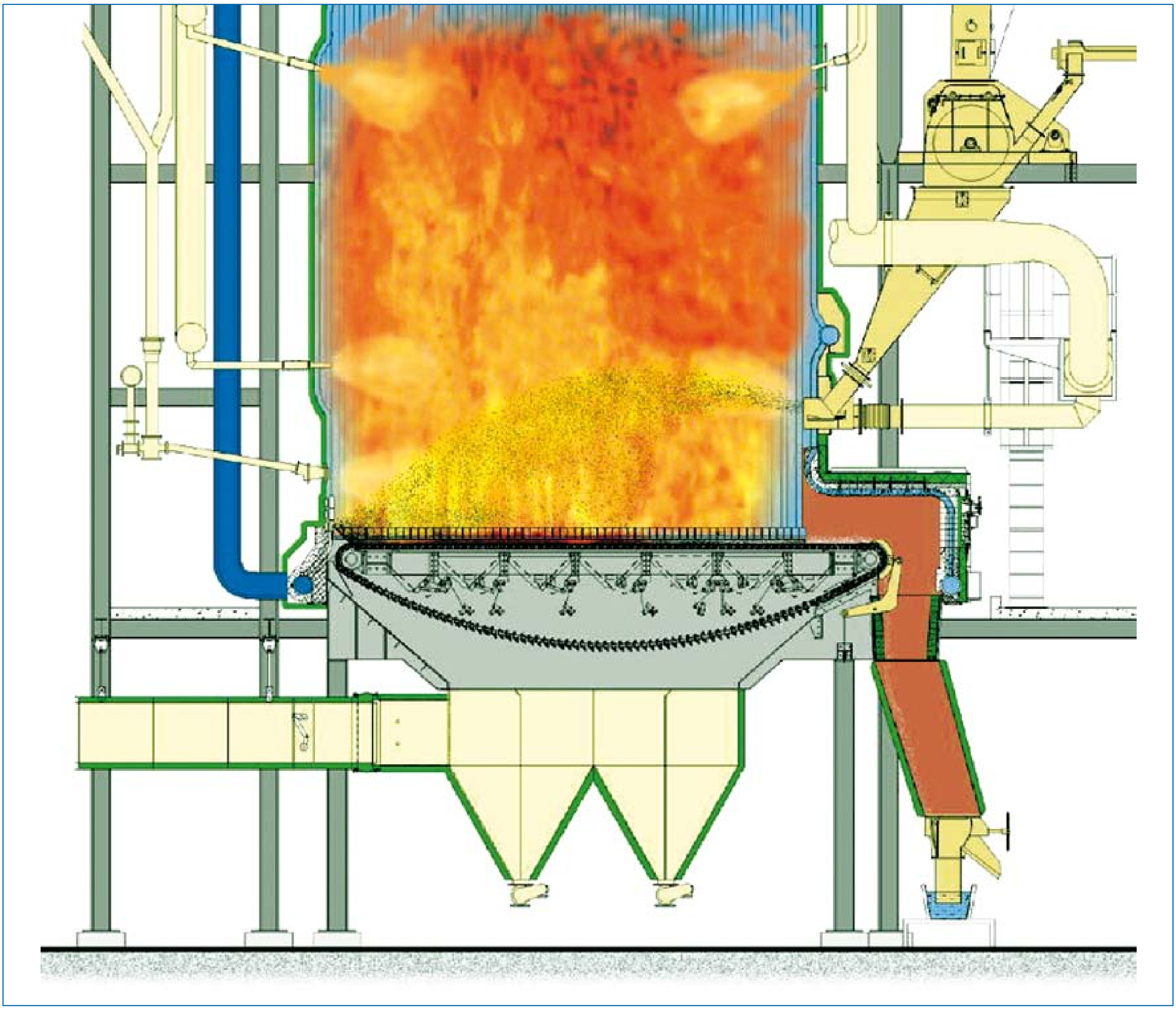

Features

- Catenary tensioned
- Controlled undergrate air distribution
- Self cleaning
- Handles a wide range of fuels
- Variable speed drive
- Uniform fuel distribution
- Grit refiring option
- High combustion efficiency
- High availability
- Low maintenance

CASE STUDY No.28
Continuous Ash Discharge Stoker with Undergrate Zoning

john thompson

ACTOM

JOHN THOMPSON
Continuous Ash Discharge Stoker with Undergrate Zoning

Background

Continuous Ash Discharge (CAD) stokers are regularly installed in coal fired industrial boilers particularly when there is a requirement for a fast response to load swings. In addition, the CAD stoker is prescribed when coal has to be burned in combination with biomass fuels such as bagasse, wood chips, bark, sunflower seed husks, cotton stalks, etc. or when coarse biomass fuels such as wood chips are to be burned alone.

Construction

The stoker mat is driven by a variable speed drive through a reduction gearbox and a high torque universal coupling device. The stoker is catenary tensioned, eliminating the need for separate tensioning devices.

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 maximize the cooling effects from the undergrate air. The chains are driven by toothed sprockets on the front shaft and pass over guide rollers at the rear. The grate bars run on a series of cast iron skid rails bolted on to the stoker frame. Metal temperature thermocouples are embedded in the skid rails to provide monitoring and alarm functions.

Spring-loaded shoes prevent the grate from opening prematurely at the front, which would otherwise allow the entrapment of foreign material such as stones, tramp metal and the like. The grate bars are designed to hang open on the return chain strand allowing ash and riddlings to fall freely into the riddlings hoppers.

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. An arrangement of a typical zoned stoker is given on the front page.

Front of 150 t/h Coal- / Bagasse-fired Boiler.

The Combustion Process

Coal and biomass fuels require to be fired quite differently. Coal is distributed over the width of the stoker towards the rearwall of the furnace where it ignites and continues to burn as it travels to the front of the furnace where the ashes are discharged. The quantity of air required to efficiently burn the coal and control the formation of various emissions varies along the length of the stoker. Unlike coal, biomass fuels are burned largely in suspension and require a substantially different undergrate air distribution pattern. The undergrate zoning provides the means to vary the air distribution to accommodate the specific requirements of each fuel.

Zoning is also used to compensate for variations of parameters in the coal such as calorific value, particle sizing, ash content and volatile matter, all of which can have a major effect on the propensity of the coal to ignite and burn efficiently.

Bagasse & Coal Feeding System.

The Complete Combustion System

A stoker is only part of a complex combustion system comprising fuel feeders, spreaders, and primary and secondary air systems. It is necessary to consider all of these components and their interaction when optimizing the performance of a boiler.

Because of the substantially different physical characteristics, independent fuel metering devices are used for coal and biomass fuels. Coal is metered by means of variable speed screw conveyors whereas biomass is generally metered via three-drum biomass feeders. A combined coal/biomass pneumatic spreader ensures proper distribution of the fuels. Considerable development work was carried out on a combined coal/biomass pneumatic spreader to ensure proper distribution of the fuel.

Combustion Efficiency on Coal

The following are some of the parameters that affect the combustion efficiency:

- The stoker rating
- Coal quality and grading
- The thickness and distribution of coal on the stoker
- Stoker speed
- Primary air quantity, distribution and temperature
- Secondary air distribution, pressure and quantity

Some of these parameters are affected by the physical design of the stoker (e.g. the grate area and the pressure drop across the grate), some by the source and handling methods of the coal, whilst others are dependent upon the skill of the operator.

Stoker Rating

A combination of adequately sized stoker area and grate speed ensures full burn out of the coal before it reaches the front ash hoppers.

Coal Quality and Grading

The coal quality and grading are important parameters that need to be carefully evaluated. The lowest cost coal does not necessarily mean the most cost-effective operation. Often it is uneconomical to transport coal of low heating value over large distances, as the cost per kJ is invariably higher. Poorly graded coal will also result in segregation, poor spreading and increased carbon losses.

Distribution of Coal

Apart from the physical grading of the coal, the design of the feeding and distribution system needs to be carefully matched to the stoker by the boilermaker.

Operating Experience

From the operating experience gained on the zoned stokers, it is clear that the incorrect setting of the major parameters not only directly affects the combustion efficiency, but also impacts on the availability of the boiler and the degree of maintenance necessary.

One specific item that falls into this latter category is the design of the coal handing plant, from receipt of the coal to its discharge into the bunker. If the design of the coal handing is such that coal becomes segregated when loaded into the bunkers, this invariably results in a mal-distribution across the width of the stoker. This can result in poor combustion with an associated drop in efficiency and physical damage to the stoker. The real cost of this to the operator is often underestimated.

Performance Data

Extensive testing was carried out on each of the boilers incorporating the stokers under discussion.

The comprehensive instrumentation installed facilitated monitoring and adjustment of combustion airflows, pressures and temperatures independently on the LHS and RHS of the stoker. On one of the boiler units, the original CAD stoker and combustion equipment was replaced by a new JT zoned stoker, bagasse feeders and pneumatic spreaders. The measured performance of the boiler reflected an increase in boiler efficiency of almost 10% compared to the operation prior to the upgrade. This resulted in significant savings in the cost of coal for the owner, coupled with a much higher availability and commensurately lower maintenance costs. The performance figures for the boiler before and after the modification are given below:

Converted Boiler		Before upgrade	After upgrade
Item	**Units**	**Coal**	**Coal**
Steam Flow	t/h	86	86
Steam Pressure	kPag	2 585	3 139
Steam Temperature	deg C	359	338
Fuel Burnt	kg/h	11 006	9 292
GCV of Fuel 'As Fired'	kJ/kg	27 810	28 060
Final Gas Temperature	deg C	182	166
Boiler Efficiency on GCV	%	76.8	86.8
CO_2	%	11.5	12.9
O_2	%	8.4	6.5
CO	ppm	230	144
Undergrate Air Temp.	deg C	153	147
Carbon in Coarse Ash	%	37	13.9

Efficiency Optimization

Higher efficiency on coal can be achieved by fitting a grit refiring system. A zoned JT Stoker with grit refiring was installed on a Sugar Factory Boiler in Mauritius. The unit fires coal almost exclusively as part of a cogeneration system where the additional costs and complexity of a grit refiring system can be justified by the increase in efficiency.

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