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ASH VOLUME REDUCTION AND BOILER EFFICIENCY IMPROVEMENT BY ASH REBURNING

by

Stanley J. Piekos, P.E.
DB Riley, Inc.
Worcester, Massachusetts

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DEUTSCHE BABCOCK
DB RILEY, INC.

Post Office Box 15040
Worcester, MA 01615-0040
http://www.dbriley.com

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Stanley J. Piekos, P.E.

Riley Stoker Corporation
Worcester, Massachusetts

ABSTRACT

The Riley Stoker ash reburn system was developed in response to a growing wood burning industry need for reduction of ash volume and more efficient carbon burnout. Riley's experience in wood and fuel burning, coupled with Customer feedback, indicated that improvements in traditional ash reinjection or overfire air systems would not yield the significant improvements that were now called for. Consequently a system was developed that utilizes an external ash reburn chamber looped in a parallel combustion path with the existing stoker.

The system that will be discussed in this paper comprises an ash reburn chamber, which is fed with ash from the existing ash handling system (modified to reroute ash to the chamber), inlet air ducting, outlet gas breeching, and controls to make up a complete package. Combustion air is taken from a separate combustion air fan located below the combustion chamber.

INTRODUCTION

Environmental pressures on the lumber and pulp and paper industry to conserve trees have led to increased costs for once abundant waste wood fuel. Simultaneous environmental pressures on limiting of landfill space have driven costs of landfilling boiler ash to new highs. These two factors combine for a new look at reducing both the ash volume and its carbon content by more efficient ash reburning.

This paper will discuss a new parallel combustion system to reduce ash volume by reburning. The system comprises inlet transfer conveyors, an ash reburn chamber, outlet conveyor, outlet breeching, and a separate combustion air fan to complete the system. Its bubbling bed, low velocity combustion is much more complete and efficient than the traditional cinder reinjection. System configuration, performance considerations, and economic factors will be discussed.

The first system of this type is has been designed and is being installed at the Fairhaven Power plant in Eureka, California. It is scheduled to be on line by mid-November, burning some twenty four(24) tons of wood ash per day.

DESCRIPTION OF ASH REBURN SYSTEM

The development of the current ash reburn system took some time, many versions of improving carbon burnout were considered.

- Improvements in a conventional cinder reinjection system were limited to optimizing the location of reinjection. At best, the benefits were marginal.
- Pulverizing the ash and burning it in a small burner was not practical.
- Mass burning the ash in the existing boiler front ash hopper, modified to accept the higher temperature, posed potential havoc with boiler combustion and emissions. The introduction of high velocity gas below the fuel distributors could potentially make boiler combustion uncontrollable.
- A parallel batch fed cell was much too labor intensive and required a potentially elaborate by-pass system.

A simple, parallel, continuous combustion system appeared to be most practical.

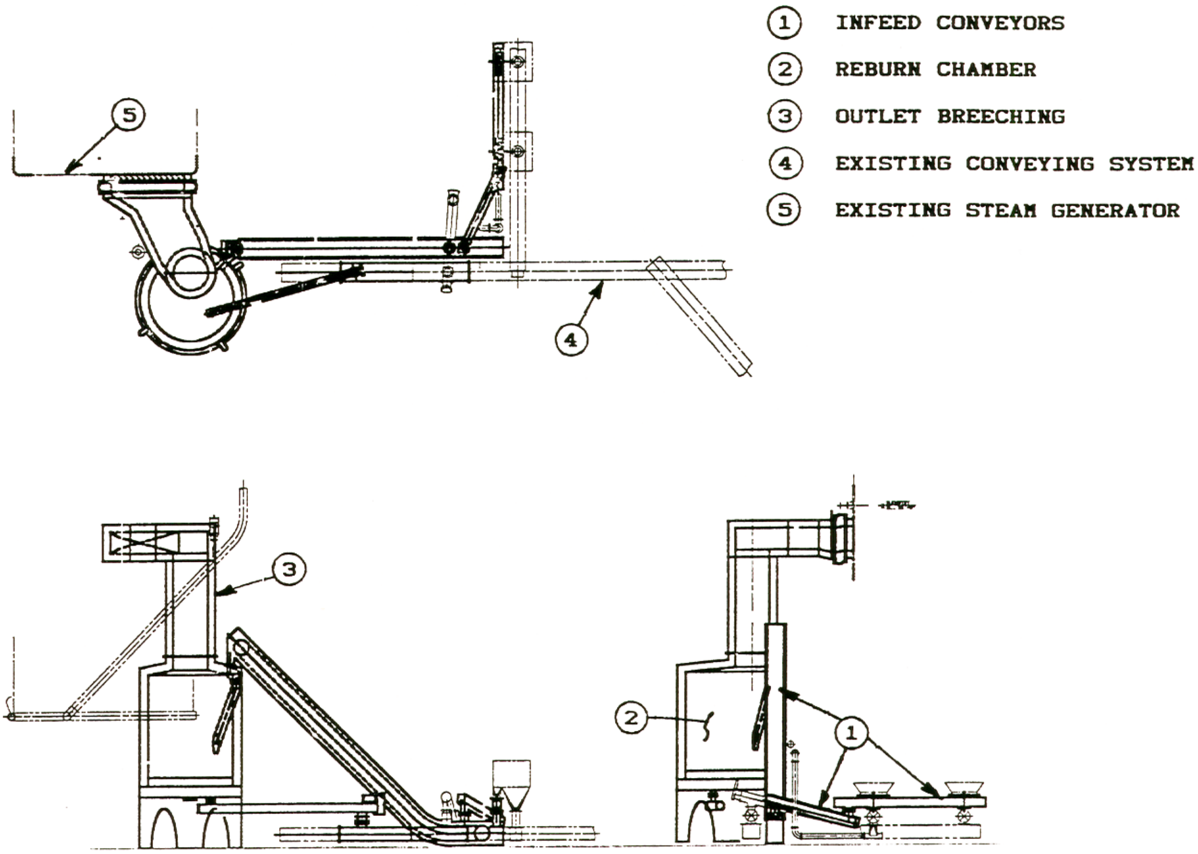

Figure 1 - ASH REBURN SYSTEM SCHEMATIC

The final wood ash reburn system described in this paper and shown in Figure 1 comprises:

- a series of conveyors to feed the fuel ash into the combustion chamber
- a bubbling bed combustion chamber
- an outlet flue into the steam generator
- an outlet deashing conveyor
- a seperate combustion air fan

The fuel feed conveyor system is designed to feed only the relatively high carbon and low density high volume ash from the dust collector and the airheater hopper. A typical ash analysis is shown in Figure 2. The relatively low carbon and high density baghouse ash continues to be funneled to the plant ash disposal system. The high silica, low carbon grate ash continues to be collected in the boiler front ash hopper, and is likewise funnelled to the plant ash disposal system. Future burning of both these ashes will be evaluated for potential additional economic paybacks.

#41,355 Ash Sample 03089-7-0473-01
#41,356 Ash Sample 03089-7-0473-02

Analysis	#41,355	#41,356
Total Moisture	63.9%	64.3%
Density (untamped)	9.6 #/cu ft	8.8 #/cu ft
Density (tamped)	13.1 #/cu ft	12.6 #/cu ft
* Loss on Ignition	60.5%	61.8%
* Ash	39.5%	38.2%
True Carbon	46.82%	47.96%

Ash Fusion	Oxid	Red	Oxid	Red
Initial Deformation	2125°F	2180°F	2180°F	2200°F
Softening Temp (H=W)	2150°F	2190°F	2200°F	2210°F
Softening Temp (H=1/2W)	2180°F	2200°F	2250°F	2215°F
Fluid Temp	2200°F	2210°F	2260°F	2220°F

* ASTM D-1102

	#41,355	#41,356
BTU	6,810	6,970
Sulfur	0.10%	0.06%

Figure 2 - TYPICAL FUEL ASH ANALYSIS

The ash reburn chamber, shown schematically in Figure 3, is a refractory lined bubbling bed combustor. The fuel is fed into it on a continuous basis through a rotary valve which acts as a positive chamber seal. Since there is no control of fuel quantities, the combustion chamber is conservatively designed to accommodate a wide swing in fuel ash flow. The bed area is designed for low gas velocity and maximum carbon burnout. Air is supplied from a separate fan through bubble caps located in the chamber bottom plate. Fuel bed temperature is controlled by increasing or decreasing the quantities of air in response to a temperature signal from the temperature sensor in the outlet flue. Air quantities are split into main combustion air and overfire air, which is modulated to control emissions. A differential pressure signal sensor monitors the bed height. Ash is drained intermittently through an outlet connection into a water cooled conveyor, then onto the existing main ash removal conveyor.

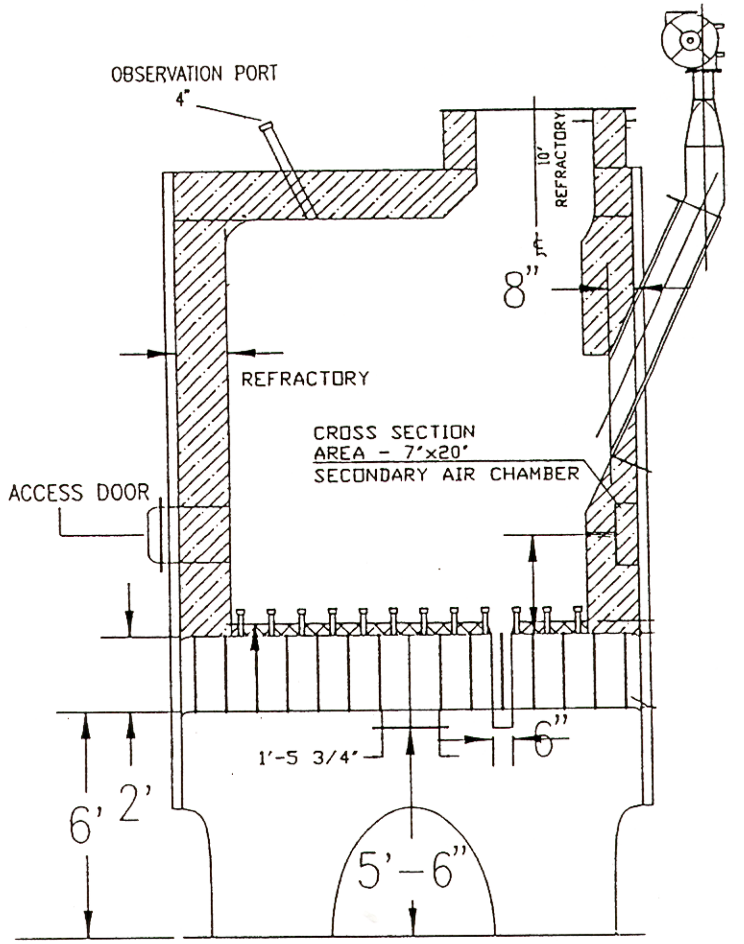

Figure 3 - ASH REBURN CHAMBER SCHEMATIC

The hot combustion gases exit the chamber through a refractory lined flue into the side of the furnace through an opening in the side waterwall. The opening was carefully designed for low velocity and a relatively spread out entry into the furnace. This is important for any number of practical reasons. Since the entry is from one side only, low velocity entry minimizes gas stratification and maintains an even furnace temperature profile.

The system also features several manual shutoff gates which isolate the new system from the existing cinder reinjection and ash disposal systems. Since the existing system was left virtually intact, reversion to the existing mode of operation can be made with minimum effort. This allows for a considerable amount of online maintenance, if necessary, and ready return to reburn operation. The system can be taken off line for up to two days without re-lighting.

PERFORMANCE CONSIDERATIONS

In addition to fuel conservation and landfill limitations, ever decreasing limits on emissions are of major concern to the lumber and pulp and paper industry. NOx and Co emissions, in particular, need to be reviewed carefully when designing new boilers as well as enhancements to existing boilers.

The selection of the various components were driven by both emissions and simplicity of operation considerations. The bubbling bed combustor with its low velocity, high burnout capacity, and separate fan with an overfire air system is ideally suited for good combustion and emission control. The furnace entrance design compliments the boiler's existing capacity to meet tight environmental emissions constraints.

Typical boiler performance predictions are shown in figure 4.

Predicted Performance Data

- Char and ash flow from airheater and dust collector hoppers

System Load	50%	Boiler 100% MCR	Max Design 125%
1. Char and ash flow lbs/hr	925	1850	2400
2. Excess air leaving chamber %	30	30	30
3. Combustion air flow lbs/hr	6600	13200	16840
4. Combustion air supply pressure iwc	12	12	12
5. Combustion air temperature °F	440	485	485
6. Flue gas flow produced lbs/hr	7050	14100	19240
7. Flue gas temperature leaving chamber °F	2000	2000	2000

Char and ash analysis: Loss of Ignition 60.5% by weight. Ash 39.5% by weight, True Carbon 46.82% by weight, HHV 6598 Btu/lb

Ash Fusion Data	Oxidizing	Reducing
Initial Deformation	2125	2180
Softening Temp. H = W	2150	2190
Softening Temp. H = ½ W	2180	2200
Fluid Temperature	2200	2210

Figure 4 - TYPICAL PERFORMANCE DATA

The continuous feed of the fuel into the chamber minimizes potential problems with a complicated control system. The simple measurement of temperature and pressure to dictate system control reduces the number of variables that need to be controlled. Combustion air flow and flow distribution are automatically controlled with minimum operator input. Preliminary review of a number of manual reburn efforts show that the reduction in carbon should be virtually complete. A sample ash analysis, shown in Figure 5, from a small reburn cell shows that the remaining carbon content in the ash is practically zero.

Analysis	
Loss on Ignition	0.3%
True Carbon	0.1%
Total Moisture	0.1%

Ash Fusion	Oxid	Red
Inital Deformation	2225°F	2210°F
Softening Temp (H=W)	2250°F	2225°F
Softening Temp (H=½W)	2260°F	2270°F
Fluid Temp	2270°F	2280°F

Figure 5 - TYPICAL ASH ANALYSIS (Leaving Reburn Cell)

CONTROLS

As shown in Figure 6, the controls for this system were designed for simplicity of operation and minimum operator input. The operation of the system can be done locally or from the main power plant control room. Since the fuel is reasonably uniform, the fuel flow is designed to be continuous and thereby minimize the number of controlled variables. The combustion process is controlled by measuring the chamber exit gas temperature and bed height then varying the amount of air and the underfire/overfire air split to control combustion and emissions.

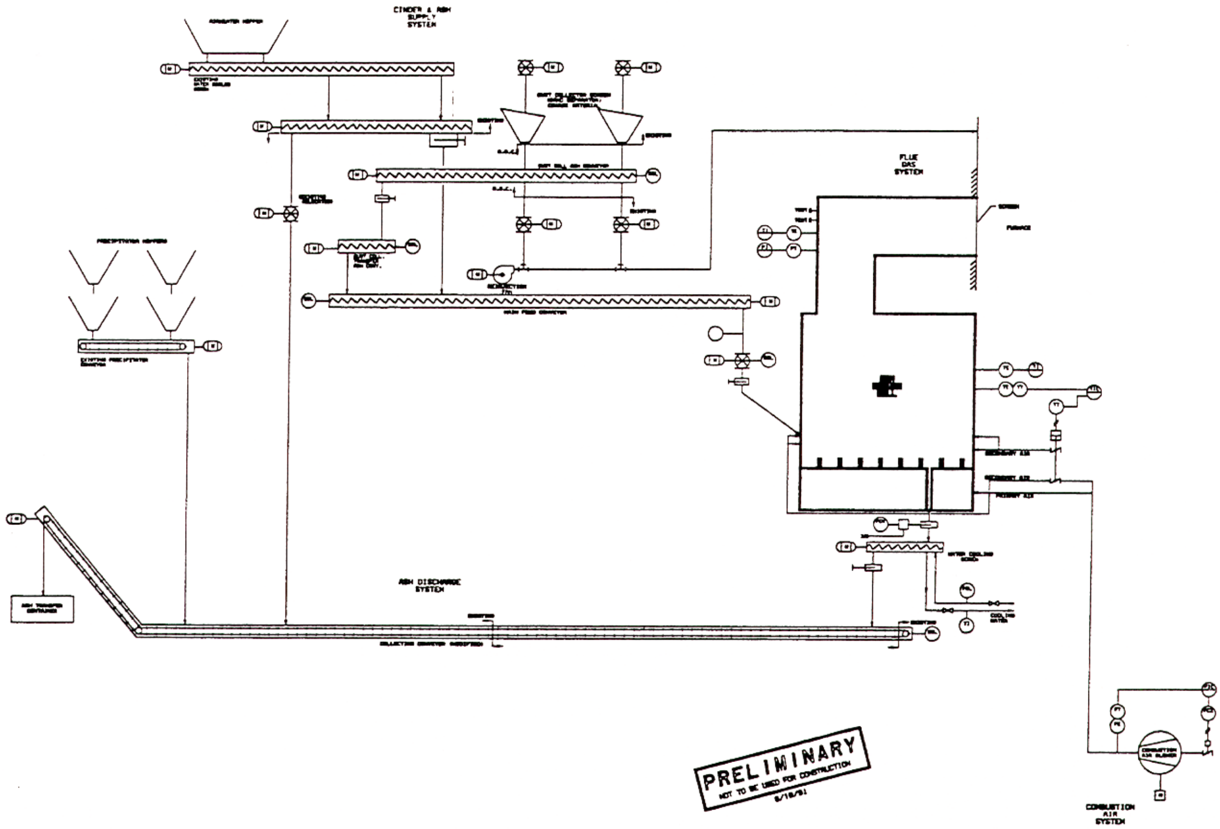

Figure 6 - TYPICAL SYSTEM P & I DIAGRAM

The fuel flow is monitored by a plugged chute sensor ahead of the rotary valve. The feed train then is designed to shut down from last indication of pluggage. If plugged, the system is reverted, manually, to non-reburn operation until the pluggage or equipment malfunction is corrected. On line monitors can be used to track temperature and pressure for early signs of equipment malfunction. Settings established during start up will be used as operation guidelines to minimize on line control system or operator compensation..

ECONOMIC CONSIDERATION

Since new boiler technology, new boiler design for emissions, and new boiler design for carbon burnout continue to advance at a rapid pace, this system is most practical and cost effective for existing, and more significantly, older wood fired units. The payback for justifying the addition of a reburn system will typically come from a combination of the need to reduce high carbon content and the need to reduce the quantity of low density, high volume ash; and practical space and arrangement limitations (which will dictate the number of conveyors required and their respective length).

As shown in Figure 7 and 8, the fuel payback is a function of the fuel cost and the boiler capacity, while the ash disposal cost is a function of ash disposal costs and unit capacity. The higher the carbon content of the ash, the greater the fuel savings payback. (These curves are intended to be general payback guidelines as they are based on a typical equipment arrangement.) Equipment costs are a function of the amount of equipment required to make the system functional, and can vary widely. The reburn chamber can vary in size depending on the quantity of ash and its carbon content. The conveyor number, length, and type will be dictated by the specific existing plant arrangement, space availability, and access constraints. The refractory lined flue size and configuration will be governed by access availability to the existing furnace, the quantity of reburn gas, and the availability of support steel. Specific payback must be analyzed on a case by case basis .

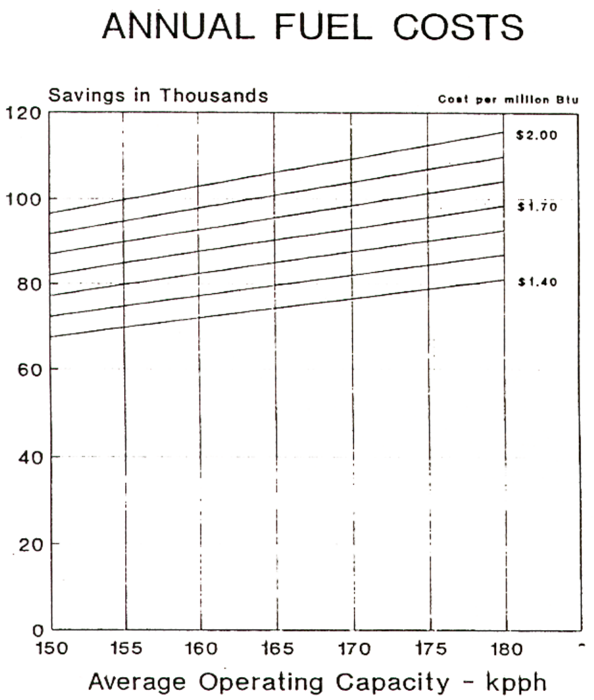

Figure 7 - TYPICAL FUEL PAYBACK

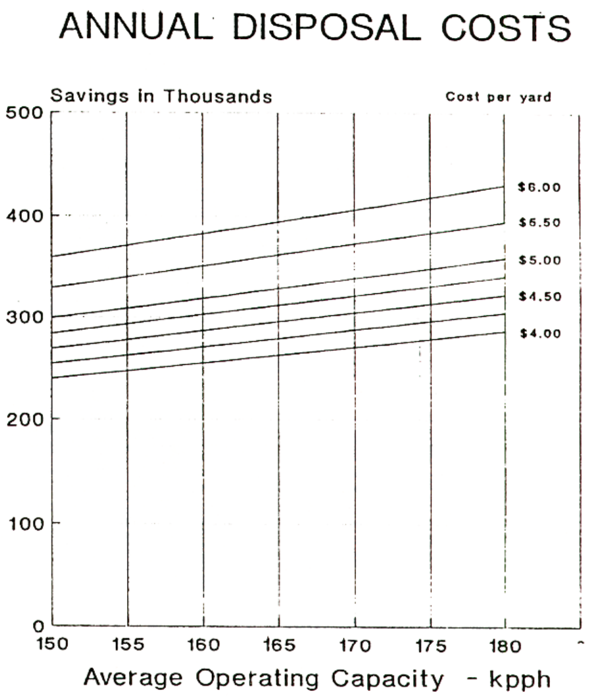

Figure 8 - TYPICAL ASH DISPOSAL PAYBACK

SUMMARY

The concept of reburning wood ash to conserve fuel and minimize ash disposal on a larger scale, is relatively new to the industry. Its payback installation and practical application is being reviewed on several fronts and will prove to be a cost effective application for existing boilers with high carbon content. The system described in this paper will be operational and evaluated before the end of this year. It will be instrumental in improving the quality of our environment as well as the economics of continuing to operate many of our older wood fired boilers within the upcoming future environmental constraints.