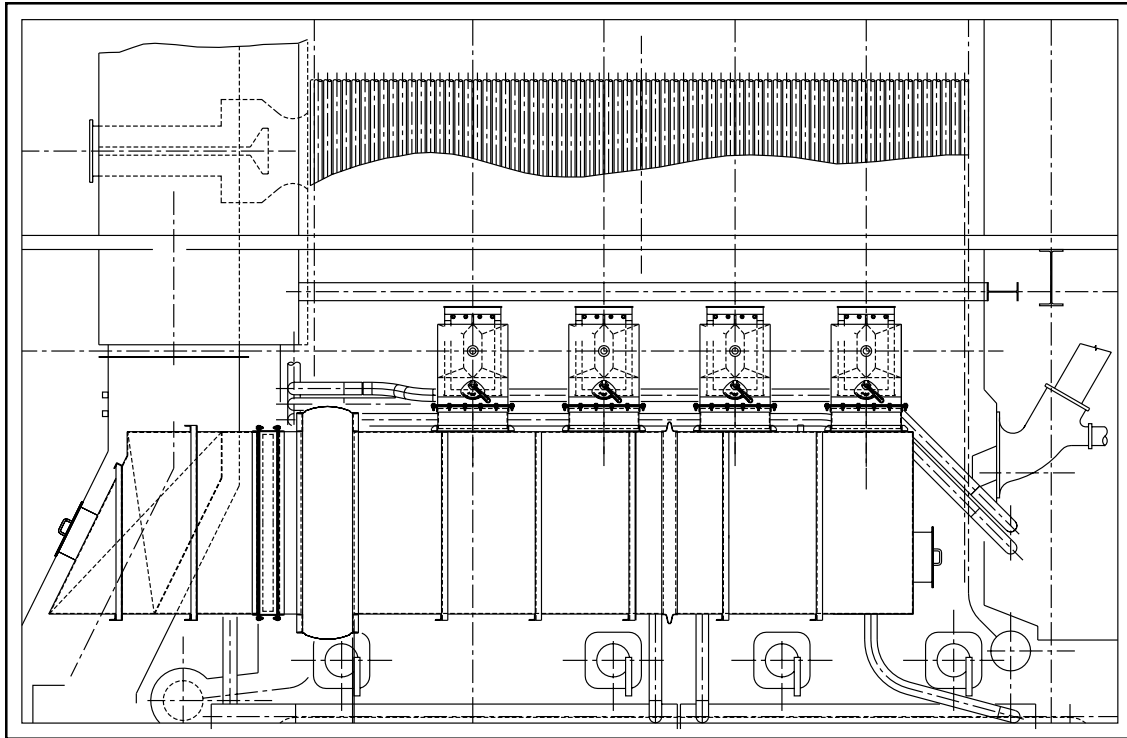


## Bark and Sludge Boiler to Get Jansen Overfire Air System



*This summer an overfire air (OFA) system upgrade, designed and supplied by Jansen, will be installed on a traveling grate, stoker-fired boiler.*

The boiler is a two-drum Stirling type unit, supplied by B&W in the early 1970s to burn wood waste, sludge, and oil. The maximum continuous rating (MCR) of the unit is 300,000 lb/hr at an operating pressure of 900 psig and final steam temperature of 825°F. At the present time, the unit averages 260,000 lb/hr steaming rate on bark, dewatered waste water treatment solids (sludge), and fuel oil. The old OFA system consisted of an OFA fan and numerous small OFA air ports located at three different elevations on the rear and two elevations on the front wall.

The size and location of the old OFA ports makes them ineffective (see related article on page 3 of this newsletter), as evidenced by the high amount of carryover from the furnace and the need for continuous oil co-firing. The Owner has several objectives for the OFA system upgrade:

- Reduce carryover of ash, fines, and char out of the furnace
- Reduce particulate emissions
- Reduce amount of fuel oil burning by more than 75%

Jansen will design and supply customized High Energy Combustion Air Nozzles™ to be installed on the side walls, approximately 10 feet above the grate.

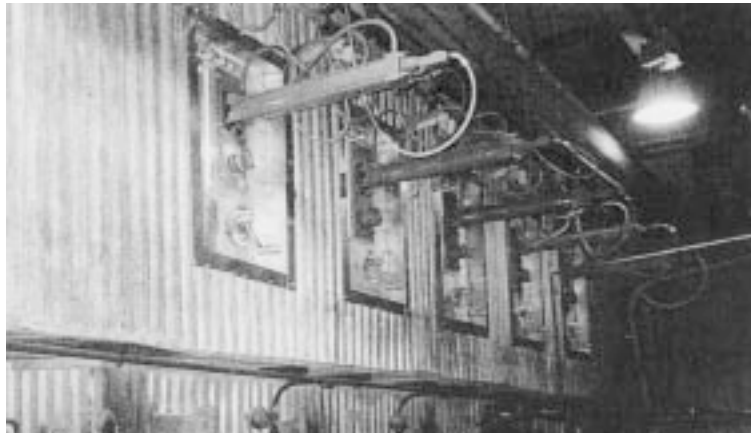
Experience on other recent installations and Computational Fluid Dynamics (CFD) modeling conducted by Jansen for this boiler has demonstrated that the new OFA nozzles will provide excellent mixing, burnout of wood materials and volatiles, and a reduction in carryover out of the furnace. Other OFA system installations by Jansen on waste fuel fired units are:

- Abitibi-Consolidated Inc. – Steilacoom, Washington
- Tolko Industries Ltd. – The Pas, Manitoba
- Mead Paper – Chillicothe, Ohio
- Smurfit-Stone Container Corp. – Portage du Fort, Quebec
- Mead Coated Board – Phenix City, Alabama

For information about these projects, please see the related article in this newsletter on page 3, or contact Ned Dye at 425.825.0500 ext. 125, or e-mail at [Ned.Dye@jansenboiler.com](mailto:Ned.Dye@jansenboiler.com).

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## No. 4 Recovery Boiler Air System Upgrade Simpson Tacoma Kraft



### Project Scope

In October 1999 JANSEN was awarded the contract to provide engineering, equipment supply, and installation services for an air system upgrade on Simpson Tacoma Kraft's (STK) No. 4 Recovery Boiler in Tacoma, Washington. The recovery boiler is a Combustion Engineering unit that was installed in the early 1970s and designed to process 2.6 million lb/day of virgin black liquor dry solids.

Prior to the upgrade, the boiler was typically processing 3.1 million lb/day of virgin black liquor dry solids using a two-level air system: primary air and tangential secondary air above the liquor nozzles. At this firing rate, the capability of the air system was limited, as further increases in solids throughput could not be sustained while at the same time continuously meeting TRS stack emission limits. JANSEN added ten Jansen High Energy Combustion Air Nozzles™ to the front and rear walls of the existing primary belt duct (five nozzles per wall), approximately seven feet above

the primary air ports. The air system was designed to increase the solids throughput to 3.3 million lb/day of virgin black liquor dry solids and maintain TRS emissions well below the permit level of 5 ppm. The air system was also designed to accommodate an increase in black liquor throughput to 3.7 million lb/day following the installation of a new economizer at a future date.

**Two unique characteristics of the JANSEN air nozzles provide significant benefits:**

1. The low pressure loss air nozzles allow the use of the existing forced draft fan and permit the installation of the over bed air level nozzles directly in the existing primary air belt duct, and
2. The convergent air nozzles provide a reliable means of measuring air flow by using transmitters to measure the static pressure in each nozzle and the furnace draft. The DCS displays air flows for each nozzle and for the total overbed air level. Having the ability to read air flow at the nozzles

allows the use of a common combustion air supply duct for both the primary and overbed air levels.

The benefits realized by STK were: (1) relatively low capital cost, and (2) short installation time. The system was installed in only five days (the entire outage was approximately seven days due to maintenance work in other areas of the boiler).

### Results

The air system modifications were installed during STK's annual outage in January 2000. During start-up the boiler was brought up to the full design load of 3.3 million lb/day of virgin black liquor dry solids as soon as liquor was available from the rest of the mill. The air system has met all of the design objectives for liquor throughput and stack TRS release.

**For further information about this project, please contact Arie Verloop at 425.825.0500 ext. 111, or e-mail:**

**Arie.Verloop@jansenboiler.com.**

### Update on Phone Numbers

Some people continue to call the old Jansen phone number in Woodinville, WA. Our phone and fax numbers were changed after our move to nearby Kirkland in December 1997. Here they are once more:

**Phone: 425.825.0500**

**Fax: 425.825.1131**

**E-mail employees:  
firstname.lastname@jansenboiler.com**

We don't want to miss helping you with your needs, so please update your rolodexes, if you do not have these numbers.

## Problem / Solution

# What to Look for in an Overfire Air System for Stoker-fired, Waste Wood Fueled (Bark) Boilers

*Combustion air systems for stoker-fired, waste wood fueled (bark) boilers have evolved over the past four decades. This article discusses the basic types of overfire air (OFA) systems that are in use on bark boilers.*

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JANSEN has used Computational Fluid Dynamics (CFD) modeling and field experience to evaluate different types of OFA systems. The evaluation looked at the following performance criteria:

- Quantities of carbon monoxide (CO) and volatile organic compounds (VOC) in the flue gas.
- Quantity of ash and unburned fuel carryover.
- Ability to operate without auxiliary fuel.
- Ability to follow load swings on waste wood fuel only.

The performance criteria listed above are all strongly influenced by the mixing of combustion air with the fuel provided by an OFA system. The factors that determine the effectiveness of OFA mixing are:

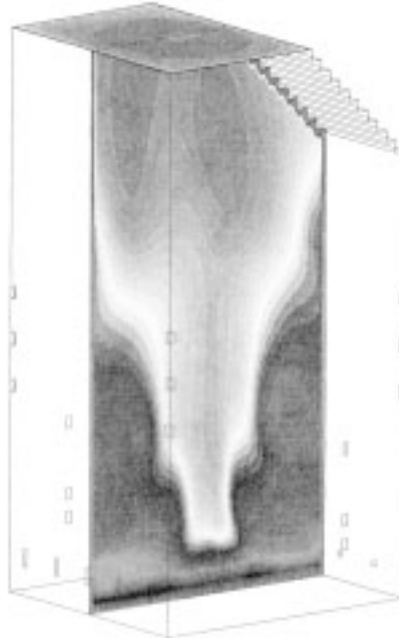
- Jet penetration depth
- Coverage of boiler cross section
- Turbulence

OFA system characteristics have been grouped into categories for ease of comparison.

### Size of Air Ports/Nozzles

Small jets were shown to not have the momentum or jet size to penetrate into the center third of the furnace. The momentum (mass flow times velocity) is low with small ports since the mass flow per air jet is low. Depending on the size of the furnace (width and depth), generally jets with less than 25 square inches do not

**CFD Modeling,  
Temperature  
Profile of a Poor  
OFA System**



penetrate to the center of the furnace. These small jets, because of the lack of momentum, are easily deflected upward by the rising flue gas. Therefore, coverage in the center of the furnace is inadequate.

The poor penetration and mixing that result from small jets do not provide the combustion conditions for good burnout of CO and VOCs and create a central core of high vertical velocity, unmixed flue gases that increase carryover and cause delayed combustion to occur up in the superheater. Without good mixing in the lower furnace,

combustion temperatures are not high enough to sustain stable burning of wet bark and wood and may require auxiliary fuel to augment the combustion.

Large ports/nozzles create jets with high momentum that penetrate well past the center of the furnace. When arranged in an interlaced pattern, the jets were found to provide good coverage of the furnace cross section. The jets are not easily deflected upward and the jets will interact with jets from the opposing wall.

The large jets should have high enough velocity (kinetic

energy) so that they interact with the opposing jets in the form of turbulent mixing. Nozzle designs that provide low pressure loss will more efficiently convert the static pressure produced by the forced draft (FD) fan into velocity. This is most important in retrofit installations where use of an existing FD fan is desired.

### **Location of Air Ports/Nozzles**

Good coverage of the cross section of the furnace is important to assure contact between the OFA and the volatiles and fines that are released off of the grate or from the fuel distributor. Without complete coverage, CO, VOCs and fines/unburned carbon can escape the furnace without being burned out. In addition to deep penetration, the jets need to be arranged along opposing walls to create a plane of OFA. The plane of OFA jets should be located above the elevation of the fuel distributors so that the OFA does not increase the mass flow of flue gas below the fuel being “thrown” into the furnace and contribute to carryover. However, the plane of OFA should be as low as possible to create rapid combustion and high temperatures that provide stable operation of the boiler without auxiliary fuel. Creating an OFA plane low in the furnace also gives additional residence time for fines and unburned carbon to burn out before they exit the furnace.

The arrangement of OFA nozzles can be on the side walls or the front and rear walls. However, there are usually physical interferences on the front and rear walls of bark boilers (fuel distributors, fuel chutes, ash re-injection lines, etc.) that preclude placing OFA nozzles in the proper location for optimum furnace coverage. With the space limitations on front and

rear walls, placement of large nozzles is restricted.

In addition, CFD modeling has shown that burnout of CO, which is a major indicator of combustion efficiency, is approximately 15% more complete with side wall, large, high velocity interlaced jets than with front and rear wall, large and small opposed jets. On the other hand, the profile of vertical velocity distribution, a secondary factor in evaluating performance, is between 10% to 15% better with front and rear opposed jets than with side wall interlaced jets.

In the past, preferences for front and rear wall jets versus side wall jets may have come from the use of small ports. With small jets and shallow penetration, front/rear wall locations are preferable to get some mixing across the furnace width. However, with modern, large, high performance nozzles, side wall OFA systems provide improved combustion over front and rear wall arrangements.

Large air nozzles can be positioned to provide complete coverage of the furnace by interlacing with the opposite wall jets or directly colliding with the opposite wall jets. CFD modeling has shown that mixing, burnout of CO, and velocity distributions are better with interlaced, large jets than with colliding jets, whether the colliding jets are of equal size or large jet colliding with a smaller jet.

Some boilers have been equipped with tangential or cyclonic pattern OFA jets. Even with large ports, these jets arrangements do not provide full coverage of the furnace cross section and allow unburned gases and fuel to escape up a center core.

### **Quantity of OFA Delivered**

By reducing the quantity of undergrate air, the amount of ash and fines carryover can be minimized. Therefore, transferring undergrate air to the overfire level improves carryover conditions. The OFA system should be designed to accommodate the maximum percentage of total combustion air within the constraints of providing enough air for grate cooling (if required) and providing proper combustion conditions on the grate. Normal range for OFA is between 35% and 50% of total combustion air for bark boilers.

### **Summary**

Summarizing the characteristics of an OFA system that provides optimum performance:

- OFA jets should be large to provide the mass flow and velocity (momentum) for good penetration.
- OFA jets should provide coverage over the full cross section of the boiler to maximize burnout of CO, VOCs, and fines.
- With the use of interlaced, large nozzles, side wall installation is possible. Side wall OFA provides most effective combustion system, offers the most flexibility in the placement of nozzles. (In most cases side wall systems are the easiest to install, provide flexibility in operation and are usually the most cost-effective.)
- To minimize carryover, OFA jet location should be above the elevation of the fuel distributors and the quantities should be between 35% and 50% of the total combustion air flow.

For further information about Jansen's OFA system design and installations, please contact Ned Dye at 425.825.0500 ext. 125, or e-mail at Ned.Dye@jansenboiler.com.

# OUR MISSION

Our Company provides combustion and boiler technology, products, and services.

We are dedicated to working with our clients to achieve their production, 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.
- Working with clients to implement these solutions.

Our team of talented and experienced individuals is committed to the highest standards of professional ethics.

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

## Recovery Boiler Circulation Studies

As reported before in this Newsletter, Jansen has built an extensive body of experience regarding boiler natural circulation. We have advised many clients about the condition and adequacy of circulation and associated fuel burning capacity of existing recovery and power boilers. The need to conduct a circulation study on a boiler is typically dictated because of any one, or combination of, the following reasons:

- To establish the maximum steaming rate at which circulation remains adequate.
- To determine pressure part modifications needed to support a significant increase in fuel burning rate.
- To make an assessment of the effect of changing boiler

- operating conditions on circulation.
- To uncover factors causing repeat pressure part failures and/or tube overheating.
- To investigate the cause of excessive scale depositions inside tubing.

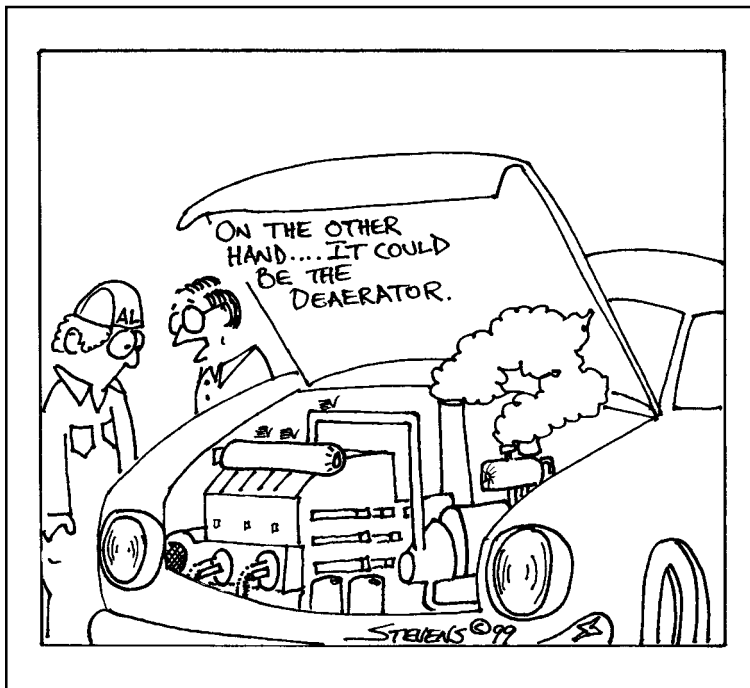
A valuable technique used by Jansen during its analyses of circulation conditions is the application Ultrasonic Flow Monitoring (UFM). UFM allows for direct water velocity measurements in selected downcomers and boiler furnace tubes without penetrating the pressure part boundary. Therefore, UFM measurements require no boiler downtime. The UFM data provides invaluable input in the evaluation of boiler circulation.

In the past year and a half, Jansen conducted circulation studies for the following mills:

- Plainwell Shasta Paper Co. – Anderson, California

- Pope & Talbot, Inc. – Halsey, Oregon
- Mead Paper – Escanaba, Michigan
- Weldwood of Canada Ltd. – Hinton, Alberta
- Champion International Corp. – Quinnesec, Michigan
- Smurfit Cartón de Colombia – Cali, Colombia
- Domtar Papers Ltd. – Cornwall, Ontario
- Weyerhaeuser Co. – Springfield, Oregon
- Westvaco Corp. – Wickliffe, Kentucky

With these recent projects, Jansen has successfully completed circulation studies of more than 60 recovery and power boilers in our industry. For further information about boiler circulation and UFM data collection, please call John La Fond at 425.825.0500 ext. 110, or Allan Walsh at ext.113.



### Recovery & Power Boiler News

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## Oxygen Enrichment of Combustion Air (OEA) to Boost Recovery Capacity

Jansen and Air Liquide are teaming to provide a new technology to increase the solids burning capacity of existing recovery boilers.

Last November, a patent was awarded to Jansen/Air Liquide, describing *Methods of Improving Productivity of Black Liquor Recovery Boilers* (US patent No. 5,992,337).

The joint Jansen/Air Liquide application of OEA to increase recovery boiler capacity is featured under the trade name of **PROMOX<sup>2</sup>**.

Jansen's expertise in recovery boilers and combustion air delivery

systems, combined with Air Liquide's expertise in on-site oxygen production, handling, and delivery, forms a unique alliance for the safe and efficient application of OEA. Specific benefits of OEA will vary from case to case; the overall potential benefits are:

- Increased solids capacity by up to 20%
- Lower sulfur emissions
- More stable operation
- Higher thermal and reduction efficiencies
- Minimum outage time needed to install
- Low capital cost to install

For further information about the application of OEA on recovery boilers, please contact Arie Verloop at 425.825.0500 ext. 111, or e-mail: [Arie.Verloop@jansenboiler.com](mailto:Arie.Verloop@jansenboiler.com).

## Jansen EPC Project Capability and Experience

For large boiler upgrade and retrofit projects, mills often choose to have one source for project implementation and responsibility. All aspects of the project, such as definition, engineering, materials supply, and installation-construction work are covered in one, single Engineer-Procure-Construct (EPC) contract.

Jansen has successfully completed many EPC boiler projects. Among these are complete lower furnace replacements, recovery boiler air system upgrades, and power boiler overfire system retrofits. For more information about Jansen's EPC capabilities, contact Mike Britt at 425.825.0500 ext. 127, or e-mail at [Mike.Britt@jansenboiler.com](mailto:Mike.Britt@jansenboiler.com).



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Recovery  
& Power  
**BOILER  
NEWS**