Biomass, Chemical Recovery & Energy-from-Waste

JANSEN Combustion and Boiler Technologies, Inc.

BOILER NEWS

Number 40, Winter 2014

OUR MISSION

Our Company provides combustion, boiler, and energy technologies, products, and services.

We are dedicated to working with our clients to help define and achieve their productivity, reliability, efficiency, safety, and environmental goals.

We accomplish this by:

- *Listening and understanding.*
- *Providing a flexible approach to problem solving.*
- *Developing creative and innovative solutions.*
- *Partnering with clients to implement these solutions.*

We commit ourselves to creating a challenging and supportive work environment that fosters opportunity for professional growth and fulfillment.

Our team is dedicated to the highest standards of professional ethics and integrity.

INSIDE THIS ISSUE

NO_x Reduction in Recovery Boilers...?

Jansen has the Answer...!

In our last Newsletter (No. 39, available on our website), we promised actual results from an upgrade that had just been completed. In summary, mill modifications to change pulp production often make recovery boiler combustion system modifications necessary. This is caused by the need to process more black liquor solids while at the same time reducing NO_x emissions. We are pleased to report on two successful recent projects by Jansen.

Historically, chemical recovery boilers have experienced relatively low NO_x emissions, due to design features of the furnace and characteristics of the fuel. Research and experience show that NO_x emissions begin to rise as the load is increased on almost any type of boiler on most fuels. This is also true for chemical recovery boilers.

Environmental regulations for chemical recovery boilers have tightened, at times on a regional basis, to limit emissions of TRS, particulate matter, CO, SO_2, VOC's, and NO_x. The main factors affecting NO_x formation are furnace heat input rates, nitrogen content of the fuel, and arrangement features of combustion air delivery.

With market trends favoring different pulp grade products, the mix of wood species may change. Sometimes, the use of hardwood (versus softwood) is increased, up to 100%. This results in an increase in the nitrogen content in the black liquor. In addition, mills may also be planning to increase production rates, which results in further increases in the BLDS supply to the recovery boiler. To maximize annual production, boiler cleaning needs to be kept to a minimum, preferably only during the annual outage. Chemical reduction efficiency must be kept at a high level, as well.

So, mills may be facing the "perfect storm" for NO_x emissions: 1) higher boiler heat input rates and 2) higher nitrogen content in the black liquor. At one large mill, the client turned to Jansen for the solution for their two recovery boilers.

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Jansen to Reduce Fossil Fuel Firing in CFB Boiler

A major packaging producer in the Southeastern US was facing a challenge with the fuel mix they desired to burn in their existing Circulating Fluidized Bed (CFB) Boiler due to shortcomings with the existing fuel handling system. The boiler is located at a recycle plant and currently burns mostly coal with the remaining fuel mix made up of wood, waste paper, and some mill generated pulping rejects.

The plant had good experience with Jansen following a successful superheater modification in the CFB Boiler earlier this year. This modification reduced the superheater tube metal temperatures which were limiting the ability of the boiler to operate at higher loads. The photo above shows the superheater tubes ready to be installed in the boiler.

The plant's goals for changing the fuel mix include increasing the boiler steaming rate, reducing coal firing to a minimum, and reducing landfill cost by burning all mill generated rejects. In order to meet these goals the plant needed an innovative solution to upgrade the fuel handling system and turned to Jansen for the project management, engineering, design, and supply for the new fuel handling system.

Historically, Jansen has built an excellent reputation for evaluating boilers and supplying combustion air system upgrades and pressure part modifications. These successful projects have been carried out on a variety of stoker-fired, chemical recovery, refuse derived fuel (RDF) fired, and fluidized bed boilers.

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Customized Engineered Solutions

www.jansenboiler.com

Multi-Level OFA Systems for Biomass Boilers – Less Effective at Unnecessary Expense

In the past decade, the Paper Industry has faced environmental and economical challenges with burning biomass fuels in their power boilers. Historically, biomass (bark, hog fuel, chip screen rejects, etc.) has been favored over fossil fuels for economic reasons and the need in many mills to dispose of available biomass fuels. With the newly posted Boiler MACT emissions requirements, mills have to determine how best to optimize their fuel mix and combustion performance.

Biomass has several advantages as a fuel and many mills would like to increase biomass burning quantities. In some cases, it requires upgrading the fuel delivery (e.g., feed bins and/or fuel distributors) and/or the combustion air delivery systems (FD fans, Undergrate Air (UGA), and/or Overfire Air (OFA)).

In the past, most biomass boilers were designed to use low quantities of OFA and high quantities of UGA to control burning on the grate. These older systems ranged from having no OFA ports at all, to many rows of small ports at various elevations on the front and rear furnace walls. For over 15 years, Jansen has gained extensive experience from upgrading more than seventy biomass boilers, augmented by the use of our in-house CFD modeling capabilities to optimize OFA supply. The overwhelming design choice for many different boiler types and sizes is to install one single level of OFA. The new OFA nozzles are typically located on the furnace side walls (usually four nozzles per wall in an interlaced pattern). The system is designed with capacity to supply 40% to 60% of the total combustion air requirements with the OFA system. This approach has resulted in both excellent combustion performance and low emissions.

Some confusion appears to be emerging about how many air levels to use on a biomass boiler. This confusion likely stems from experiences on Chemical Recovery Boilers that burn fuel with different combustion characteristics in much larger furnaces. For decades, these boilers have used multiple levels of combustion air - and Jansen is no exception. Please refer to the lead article on the subject in this Newsletter, relating to NO_x reduction!

A biomass boiler is different in the design, fuel feed method, and burning characteristics. As biomass consists of approximately 70% volatile matter and 30% fixed carbon, the main process occurring on the grate is to drive off the volatile gases. These products of incomplete combustion are then mixed with OFA and burned in the upper furnace. The key to good mixing and burnout is strong, interlaced jets reaching well into the furnace. Designs with multiple OFA levels will reduce the air flow per individual nozzle and result in reduced air jet momentum and penetration. The extended flame zone caused by a multiple level OFA system also requires more furnace residence time than is often available in biomass boilers, and reduces heat release low in the furnace where it is needed to help dry and burn fuel on the grate. In addition, the presence of load burners in power boilers often compromise the design and push the upper OFA levels to near the furnace exit. These factors result in higher carbon monoxide (CO) emissions, one of the key species that is regulated by the new Boiler MACT rulings. Higher char carryover is also possible, reducing boiler efficiency and increasing the likelihood of higher particulate matter (PM) emissions and back-end fires. To try to overcome these detrimental affects, some vendors have used high pressure fans to try to enhance mixing, which increases the parasitic electrical load to the boiler.

Beside the lower combustion and CO emissions performance, the cost to install multiple air levels can be much higher than a single level. This is due to additional pressure part openings in the furnace walls, more air ducting and increased number of OFA nozzles, and the likelihood of having more obstructions and interferences to "work around". Unfortunately, as installation is often contracted by the mill at a later date, the additional installation costs may not be realized until after the OFA vendor has been chosen.

In some rare cases, the requirement to control NO_x emissions in a power boiler may outweigh the need to maintain low CO emissions. In this situation, a multi-level OFA system may be appropriate, but the potential detrimental effects of the multi-level system must be clearly understood when assessing the proper system design.

Jansen would be pleased to evaluate your specific application on your biomass boiler and develop our customized, engineered solution to best meet your needs and goals. If you have a specific inquiry, please contact John La Fond or Arie Verloop by e-mail at firstname.lastname@jansenboiler.com.

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NO_x Reduction in Recovery Boilers...? Jansen has the Answer...!

To improve the recovery boilers' BLDS throughput capacity and offset potential increases in NO_x, Jansen designed upgrades to the existing combustion air delivery systems and made adjustments to the liquor delivery. Further staging of combustion air supply was required; the solution was to add a fourth level of air, named quaternary air (QA), to allow for better control of air supply to both furnaces.

Jansen upgrade solutions are custom designed for each particular boiler. It starts with Jansen conducting evaluations of the boiler's BLDS burning capacity and associated NO_x generation before and after making the air system modifications.

The steps in this process are typically: 1) site visit to collect data, 2) process evaluations and mass and heat balance calculations, and 3) Computational Fluid Dynamics (CFD) modeling. CFD modeling allows the furnace combustion conditions to be simulated for individual cases with different BLDS supply rates, heating values, fuel composition (including nitrogen content), and configurations of combustion air supply. CFD modeling is carried out in-house by Jansen personnel and provides valuable input to the engineering design. The end result is an air system design configuration that best meets the client's needs and project goals.

STACK TEST RESULTS: Results of the two boilers from certified stack testing "After" the upgrades are shown below, and compared with the "Before" results. (Note: stack testing was conducted by independent third party). Both boilers achieved NO_x emission reductions of 33% even though the BLDS throughput and liquor nitrogen content had increased.

	"Before"	"After"
Recovery Boiler A		
BLDS Throughput (%)	100	109.3
TRS (ppm on dry gas at 8%O_2)	-	0.6
SO_2 (ppm on dry gas at 8%O_2)	<23	1.0
CO (ppm on dry gas at 8%O_2)	<19	71
NO_x (lb/ton BLDS)	**1.22**	**0.82**
Recovery Boiler B		
BLDS Throughput (%)	100	109.0
TRS (ppm on dry gas at 8%O_2)	0.3	0.1
SO_2 (ppm on dry gas at 8%O_2)	1.4	1.3
CO (ppm on dry gas at 8%O_2)	291	28
NO_x (lb/ton BLDS)	**1.64**	**1.10**

For both recovery boiler upgrade projects at this mill, all of Jansen's performance guarantees were met, including an increase in percent reduction efficiency by more than 3% points. Boiler A had a 12-month run-time between water washes after the upgrade, and the upgraded Boiler B has been in full operation since May of this year without signs of plugging.

These two projects continue Jansen's successful history with over 30 recovery boiler upgrades in more than 25 years, and never missing one single guaranteed performance parameter!

More detailed information on these recent NO_x reduction projects will be presented at the annual Recovery Boiler Committee Conference of the American Forest & Paper Association (AF&PA), to be held in Atlanta in mid-February 2014.

For general information or specific inquiries, please contact Arie Verloop at 425.952.2825, or John La Fond at 425.952.2832 or by e-mail at firstname.lastname@jansenboiler.com.

Boiler MACT & CISWI Rulings Are Here

The US EPA officially published final Boiler MACT and CISWI rulings in January 2013. The permitted levels of several emission species, particularly carbon monoxide (CO) and filterable PM were stated for various types of boilers and fuels. In most cases, boilers will have to meet the new standards by January 31, 2016.

There are two significant challenges for boiler owners/operators: 1) to understand the latest classifications and rulings for emissions levels and implementation periods, and 2) determining and understanding their boilers' current emissions profiles and combustion characteristics. Jansen has been assisting clients with determining how the Boiler MACT and CISWI regulations will impact their operations and by providing solutions for units that would exceed the new limits.

How Jansen Can Help?

Jansen assists boiler owners/operators by offering an evaluation of the boiler's combustion characteristics, including tuning options. If operational improvements are not sufficient to meet the new emissions requirements, Jansen can provide combustion system upgrades and team with pollution control equipment providers to help comply with the new regulations.

For further information and specific inquiries, please contact John La Fond at 425.952.2832 or Arie Verloop at 425.952.2825 or by e mail at firstname.lastname@jansenboiler.com.

Jansen WELCOMES

Tyler Kimberlin. We are pleased to announce that Tyler Kimberlin has joined Jansen, starting in April of this year. Tyler is a Senior Mechanical Engineer working in the process and design departments.

Tyler's experience ranges from R&D to engineering and design, through construction, start-up, and performance/emissions testing. Tyler first started work at fabrication/boiler shops before internships lead to 9 years of employment with a technology provider, Novo Energy, where he played a key role in the development and implementation of waste-to-energy combustion and air pollution control technologies. Prior to taking employment with Jansen he worked for Renewable Resource Consultants providing combustion and boiler consulting to W-T-E facilities.

Tyler graduated from Colorado State University with a B.Sc. in Mechanical Engineering and is a registered Professional Engineer.

Tyler can be reached at 425-952-2837 or email: tyler.kimberlin@jansenboiler.com. Please join us in welcoming Tyler.

NEW PRODUCT DEVELOPMENT
Actuated Dampers on Individual OFA Nozzles

Jansen has supplied manual dampers on our High Energy Combustion Air Nozzles™ on biomass, RDF, and chemical recovery boilers for many years (more than 100 boilers upgraded, with more than 1000 nozzles in operation). Recently, at a Canadian pulp and paper mill on the West Coast, we provided actuators to mount on selected nozzle dampers to allow automated supply pressure control (See photo below).

Biomass boilers at pulp and paper mills traditionally operate over a range of loads as they swing to maintain steam header pressure. The dampers, mounted at the inlets to the OFA nozzles, are manually set up during initial startup and are not typically adjusted during normal operation. As the boiler load swings or fuel mixes change, fluctuation in air flow to the OFA level results in variation in OFA jet pressure and velocity. If the OFA flow swings too widely, the penetration and mixing conditions in the furnace may be compromised.

The objective of automatically modulating selected OFA nozzle dampers is to maintain good supply pressure at the OFA nozzles even when flow decreases significantly. The automated dampers adjust to maintain a back pressure in the supply duct so that high jet velocities are maintained through the nozzles with fully open dampers. The result is smooth operation and effective OFA mixing over a wide range of loads.

The system shown has actuators mounted on nozzles with a single discharge opening into the furnace. Several years ago, Jansen began to offer a split nozzle (e.g., 66%/34% open area split) for seasonal or daily variations in load. The split nozzles have individual dampers and the small and/or large dampers can be equipped with automatic actuators. This would give better combustion stability and improved emissions control over a wider range of loads and operating conditions, as well as reduce the amount of operator attention required to manually adjust nozzle dampers.

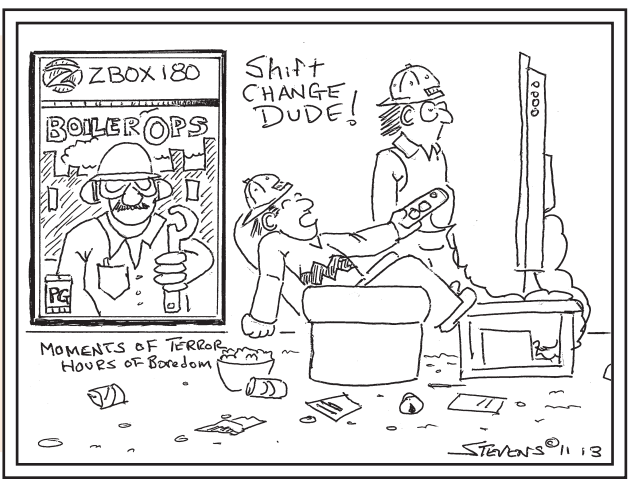
Due to the constant size of the nozzle opening, each nozzle acts as an individual air flow measurement device. Knowing air pressure and temperature, the OFA flow can be calculated for each nozzle and summed for total OFA supply.

If you have an interest in automated dampers or have a specific inquiry, please contact John La Fond or Arie Verloop by e-mail at firstname.lastname@jansenboiler.com.

Boiler House Cartoons on Jansen Website

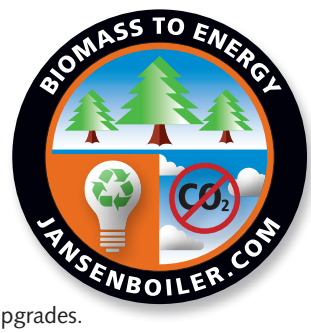
A collection of boiler house cartoons can be viewed on our website: www.jansenboiler.com. Over 30 cartoons by Gordon Stevens shown previously in this newsletter are presented on the site. Each cartoon depicts a humorous situation with people and equipment in the boiler house.

Note: *a few copies are left of our popular printed 2013 Cartoon Calendars, a Retrospective of Boiler House Cartoons, showing 26 of Gord's best. Please drop us a line if you would like to receive one of these copies.*



NEWS Briefs

Since our last newsletter (No. 39, Spring 2012), Jansen has conducted the following process and design engineering projects in the Forest Products, Independent Power Producers, Energy-from-Waste, and other industries (many projects are in progress):



- Boiler natural gas (co)-firing feasibility evaluations and cost estimating.
- Combustion system upgrades for chemical recovery, biomass, bagasse, and RDF-fueled boilers.
- Chemical recovery boiler upgrades for increased capacity and NO_x reduction.
- Superheater/attemperator system capacity upgrades and/or new supply.
- Biomass, RDF, and MSW boilers engineering evaluations.
- Chemical recovery boiler performance evaluations and capacity studies.
- Boiler circulation studies.
- Definition engineering of stoker-fired and fluidized bed boiler biomass capacity upgrades.
- CFD modeling of biomass, bagasse, chemical recovery, RDF, and MSW-fueled boilers.
- Boiler operational fine-tuning and optimization support.
- Boiler MACT, GACT, and CISWI compliance review and operational tuning.

This work was conducted, or is currently in progress for the following companies:

- APRIL Group
- Canadian Forest Products Limited (Canfor)
- Cariboo Pulp & Paper
- Cascade Pacific Pulp LLC
- Catalyst Paper
- Coastal Carolina Clean Power
- Clearwater Paper
- Connecticut Resources Recovery Authority
- Dominion Virginia Power
- Domtar Inc.
- FMC Corporation
- Georgia-Pacific LLC
- Graphic Packaging International
- Ingenio Madre Tierra
- International Paper Company
- KapStone - Longview Fibre
- MeadWestvaco
- Minnesota Power
- NewPage Corporation
- Packaging Corporation of America
- Plum Creek
- ReEnergy Holdings LLC
- RockTenn
- SAPPI North America
- Sonoco Products Co.
- Traxys Power
- Veolia ES
- Xcel Energy
- Wheelabrator Technologies, Inc.
- Weyerhaeuser Company

For further information on these types of projects, please contact Arie Verloop at 425.952.2825 or by e-mail at arie.verloop@jansenboiler.com. Additional information and specific project references can be found on our website at: www.jansenboiler.com.

Jansen Conference Presentations and Technical Papers

In recent years, Jansen personnel have made many technical presentations at conferences and industry meetings. These presentations were:

1. **Superheater Modifications and Boiler Upgrades to Maximize In-House Power Generation;** co-authored by John La Fond, Marcel Berz, Samit Pethe, and Arie Verloop and presented at the 2011 TAPPI Engineering, Pulping & Environmental Conference, October 2011, Portland, Oregon.
2. **Biomass Combustion Principles and Boiler Optimization;** presented by Arie Verloop at the annual TAPPI Kraft Recovery Course, January 2011 through 2014, St. Petersburg, Florida.
3. **An Improved Method for Modeling NO_x Emissions from Recovery Boilers;** presented by Dr. Allan Walsh at the annual AF&PA Recovery Boiler Committee Conference, Atlanta, Georgia, February 8, 2012.
4. **Carbon Monoxide Emission Improvements from Combustion System Upgrades at the Wheelabrator Portsmouth Refuse Derived Fuel Plant;** co-authored by Samit Pethe, Mike Britt, and Scott Morrison (Wheelabrator) and presented at the 20th North American Waste-to-Energy Conference (NAWTEC) held in Portland, Maine, April 23 to 25, 2012.
5. **Biomass Combustion Troubleshooting;** by Arie Verloop, published in BioEnergy Insight Magazine, June 2012, Issue 3, Volume 3, p. 56-58.
6. **CO Emissions: Combustion Enhancements to Meet Boiler MACT Limits in Biomass-Fired Boilers;** presented by John La Fond at the AF&PA, NCASI, AWC Boiler MACT Workshop, in Durham, North Carolina, March 13 and 14, 2013.
7. **Recovery Boiler Combustion System Upgrade for Improved NO_x Emissions Performance;** by John La Fond, presented at BLRBAC, April 10, 2013, Atlanta, Georgia.
8. **Biomass Replaces Coal at the Hibbard Power Generation Facility;** co-authored by Samit Pethe, Robert Bastianelli, and Luke Schwartz (both Minnesota Power), presented at the CIBO Fluid Bed & Stoker Fired Boiler Operations and Performance Conference, May 20-22, 2013, Louisville, Kentucky.
9. **Fundamentals of Biomass Application to FBC and Stoker Fired Boilers;** presented by Roger Lawton at the CIBO Fluid Bed & Stoker Fired Boiler Operations and Performance Conference, May 20-22, 2013, Louisville, Kentucky.
10. **Recovery Boiler Combustion System Upgrades for Improved NO_x Emissions Performance;** to be presented by John La Fond at the annual AF&PA Recovery Boiler Committee Conference, Atlanta, Georgia, February 12, 2014.

If you have an interest in receiving an electronic copy of one or more of these papers or have a specific inquiry, please contact the authors Samit Pethe, Allan Walsh, Marcel Berz, John La Fond, Roger Lawton, or Arie Verloop by e-mail at firstname.lastname @jansenboiler.com.

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Jansen to Reduce Fossil Fuel Firing in CFB Boiler

With the CFB Boiler, fortunately, this plant had the right kind of boiler to burn a variety of fuels. CFB operation has several design advantages which allow it to burn a mixture of different fuels and produce low emissions. The problem was getting this myriad of fuels into the boiler!

The new fuel handling system is designed to process various fuel streams which have a wide range of properties, including size, moisture content, and heating value. To minimize the risk for plugging problems, the different fuel streams will be kept separate until they reach the boiler.

Jansen teamed with ProcessBarron (PB) of Pelham, Alabama, for supply of the fuel handling equipment. Jansen and PB have been working together for over ten years on a variety of successful projects in North America. For this project, PB will also assist the plant with the installation of the fuel handling upgrade. Since 2002, Jansen and PB have been co-sponsors of the popular bi-annual Biomass Boiler Workshops. For 2014 dates and locations, please see below.

In addition to the design and supply of the new fuel handling system (bins, conveyors, feed chutes, etc.), the scope of supply also includes a modification of the superheater attemperator and technical services during and after the outage. The plant plans to install the new equipment during a scheduled outage in April 2014.

For further information and specific inquiries, please contact Matt Henderson at 425.952.2844 or John La Fond at 425.952.2832 or by e mail at firstname.lastname@jansenboiler.com.

ATTEND OUR 2014 Biomass Boiler Workshops

- **Raleigh/Durham, North Carolina, May 8-9, 2014**
- **Memphis, Tennessee, September 18-19, 2014**

Since 2000, these workshops have been attended by some 900 representatives of numerous plants in the Pulp/Forest Products Industries, Independent Power Producers and Energy-from-Waste Industry.

The workshops consist of presentations about new technological developments and results to improve the operating performance, waste fuel burning capacity, efficiency, and fuel economy of biomass-fired boilers (mostly stoker-fired). In addition, the program will include troubleshooting and problem solving discussions of challenges that attendees bring to the workshop. Participants will benefit by: 1) learning about the current retrofit technology for biomass boilers and associated equipment; 2) seeing how other mill operations solve their biomass boiler area problems; and 3) receiving information and solutions to their specific problems. Attendance to the workshop is free of charge; space is limited.

Participants take notes during a past Biomass Boiler Workshop

The workshops are co-sponsored by:

JANSEN Combustion and Boiler Technologies, Inc. · EMERSON Process Management · processbarron · PSA

For sign-up and to receive a detailed program of the technical presentations, workshop location, and hotel, etc., please contact Pat Azeltine or Cathy Thomas by phone at 425.952.2843/2835 or by e-mail at FirstName.LastName@jansenboiler.com.

RECEIVE OUR Newsletter by E-mail

This Newsletter, No. 40, Winter 2014, is again being sent by e-mail to our contacts for whom we have an e-mail address. It will also be sent via regular postal service. We are continually expanding the electronic distribution list for our newsletter.

To receive this and upcoming Newsletters electronically, you may directly sign-up through the link on our website (http://jansenboiler.com/publications/newsletters/) or alternatively, send your e-mail address to editor@jansenboiler.com and you will be included on the list.

JANSEN Combustion and Boiler Technologies, Inc.

Boiler News is published regularly by Jansen Combustion and Boiler Technologies, Inc. to provide information to Owners and Operators of boilers.

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