

Interstate Paper's Riceboro, GA, mill improves recovery boiler combustion performance and uptime with detailed analysis and a new air system

## Interstate Paper Revives Recovery Boiler with Stacked Air System

By **DOMINICK GARTON**

**T**he recovery boiler is a blessing and a curse for most mills. It's often the single most expensive piece of equipment in the mill, it consumes a huge (and hugely unpredictable) percentage of a facility's maintenance budget and its down times are at best unpredictable and at worst catastrophic. Combustion is often far below optimal levels, which causes a host of problems, including high emissions levels, excessive use of auxiliary fuel, char bed instability, low chemical reduction efficiency and a lower than optimal rate of heat-into-steam conversion.

Obviously, improving the operation and efficiency of a recovery boiler will have a substantial impact on a mill's bottom line. But far too many mill managers accept the temperamental behavior of their boilers for two reasons: They don't know that their current boiler's performance can be improved, and they believe that major improvements require million dollar investments in brand new boilers.

This is not so, as a case study from a US mill illustrates. In early 2003, Interstate Paper in Riceboro, GA, contracted with Anthony-Ross to assess its recovery boiler operations and suggest solutions. Mill managers were concerned about frequent plugging, high maintenance costs and excessive downtime. They wanted a solution that would help their current boiler operate more efficiently, rather than having to replace the boiler entirely.

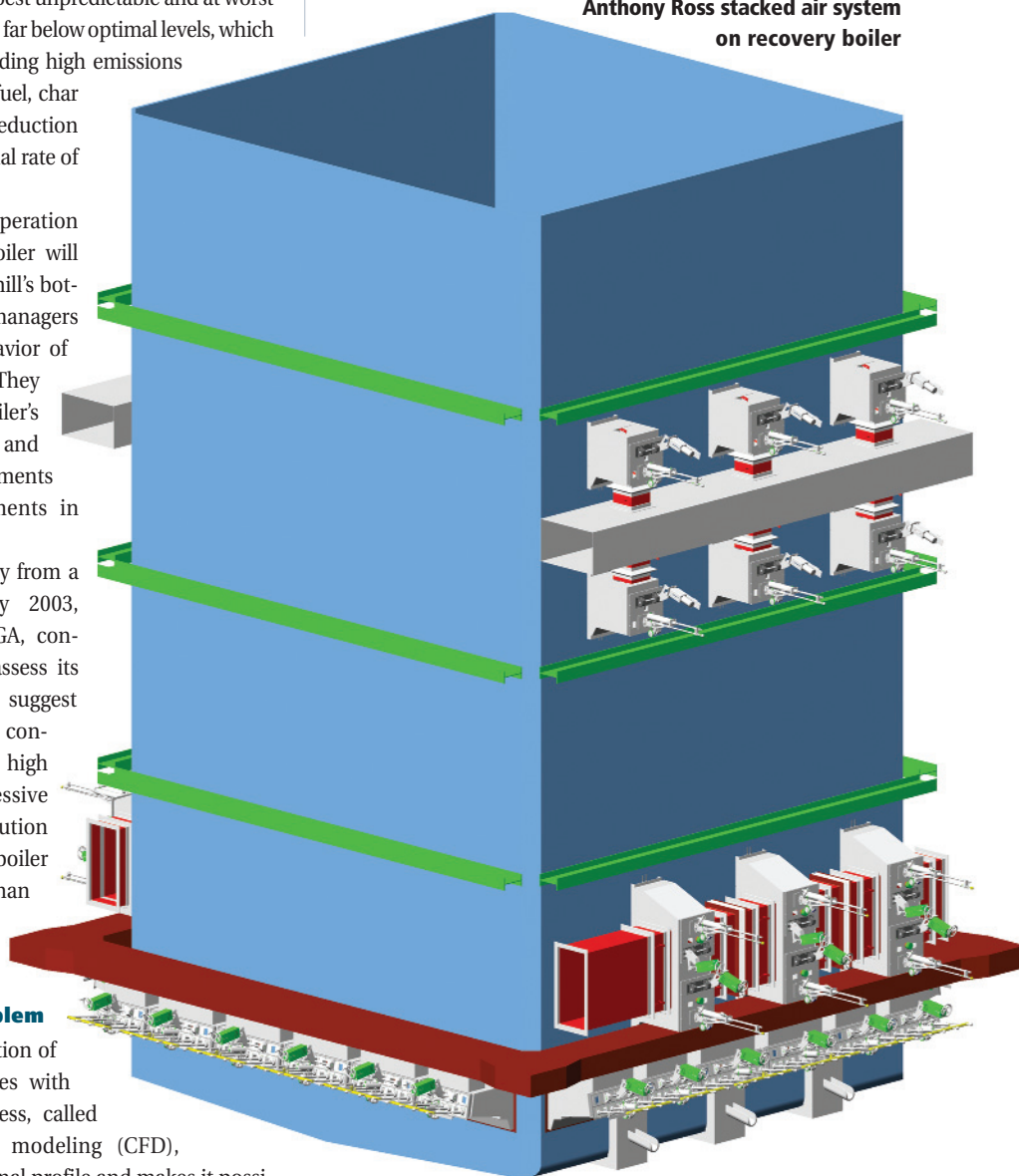
### Step 1: Assessing the Problem

Anthony-Ross begins the evaluation of a boiler's operational challenges with computer modeling. This process, called computational fluid dynamic modeling (CFD), shows a boiler's current operational profile and makes it possi-

ble to predict the efficiencies and outcomes that can be expected with several different solutions, all without having to touch the boiler.

**FIGURE 1.**

**Anthony Ross stacked air system on recovery boiler**



Like most clients, Interstate Paper was shocked when the CFD data showed just how inefficient its boiler actually was. CFD modeling clearly showed that one side of the boiler (in this case, the left side) was not being fully utilized. Physical carryover tests on the left and right sides of the boiler supported the CFD conclusions. In addition, anecdotal evidence, including the propensity of the boiler to plug on the right side, supported the CFD conclusions. This is not unusual. As is often the case with recovery boilers, Interstate Paper's combustion air system was not providing optimal mixing conditions. A large quantity of excess air was required to improve the combustion rate, pushing the heat release high in the furnace. The mixing system was inadequate; even at high excess air levels, the combustion was incomplete at the bull nose level. In addition, very high levels of CO existed throughout the right side of the furnace, indicating poor mixing and combustion where the flue gases are channeled. Sufficient oxygen concentration was available for consumption, but the lack of sufficient mixing within the furnace made the oxygen unavailable. The left side of the furnace, in particular, had sufficient oxygen available, but the right side, where the flue gas channeling existed, did not. All of this led to high plugging rates and excessive boiler downtime.

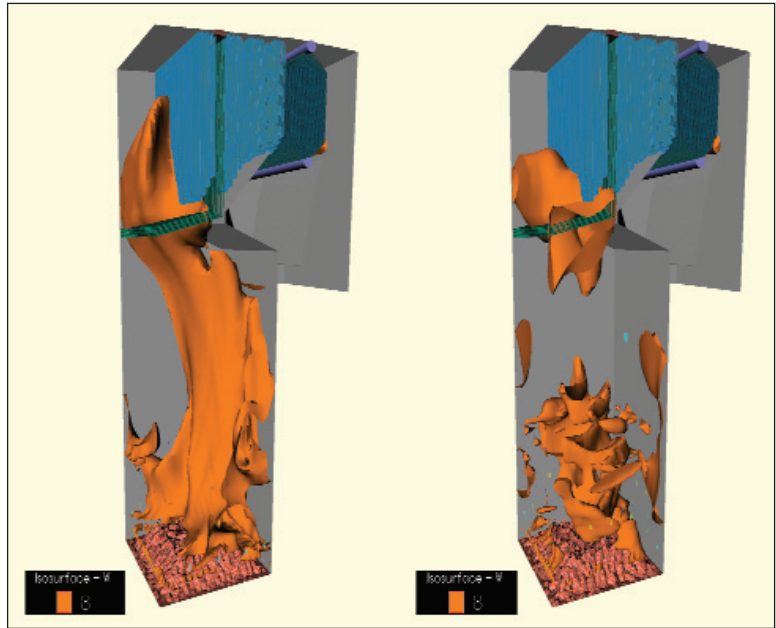
The boiler also had problems at the lower furnace. Smelt flows were widely variable and extremely noisy. Chemical reduction efficiency was unsatisfactory, and it was difficult to balance lower furnace conditions with the all important run time of the furnace.

Increasing airflow in the lower furnace raised the carryover of smelt and unburned liquor particles, so airflow was purposely held low. The firing liquor temperature was held near 126° C, and, combined with slow oscillation of both liquor guns, provided bare minimum char bed stability. However, the greater wall surface-to-load ratio removed heat from the lower furnace, which meant the furnace was extremely sensitive to firing disturbances such as liquor quality sulfidity, percent solids and ash recycle changes. Constant loud "booming" around the spouts was a very real concern from both operations safety and housekeeping standpoints. Under these conditions, the mill found it difficult to keep the lower furnace sufficiently hot to improve smelt runoff and raise the chemical reduction efficiency.

The CFD model data strongly indicated that the existing combustion system was the root cause of the problems on this boiler.

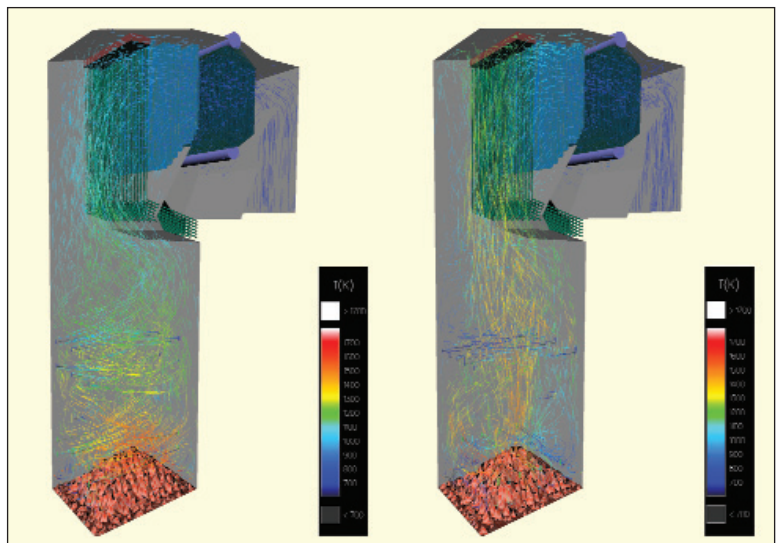
**FIGURE 2.**

**Conventional system vs stacked air system:** These two iso-views show that the vertical velocities are much slower in the stacked air system (right) than a conventional air system. All areas within the orange color have vertical velocities 8 m/sec or greater. Clearly, the stacked air system is able to reduce the upward velocities throughout the furnace, and this has a major impact on the physical carryover of material.



**FIGURE 3.**

**Chimney effect:** The CFD modeling to the left shows the flue gas patterns on the original boiler with a conventional air system versus that same boiler modified to a stacked air system (right). This clearly shows the improved vertical turbulence.



The fundamental “Ts” of combustion (time, temperature and turbulence) did not exist for the required dry solids loading. Clearly, the furnace needed a redesign of the combustion system to speed the mixing time constant, release greater amounts of heat lower in the furnace and reduce the physical carryover. Although there was sufficient airflow at the secondary and tertiary levels, very little turbulence height existed within the furnace. Flue gas flows passing through the secondary and tertiary air port opening were mixed, but the turbulence quickly subsided after leaving the air port opening zones. The mixing inertia was not maintained above the air port openings, and quickly dissipated after exiting each short mixing zone. In short, much of the furnace volume had very little mixing opportunity.

**Step 2: Choosing a Solution**

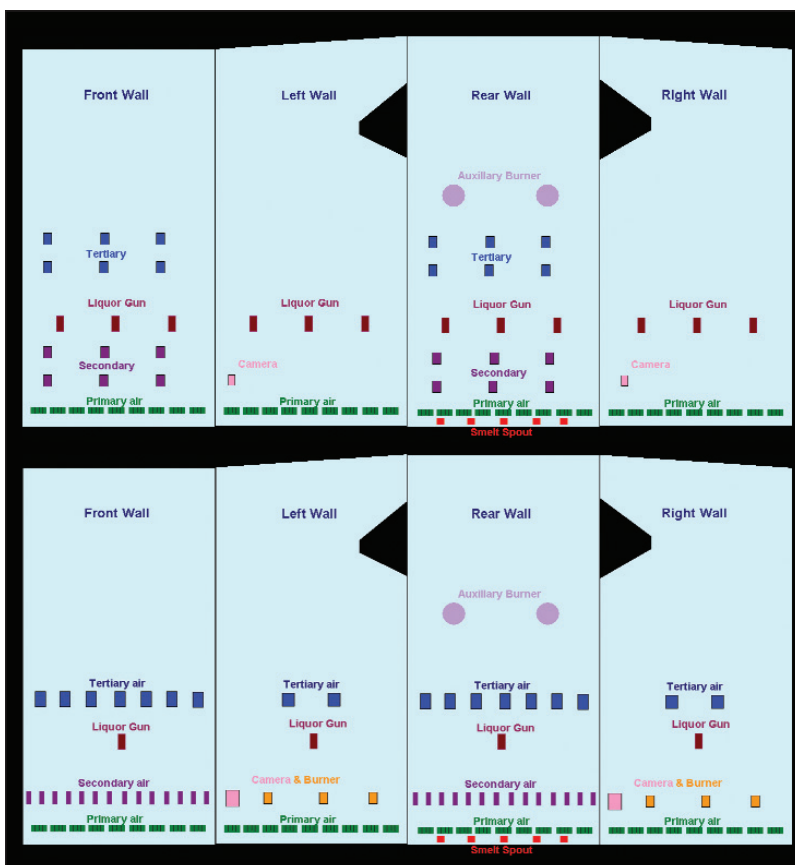
With the problem identified, the next step in the process was to use the CFD data of the existing boiler conditions as a baseline, then to develop five potential solutions. Each option was examined and compared with the baseline data. The solution

for Interstate Paper was a new Stacked Air System (SAS), in this case, a secondary and tertiary air system.

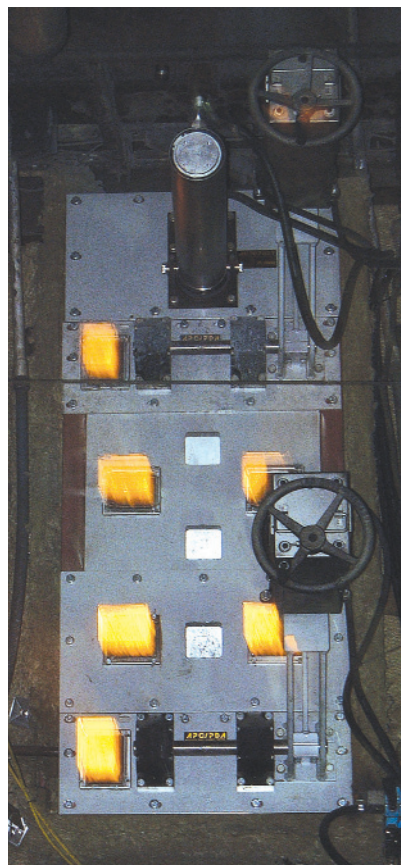
This system included multi-level secondary and multi-level tertiary air port openings, each arranged to support the mixing momentum generated from the ports below. CFD modeling indicated that the best potential solution was possible by simply changing the air port sizes and arrangements at the secondary and tertiary air levels. The existing FD and ID fan systems were more than sufficient and did not require replacement.

The design that combined the required mixing improvements with the best economy of investment was chosen and engineered. Anthony-Ross engineers developed a plan showing exactly where the new air ports would be cut. The components for the new air system were engineered at the supplier’s headquarters in Beaverton, OR, and then shipped to Riceboro for installation. An Anthony-Ross installation supervisor was on hand to oversee the crew who performed the installation, and an application engineer tuned the air system to optimize performance and then trained the boiler’s operators.

**FIGURE 4.**  
**Two air system configurations**



**Closeup of a single secondary air nozzle at Interstate Paper, Riceboro, GA**



**Immediate Results, Long-Term Benefits**

The boiler was down for fewer than eight days for the retrofit, and when it came back on-line, results were immediately apparent. Following startup, several physical tests verified the improved boiler performances. The first indication of improvement needed no tests to verify; the booming noises from the smelt spouts completely disappeared. The boiler came online with little noise, and the higher heat release in the lower furnace was evident by looking through the sight glasses at the primary/secondary elevation. The high heat release allowed a significant reduction in combustion air temperature by closing the low pressure steam coil air heater.

Further improvements developed as the first 12 weeks of operation unfolded. Perhaps most noteworthy was the reduction of operator and management time in correcting, and in some cases eliminating, the all too familiar problems

associated with poor combustion performances. In the first 12 weeks, the mill saw a 61% decrease in boiler downtime. After the first year of operation, much less maintenance was required in the superheaters during the boiler inspection. This resulted in a maintenance saving of more than \$80,000 during each annual outage.

Now, four years after installation, Interstate Paper continues to realize the long-term benefits of improved air combustion, which are estimated at \$1 million/yr. Longer runtime, increased load capacity, improved reduction efficiency, improved boiler efficiency, decreased emissions and increased operational stability all contribute to a healthier bottom line.

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