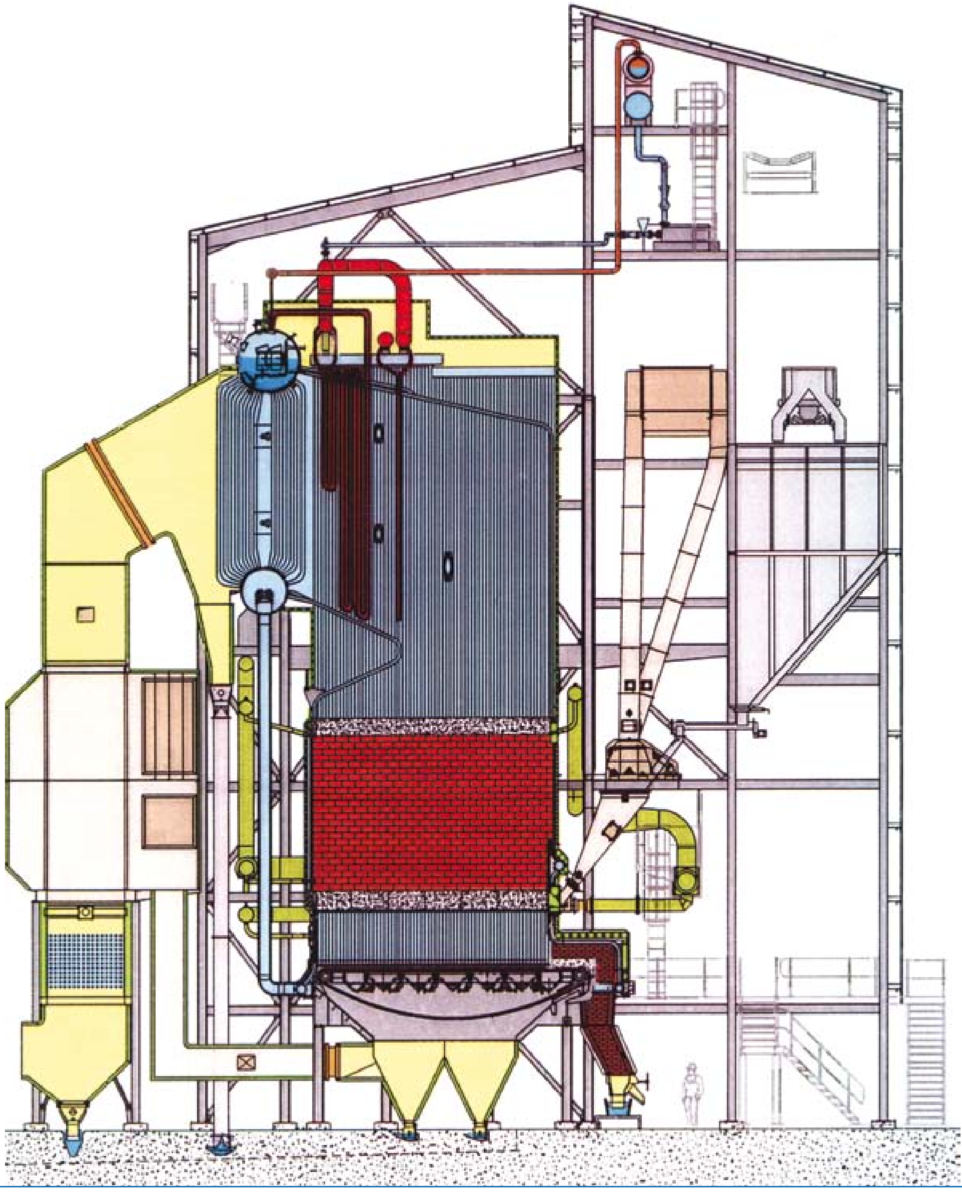

Features

- Panel walled combustion chamber
- Sandwich wall construction
- Single pass mainbank
- 2-Stage controlled superheater
- Girth support
- Zoned CAD stoker
- Sweetwater condenser
- Parallel flow airheater
- Extended surface economiser
- Mud drum feedwater heater

Design Data

		Bagasse	Coal
Evaporation	t/h	150	120
Steam Pressure	kPa	3 100	3 100
Steam Temperature	°C	400	400
Feedwater Temperature	°C	105	135
Final Gas Temperature	°C	202	209
GCV Efficiency	%	65,6	81,0
NCV Efficiency	%	83,9	83,7

Fuel (as fired)

		Bagasse	Coal
Moisture	%	52,0	3,1
Ash	%	3,5	12,2
Brix	%	1,2	N/A
Volatiles	%	38,3	26,5
Fixed Carbon	%	6,2	58,2
GCV	kJ/kg	8 690	27 940
NCV	kJ/kg	6 790	27 070

CASE STUDY No.27
150 t/h Single-pass Bagasse- / Coal-fired Boiler

john thompson

ACTOM

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

Background

In 1998, PGBI, acting on behalf of the Transvaalse Suikerkorporasie Beperk, placed an order with John Thompson for the supply of boiler plant and ancillary equipment as part of a programme to rationalise the steam and power generation at the Malelane Sugar Factory. The project, commissioned in 1999, was handled on a turnkey basis with John Thompson Boilers supplying the boiler and boilerhouse, civil works, electrics, instrumentation and gas clean up equipment.

The design criteria for the project required a 31 bar Watertube Boiler capable of generating 150 t/h of steam firing bagasse or 120 t/h on coal whilst maintaining a steam temperature of 400 °C within the load range of 30% 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 alternate 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 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 six 3-drum John Thompson fibrous fuel feeders driven by AC inverter drives. Coal is fed through six robust metering screws, also driven by AC inverter drives, and discharged 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.

Coal & Bagasse Feeders.

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 with interstage spray attemperation.

Good quality water is required for the attemperator in order to avoid deposits in the superheater and on the turbine blades downstream. To eliminate the need for a demineralisation plant, with its high capital and operating costs, John Thompson custom designed a "sweetwater" condenser for the project. This unit condenses saturated steam drawn from the steam drum, utilising feedwater from the exit of the economiser as the cooling medium to provide the pure spray water required for de-superheating.

Convection Bank

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

A substantial collecting hopper is positioned directly behind the generating bank to collect the fly-ash, grit and sand carried over from the furnace. This hopper is very effective in reducing the dust burden to the heat recovery equipment thereby minimising erosion in the airheater and economiser.

HEAT RECOVERY EQUIPMENT

Airheater

The airheater is a two-pass parallel flow unit designed for an outlet air temperature of 240 °C when firing bagasse.

The unit is fitted with a positive bypass system to control the maximum undergrate air temperature to 150 °C when coal firing. It also serves the dual function of maintaining airheater tube metal temperatures above the acid dew point, thereby reducing dew point corrosion of the airheater tubes.

Economiser

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

When firing coal the incoming feedwater is preheated to 135 °C by means of a feedwater heater situated in the mud drum. This ensures that economiser metal temperatures are kept above the acid dew point, thereby minimising corrosion.

ANCILLARY EQUIPMENT

Draught Plant

A 185 kW single inlet, radial vane damper controlled forced draught fan blows combustion air through the airheater to the stoker plenum chamber.

A discharge damper controlled 185 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 750 kW inlet louver damper controlled electrically driven ID fan.

The impeller is of the self-cleaning, forward curved radial tipped blade design. The fan is located after a wet gas scrubber that protects the impeller from erosion. The exhaust gases are discharged to atmosphere through an existing 40-metre high gunnite lined self-supporting mild steel stack.

Gas Clean Up Equipment

The exhaust gases are cleaned up by a venturi throat-type scrubber made of mild steel with gunnite lining. An automatically controlled adjustable venturi damper maintains a constant pressure differential in the venturi throat irrespective of load. Grit emission from the plant is below 150 mg/m^3 at STP and 12% CO_2 on both fuels.

Instruments and Controls

The control system hardware consists of a Modicon Quantum PLC housed in the boiler control room communicating via the Modbus-Plus protocol to a dedicated SCADA system running Wonderware's "In Touch" software. The PLC is connected by additional ModbusPlus networks to Modicon Momentum intelligent I/O modules grouped into specific areas of the boiler. It is also linked to existing PLC's and SCADA's on the plant.

Back End Equipment.

John Thompson a division of ACTOM (Pty) Ltd.

Cape Town (Head Office)	info@johnthompson.co.za	Tel: +27 (0)21 959-8400
Johannesburg	infojhb@johnthompson.co.za	Tel: +27 (0)11 392-0900
Durban	infodbn@johnthompson.co.za	Tel: +27 (0)31 408-9700
Cresta (Air Pollution Control)	infoapc@johnthompson.co.za	Tel: +27 (0)11 478-0456

www.johnthompson.co.za

7/2019