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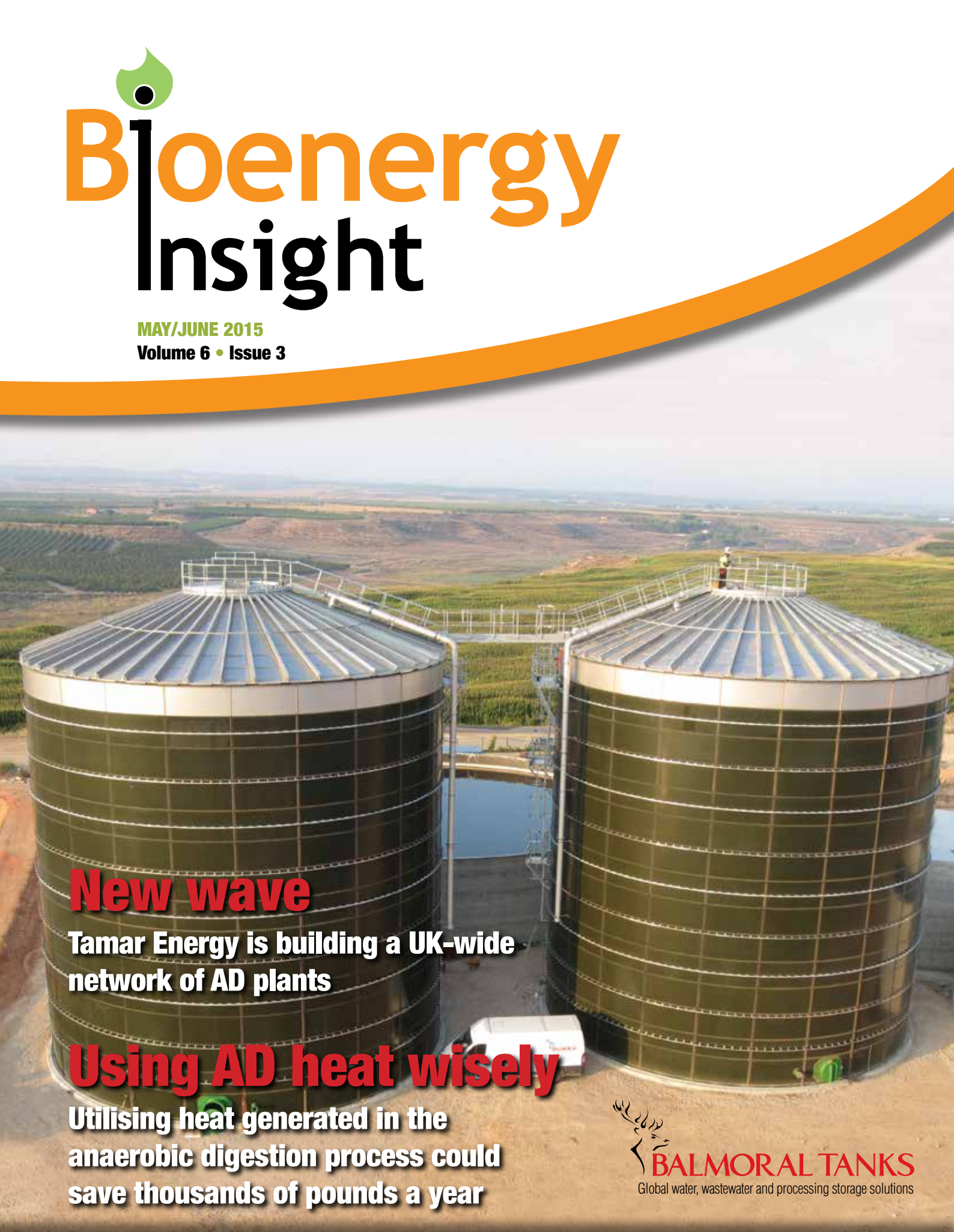

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A look at how Sunoco's biomass and waste fuel CFB boiler and fuel handling system was updated

A better boiler

Sonoco Products Company (Sonoco) is an industry leading consumer packaging producer. Its plant located in Hartsville, South Carolina, was faced with some challenges regarding its Circulating Fluid Bed (CFB) boiler due to shortcomings with the existing CFB boiler design and fuel handling system. The boiler burned mostly coal with the remaining fuel mix made up of biomass, and some mill generated recycle pulping and product rejects comprised of paper, fibre, and plastics.

Sonoco's project goals included:

- Reduce the reliance on coal firing for cost and environmental reasons
- Increase amount of recycle waste paper and plastics burned to reduce landfill and transportation cost
- Increase amount of biomass and process rejects burned to utilise cheaper available opportunity fuels
- Design a fuel handling system to handle various fuel streams as well as accurately measure the individual mass flowrates
- Reduce fuel feed plugging and reliability problems
- Remove as much metal as possible from the fuel streams

Sonoco's CFB boiler and multi-fuel handling system

Perfect partnership

In order to tackle these challenges on a turnkey design, supply and install basis, Sonoco selected Jansen Combustion and Boiler Technologies (Jansen) from Kirkland, Washing; and ProcessBarron, based in Pelham, Alabama. The company already had a good working relationship with Jansen and ProcessBarron and so it was determined that these two companies would carry out a process evaluation of the boiler to determine the shortcomings of the existing CFB boiler and fuel feed system, as well as engineer, supply, and install all necessary equipment. Jansen assumed the role of prime contractor and ProcessBarron was a subcontractor to Jansen.

Historically, Jansen has built an excellent reputation for studying boilers and performing air system upgrades, while ProcessBarron is known for its ability to design, supply, and install materials handling and air handling equipment. The two companies have had a cooperative arrangement for more than 10 years and have worked together on a variety of successful projects in North America and beyond.

To determine what needed to be done to the CFB boiler to satisfy Sonoco's requirements, Jansen performed a process evaluation of the boiler and collected boiler operating data, field measurements, and fuel and ash samples during a site visit. This information was used as the basis of heat and mass balance calculations for comparison to the original design and to project future conditions.

The boiler was originally designed to generate up to 120,000lbs per hour of steam while burning coal or a mixture of coal and wood. However, the unit's steaming rate was negatively impacted by the use of non-fossil fuels due to limitations including high tube metal temperature alarms at the primary superheater outlet; sporadic swings in SO_2 emissions that limit bed temperature flexibility and results in high excess air operation; and biomass fuel feed difficulties caused by plugging in the fuel feed chutes and bridging in the biomass fuel bins.

Jansen's process evaluation determined that the boiler was capable of generating up to approximately 108,000 lb/hr of steam when burning the desired fuel mix of 80% heat input from biomass, waste paper, and pulping rejects, 10% heat input from Tire Derived Fuel (TDF), and up to 10% heat input from coal. However, to achieve this much-desired goal, several changes had to be made. The superheater was rearranged to lower existing steam temperatures, as well as extensive improvements to the fuel handling equipment on the boiler, in the wood yard, and in the waste paper area. Jansen handled the engineering and design for the superheater modification and ProcessBarron designed, supplied, and installed all of the material handling equipment.

In order to maintain the most flexibility regarding future boiler operating conditions, Jansen relocated a section of the primary superheater surface area into the secondary superheater. This was accomplished by relocating the primary superheater outlet header, the secondary superheater inlet header, and the inter-stage piping. This resulted in approximately 25% of the primary superheater surface area being relocated downstream of the new attemperator that was installed in the inter-stage

Relocating the primary outlet and secondary inlet headers

Waste fuel screening, metal removal and storage

piping to better control the final steam temperature, thus increasing the secondary superheater surface area.

Since the existing primary superheater pendants that were to be relocated into the secondary superheater were extensively warped from years of overheating, new pendants were also supplied and installed as part of the superheater modification.

Meeting requirements

ProcessBarron provided the engineering, supply, and installation of the fuel handling equipment and system modifications. The new fuel handling system was designed to process various fuel streams which have a wide range of properties, including size, moisture content, and heating value. The various boiler fuels include:

- Biomass
- Coal
- TDF
- Recycle plant rejects — fibre, plastics, and 'pulper rags'

Using the results from the boiler study, Jansen determined the specific amounts of the different fuels that could be burned under various boiler conditions. ProcessBarron utilised these calculations to determine the minimum and maximum capacities of each fuel stream. For several reasons, the new fuel feed system was designed to keep the different fuel streams separated as much as possible until they reached the boiler.

This design was important to give the boiler operators the flexibility to burn various combinations and ratios of fuels depending on the plant needs at that time. The plant's production of recycle rejects varied so the demands of burning this fuel needed to be flexible. Since these fuels would come and go, the burning of these fuel streams needed to be as flexible as possible.

Another very important reason for the individual fuel streams were the new environmental law requirements of instantaneously measured fuel feed flowrates of each fuel stream. This goal was accomplished by utilizing weigh scale devices off each fuel feed streams working in conjunction with load cells on the boiler fuel feed bins and coal bunkers. A formula utilizing mass flow rates and weight differentials in the boiler feed bins was used to accurately calculate the exact amount of each fuel entering the boiler on a real time basis.

Another of Sonoco's project goals was to improve reliability, reduce maintenance, and eliminate the plugging problems prone to the previous system design. The major culprit to these problems was the handling of the waste paper, plastics, and recycle rejects. All these materials required significant onsite shredding before they could be run through the materials handling and storage system. The mill had recently purchased a TANA type mobile shredder that shreds a variety of their non-recyclable product and recycle reject materials.

ProcessBarron designed a four screw 'live bottom' reclaimer that could receive this material directly from the shredder, and/or directly from a bucket type front end loader that would load from the previously shredded fuel piles. The four screw reclaimer had a 1,200ft^3 (35m^3) storage capacity and a normal output capacity of 25 tonnes per hour with a maximum of 50 tonnes per hour. There were dual drives (one per two screws) to give the reclaimer redundancy and about two hours of retention time under normal load. This allowed for down time for the daily preventative maintenance require on the shredder.

The two drive system was also important since this reclaimer was handling material that was not yet screened, nor was any metal removed. The reclaimer was designed to produce a steady uniform stream of fuel. This was imperative if good results were to be expected from the metal removal and screening process.

Bridging and plugging problems plagued the previous system and it was determined that oversized material was one of the biggest causes. In any materials handling system, the material size must be maintained to the design specifications, because the conveyors and chutes are all sized with performance characteristics and clearances around those specifications. Handling oversized material that is too big is asking for material flow and bridging trouble, even with well-designed equipment.

Immediately upon leaving the receiving four screw reclaimer, the material went through an intense metal removal process and a precise screening process to reject out any metal and oversized materials. The fuel stream was transferred to an elevating belt conveyor where the material passed by a suspended electromagnet at the base of the conveyor and a magnetic head pulley at the belt conveyor discharge.

From there the material passes over a disc screen designed to remove material greater than 3" in size. Because of the importance of removing as much oversized material as possible without recycling the accepted material, the disc screen was oversized by 50%. This extra dimension along with a specialty designed distributor inlet chute provided more than adequate coverage across the disc screen area to achieve the material classification desired. From there the rejected oversized material could be diverted to the ground or back through an existing shredder.

The accepted material was then delivered to an existing 9,500ft^3 (270m^3) storage silo via a specialised pocket belt conveyor. The design of the pocket belt conveyor allowed ProcessBarron to maintain the existing equipment footprint and convey material at a 40 degree angle; well outside the capabilities of traditional belt conveyors. The silo was retrofitted with a Raumaster Oy circular screw reclaimer (CSR), which replaced a different style reclaimer that utilised a rotary chain arrangement. This original reclaiming device had severe material flow and reliability problems handling this difficult waste fuel. The new silo infeed conveyor was also fitted with a magnetic head pulley for a third metal removal opportunity before entering the storage silo.

The base of the silo is where the TDF system was located. This system utilised a twin screw hopper reclaimer to feed TDF at varying rates up to 1 tonne per hour. The TDF was blended with the waste

Waste fuel storage silo

fuels that were exiting from the storage silo via the CSR. This blend of waste fuels, recycle rejects, and TDF was then transferred by an existing elevating belt conveyor to a new dedicated fuel feed bin on the boiler house area.

The existing biomass receiving and delivery system to the boiler was tweaked with some additional screw and belt conveyors to resolve some plugging and throughput issues as well as providing the opportunity to weigh the biomass portion to the boiler fuel. The existing storage silo and out-feed reclaimers were reused in kind. The existing biomass pneumatic delivery system to the boiler was also reused with some minor modifications to improve performance and maintenance.

At the boiler house the coal handling bunkers and coal weigh feeders were still in good shape and were able to be reused in the new boiler feed system arrangement. Even though the coal feed requirements where minimal in the new boiler fuel feed mix, there were certain conditions where some coal feed would be required. The existing coal feeders had enough turndown to meet these requirements.

The existing boiler biomass feed bins, waste fuel feed bins, and combined fuel delivery drag conveyors were completely replaced and redesigned. Since the waste fuel and biomass fuel feed streams had similar flow characteristic properties and they both had similar mass flow requirements into the boiler, it was decided to design separate, but identical, storage and reclaim bins for each fuel. In the future this would allow Sonoco to store any of the two fuel streams in either bin or a combination of both fuels in one bin.

Each bin was designed with a storage capacity of 1,400ft^3 (40m^3) with variable out-feed rates up to 20 tonnes per hour each. This design provided the mill with incredible flexibility and redundancy when burning these cheaper biomass and waste fuels. These fuels were the best economical option for the mill to burn, but previous boiler restrictions and throughput limitations caused by plugging, bridging, and equipment reliability resulting in low annual totals of these fuels being burned.

In addition to the new system having lots of redundancy built into the design, the design also had bins, hoppers, and chutes calculated with proper slope angles and clearances to allow these difficult materials to flow through the system without interruption and with controlled accuracy. The individual fuel feed streams where helpful in that area due to the specific design of each system for the appropriate fuel flow properties.

Happy customer

After the project, Sonoco has been able to maximise burning of the secondary material fuels such as recycle, rejects, waste paper and plastics, as well as other opportunities that fit within the allowable fuels. This has reduced not only fuel cost, but landfill cost as well. The plant has also reduced downtime on the boiler by removing more metal from the fuel streams thus allowing them to run the boiler for longer periods of time before fouling from the metal accumulation.

The plant also sells the metal for scape and has seen a significant increase in revenue from the scape metal. Additionally, maintenance and downtime on both the boiler and fuel feed systems has been greatly reduced by the new designs on the superheater, boiler fuel infeed chutes, and the different fuel feed systems.

The team of Jansen and ProcessBarron to evaluate, design, supply, and install the boiler upgrades and the fuel handling systems was a very successful combination. Sonoco was given a total turnkey project solution with only one total performance guarantee. Jansen and ProcessBarron both participate in the semi-annual Biomass Boiler Workshops held in different locations around the US. ●

For more information:
This article was written by Cliff Moss of ProcessBarron and Matt Henderson of Jansen Combustion and Boiler Technologies.
Visit www.processbarron.com and www.jansenboiler.com


CFB boiler fuel handling system with biomass and waste fuel storage/reclaim bin, coal silos and feeders, drag conveyors, and rotary airlocks