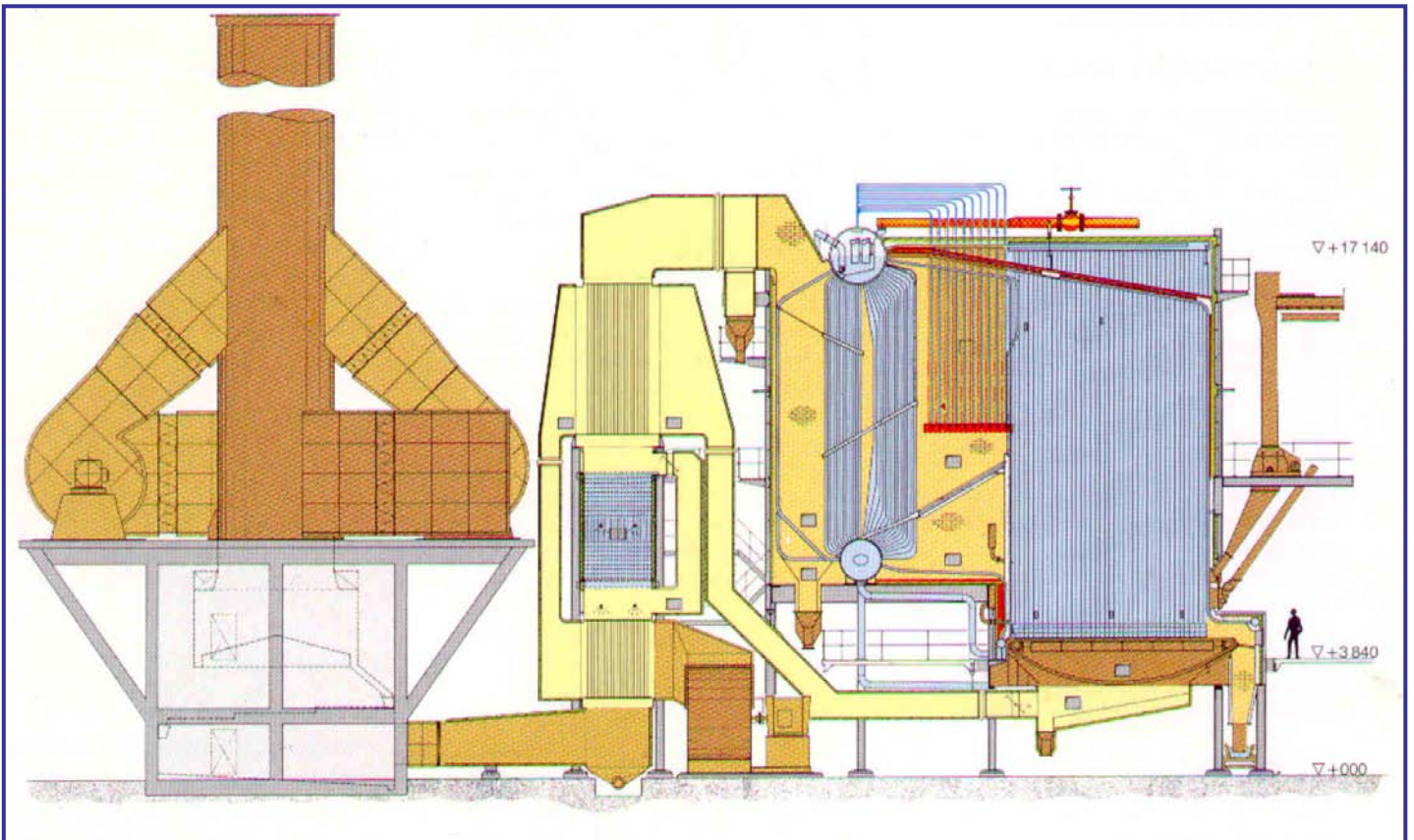
150 t/h Three Pass Bagasse/Coal Fired

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

		Bagasse			Coal			Fuel (As Fired)		
		%	t/h	3,0	%	t/h	3,0	%	t/h	3,0
Moisture in Fuel	%	55	50	3,0	Moisture	%	50	55	3,0	
Evaporation	t/h	150	176	128	Ash	%	1.7	1.5	16	
Steam Pressure	kPa	3 100	3 100	3 100	Brix	%	1.6	1.5	N/A	
Steam Temperature	°C	110	110	110	Volatiles	%	N/A	N/A	27.5	
Final Gas Temperature	°C	150	160	125	Fixed Carbon	%	N/A	N/A	53.5	
GCV Efficiency	%	66,6	69,8	86,8	GCV	kJ/kg	9 407	9 407	27 500	
NCV Efficiency	%	86,2	87,1	89,9	NCV	kJ/kg	7 533	7 533	26 520	
Installed Power	kW	1 720	1 720	1 720						
Absorbed Power at MCR	kW	1 065	1 130	450						



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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 Boilers 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 – 25t/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 stokers which are catenary tensioned, are driven by hydraulically operated pawl and ratchet mechanisms. 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 minimized. The superheater bends are shrouded.

CONVECTION BANK

Gas velocities are kept below 15m/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 air heaters. The high temperature air heater 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 air heaters are partly by-passed when burning coal. The low temperature air heater which operates below the acid de-w 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.

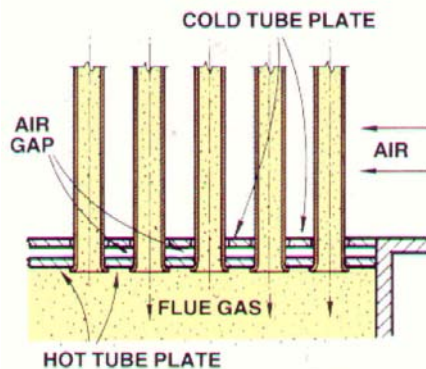


FIG 1: "Double Skin" Tube Plates of Cold Airheater.

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 150mg/m³ at STP at 12% CO₂.

Draught Plant

A single damper controlled 180 kW direct driven backward bladed forced draught fan blows combustion air through the air heater 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 an 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 O₂ meter is used as feedback to close the combustion control loop. A typical O₂ trace is shown in Figure 2.

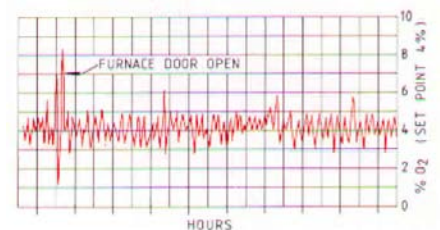


FIG 2: Typical O₂ Trace.

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

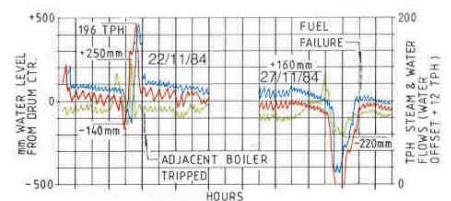


FIG 3: Chart Illustrating Drum Level Characteristics.

- Steam Flow ■
- Water Flow ■
- Drum Level ■



JOHN THOMPSON. A division of ACTOM (Pty) Ltd

Cape Town Head Office – PO Box 129, Bellville, RSA, Tel:+27(0)21 959-8400, Fax:+27(0)21 959-8545, e-mail:info@johnthompson.co.za

Johannesburg Office – PO Box 8382, Edenglen, RSA, Tel:+27 (0)11 392-0900, Fax:+27 (0)11 392-0938, e-mail: infojhb@johnthompson.co.za

Durban Office – PO Box 32292, Mobeni, RSA, Tel:+27 (0)31 408-9700, Fax:+27 (0)31 408-9722, e-mail: infodbn@johnthompson.co.za

www.johnthompson.co.za