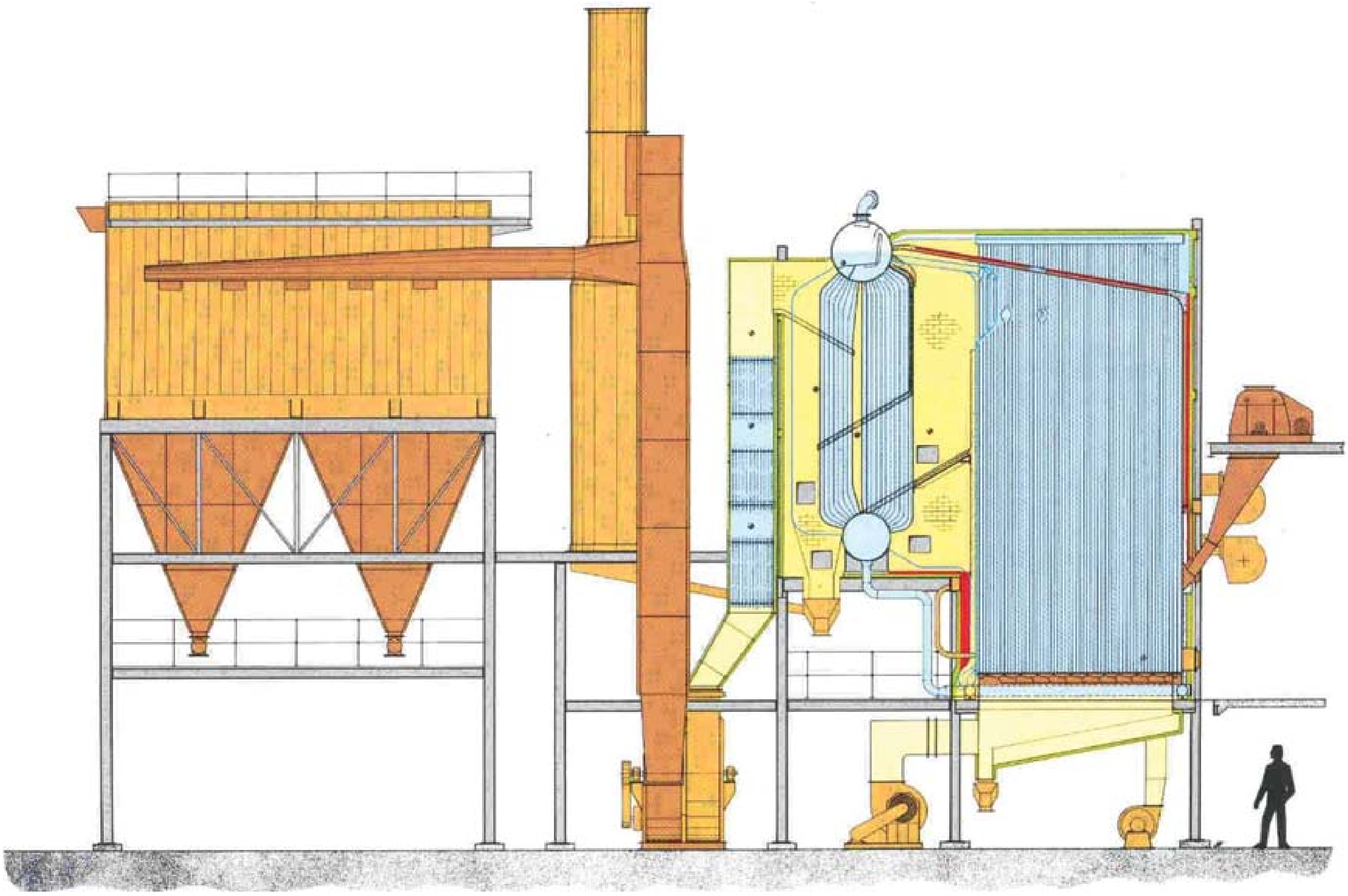

Features

- Bottom supported boiler
- Tangent tube combustion chamber
- Dump grate stoker
- Mild steel bare tube economiser
- High pressure feedwater heater for corrosion protection of the economiser
- Low gaseous emission levels
- Wide capability on fibrous fuels
- Provision for retro-fitting of superheater surface

Design Data

		Cotton Stalks	No.6 Fuel Oil
Evaporation	t/h	20	20
Steam Pressure	kPa	2 800	2 800
Steam Temperature	°C	Dry Sat	Dry Sat
Feedwater Temp ex Deaerator	°C	110	110
Feedwater Temp to Economiser	°C	110	135
Final Gas Temperature	°C	200	220
GCV Efficiency	%	78,9	84,5
NCV Efficiency	%	86,8	90,1
Installed Power	kW	260	260
Absorbed Power at MCR	kW	108	156

Fuel (As Fired)

		Cotton Stalks	No.6 Fuel Oil
Moisture	%	15	1,0
Ash	%	2	0,2
Volatiles	%	66	–
Fixed Carbon	%	17	–
Sulphur	%	–	3,3
Viscosity at 50 °C	cSt	–	175
GCV	kJ/kg	16 110	43 000
NCV	kJ/kg	14 640	40 600

CASE STUDY No.15
20 t/h Three-pass Cotton Stalk- / Oil-fired Boiler

john thompson

ACTOM

JOHN THOMPSON
20 t/h Three-pass Cotton Stalk- / Oil-fired Boiler

Background

In 1982 a group of agro-industrialists commissioned Edward L Bateman Limited to evaluate a system of harvesting and baling cotton stalks, for its suitability to provide fuel for steam and power generation. During the survey, it transpired that no commercially proven boiler was available for this purpose and boilermakers having biomass fuel firing expertise were approached to develop one. John Thompson, who specialise in this field, was their final selection and a contract was concluded for the design and supply of a 10 t/h unit.

The boiler was commissioned in 1985 and although designed primarily to burn cotton stalks, other biomass fuels such as pecan nut shells, wood chips, wheat straw and cottonseed husks have also been burnt successfully in this plant.

Shortly afterwards, Edward L Bateman placed a second order with John Thompson for a 20 t/h unit for a similar project. Both boilers were designed to permit the retrofitting of superheaters to enable the cogeneration of steam and power. This Case Study describes the 20 t/h unit.

Fuel Harvesting and Baling

Cotton stalks left after cotton harvesting are uprooted and shredded mechanically. This material, which has a moisture content of about 60%, is transported in a trailer to a large mobile baling press. The bales measuring approximately 3m x 3m x 7m are stored in the field. During storage moisture content drops to between 30% and 40% after one or two weeks and to as low as 15% after a few months. At this moisture content, the bales, which are now ready to be burnt, have a mass of about 100 tons. Bales have been stored satisfactorily in this way for up to 2 years.

Combustion Equipment

Cotton bale transporters carry the fuel bales to the debaling system at the power house. Debaled stalks are conveyed on an en-masse type conveyor to a chute mounted above a single John Thompson stainless steel three drum metering feeder fitted with a 2.2 kW hydraulic variable speed drive. Specially developed tapered fingers are fitted to the rolls to prevent the stringy shredded cotton stalk fibres from choking the feeder.

Figure 1: Fuel handling plant showing the debaler and open air storage of bales.

An aircooled stainless steel pneumatic distributor with adjustable deflector plate spreads the fuel into the furnace. The larger particles burn on the two section John Thompson dump grate stoker, with the balance burning in suspension above the grate. Grate sections are dumped periodically to remove sand and ash. Full load can be carried whilst dumping.

The boiler is fitted with two oil burners. This fuel is used when no cotton stalks are available.

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 watercooled tangent tube furnace is sized for a low gas exit temperature. This reduces furnace slagging and convection pass fouling. A separate pass, shielded from direct furnace radiation is provided for the possible retro-fit of a crossflow drainable superheater.

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

Convection Bank

To minimise erosion, design gas velocities in the cross baffled three pass convection bank are less than 15 m/s. Sootblowers are fitted at strategic points to clean heating surfaces.

Heat Recovery Equipment

The boiler was commissioned with a John Thompson two bank mild steel bare tube economiser equipped with sootblowers. After commissioning it was found that when burning substandard fuels, fouling factors were higher than anticipated and a third economiser bank was added. This provides additional protection for the bag filter which has an operating temperature limitation.

Ancillary Equipment

Pre-Boiler System

Condensate and de-mineralised make-up water is deaerated at 110 °C in a 20 t/h John Thompson pressure deaerator. Feedwater from the deaerator is preheated in a John Thompson high pressure feedwater heater to 135 °C to prevent acid dew point corrosion of the economiser when firing high sulphur fuel oil.

A 55 kW electrically driven feedpump delivers water from the deaerator via the feedwater heater to the economiser. A second feedpump, which starts automatically in the event of low feedline pressure, provides standby capacity.

Draught Plant

A damper controlled 5.5 kW direct driven forced draught fan delivers combustion air to the stoker plenum chamber. A damper controlled 11 kW direct driven secondary air fan delivers cold high pressure air to the secondary air nozzles and the fuel distributor.

Gas is exhausted from the system by means of a 160 kW direct driven, forward curved, radially tipped, induced draught fan.

Gas Clean-Up Plant

Particulate emissions are removed in either a venturi throat type scrubber or bag filter depending upon the quality of the fuel being burnt. The bag filter is used when burning fuels having a high alkali metal oxide to silica ratio. The scrubber is used when this ratio is low. This arrangement limits emissions to below 150 mg/m^3 at STP and 12% CO_2, for a wide range of fuels.

Ash and Dust Handling Plant

Ash and dust is hydraulically sluiced to dewatering ponds from where the solids are removed by means of a John Thompson scraper conveyor which discharges onto a trailer. The sluicing water is recycled.

Figure 2: General view of the boiler and associated 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