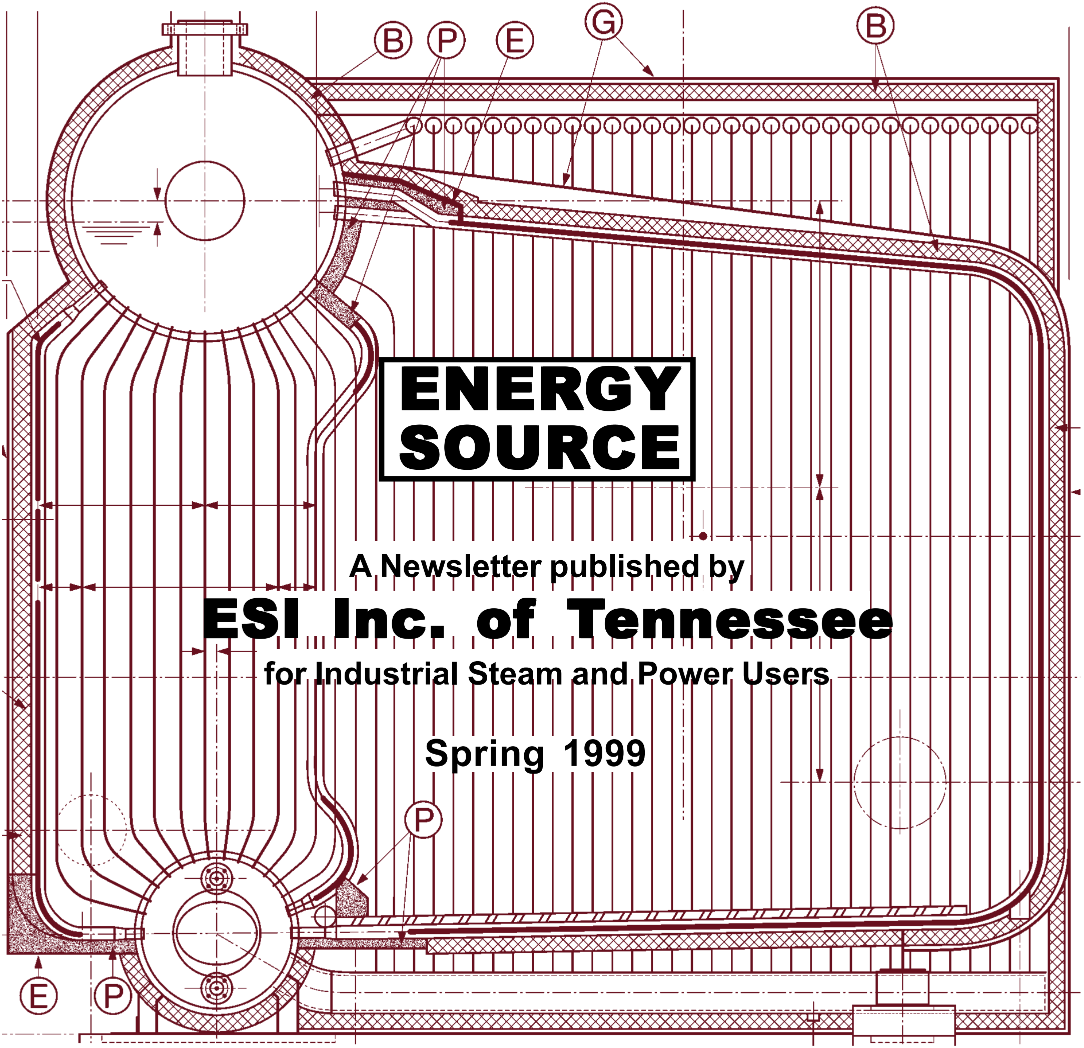

ENERGY SOURCE

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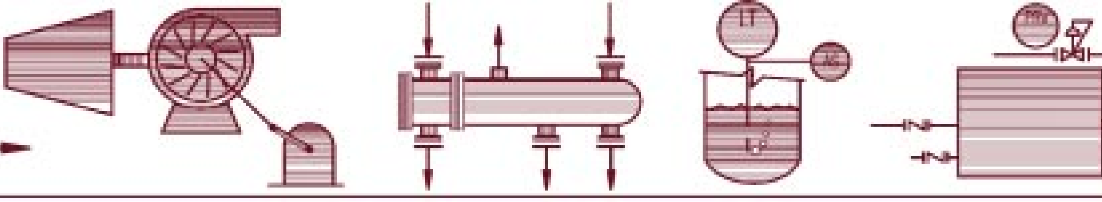

A Case Study: Fraser Papers Solves Sludge Problems

By: Brian E. Taylor, Project Manager, Fraser Papers, Inc.
Steve Frost, Project Manager, ESI

Introduction

Fraser Papers contacted ESI to perform a preliminary engineering evaluation for the installation of a bubbling fluidized bed boiler at their West Carrollton, Ohio Paper Mill. This preliminary evaluation evolved into an EPC contract for installing a complete sludge handling system and bubbling fluidized bed boiler fired with coal and paper mill sludge. The Fraser Papers West Carrollton Mill is comprised of a recycled pulp deinking operation, four paper machines, and a finishing plant which yields approximately one hundred dry tons per day of sludge.

The Problem

Fraser Papers was faced with the continual problem that all paper mills have to battle, what do you do with the sludge produced by your process? In today's climate of stricter environmental regulations and shrinking available landfill space, there is a need to find creative ways to dispose of paper mill sludge. Fraser Papers anticipated the critical need to reduce the amount of sludge that they were sending to a landfill day after day.

Technology Selection

To determine how to handle their "sludge problem", Fraser surveyed the industry to determine the best available technology for the task. This search resulted in the selection of the bubbling fluid bed boiler technology.

A bubbling fluidized bed boiler has many advantages when burning fuels with high ash and moisture contents such as paper mill sludge. First, it utilizes sand as a thermal heat sink in the bottom of the unit where the fuel is introduced. The sand is heated to over 1550°F. This hot mass evaporates the moisture and quickly ignites the fuel. Unlike a conventional grate-fired boiler, this heat sink allows the boiler to be very forgiving when fuel conditions change. Secondly, bubbling fluidized bed boilers are inherently low NOx and CO producers. This is true because combustion temperatures are much lower than that of conventional grate-fired boilers. Thirdly, bubbling fluid bed boilers have excellent fuel and air mixing due to the injection of high-pressure combustion air in the bed area. The result is low unburned carbon losses and high combustion efficiencies.

Previously, Fraser was utilizing coal to produce the majority of the steam from their existing boilers. The high heating value of coal would complement the relatively low heating value of the sludge; therefore, it was selected as the other primary fuel. In order to give the boiler the maximum flexibility, natural gas and #2 fuel oil start-up and load burners were installed.

The next step in the process was to determine the overall scope and cost of the project and to select the bubbling fluidized bed boiler manufacturer. ESI was selected to perform an initial engineering study resulting in a budget and scope which enabled the project to be funded. This study included obtaining and evaluating proposals from most of the major fluidized bed boiler manufacturers. For this project, Babcock and Wilcox was ultimately selected as the vendor of choice. A schematic of the bubbling fluidized bed boiler used at Fraser is shown in Figure 1.

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The Project

The project can best be described as a series of challenges which afforded all those involved ample opportunity for “creative thought”. A few of the more difficult challenges are discussed in this article.

Site Preparation

There were many challenges that were unique to the Fraser Papers site. First, there was not enough land available to build the facility in a new green field structure. Second, the process was spread out on either side of a main, active Conrail line. Third, the decision was made early in the project that the new boiler would have to be operated by the same personnel that were presently operating the existing boilers. These factors led to the decision to remove two antiquated existing coal-fired boilers and auxiliary equipment in order to make room for the new boiler. Consequently, great precautions and planning went into the construction process in order to keep the mill on-line. The construction schedule required that the roof of the boiler house be removed for four months during the late winter to allow for the construction of the new boiler in the building. Restrictions of the site caused ESI to utilize an 86-ton tower/gantry crane to set the equipment into the existing building. Figure 2 shows the crane setting the 48,000 pound steam drum sixty-five feet inside the existing building.

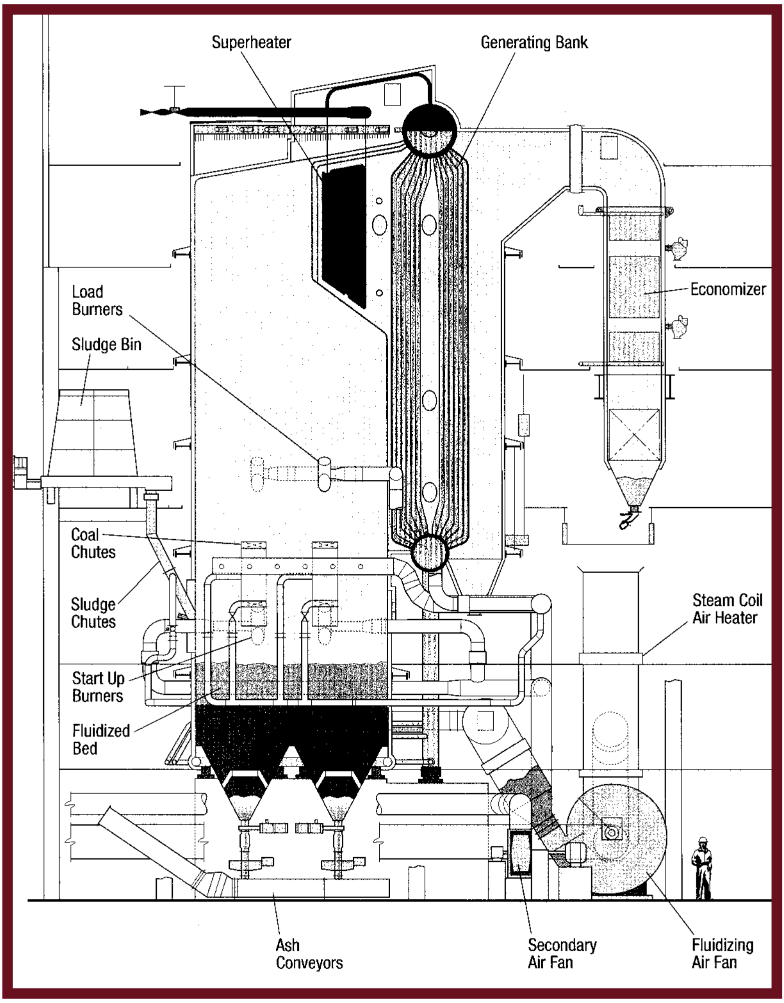


Figure 1. Bubbling Fluidized Bed Boiler Schematic.

Sludge Handling

Getting sludge to the boiler proved to be a project in itself. First, sludge is pumped over 600 feet from the wastewater treatment facility to the new dewatering plant. The dewatering plant consists of two Andritz screw presses capable of taking the sludge from 95% moisture down to less than 50% moisture. To enable the presses to perform properly, it is necessary to add polymer and flocculate the sludge. After the sludge is pressed, it is conveyed to the boiler through a series of stainless steel screws and drag chains.

Figure 2. Setting of the 48,000 pound steam drum utilizing an 86-ton tower/gantry crane.

Flue Gas/Ash Handling

Since Fraser is located in the heart of downtown West Carrollton, clean-up of air emissions is a sensitive issue. To accomplish this, the boiler is equipped with a baghouse which is recognized as one of the best technologies available for particulate clean-up. Even though the bubbling fluidized bed boiler is a low NOx producer, a Selective Non-Catalytic Reduction system which uses ammonia injection was added to further reduce the NOx emissions. The bubbling bed temperature control methodology is ideal for the calcination and sulfation scrubbing of sulfur dioxide (SO_2). The sorbent for SO_2 emissions control for the Fraser unit is provided by the calcium carbonate inherent to the sludge fuel.

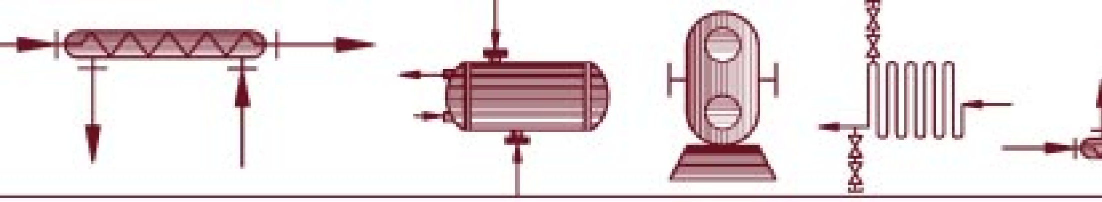
Problems were experienced with the ash handling system during the start-up of the boiler. Most of these problems were due to the physical behavior of the ash. Initially, the ash would not flow out of the baghouse hoppers into the pneumatic conveying system without a larger than normal amount of aeration. If the ash remained in the hoppers for any prolonged duration, the baghouse hoppers would bridge. To solve this problem, multiple air cannons were installed on each baghouse hopper. After this installation, all the ash conveying problems were alleviated.

Controls and Instrumentation

While the bubbling fluidized bed boiler itself is a relatively simple device, the control of the various fuel preparation systems, fuel metering and conveying systems, and emission controls systems is quite complex. To perform this task, a new generation distributed control system located in the old boiler house was selected. The control system allows the operators to monitor all the new equipment spread out over the ten-acre site. ESI set up the system to handle the numerous variations in sludge flow, sludge moisture, and auxiliary fuels, while maintaining compliance with the emissions standards.

Conclusion

The boiler and all the associated equipment were started up in the fall of 1998. The boiler project has been quite a success, with Fraser Papers currently burning all the paper mill sludge they produce. This has resulted in a positive impact to Fraser financially due to the reduction in landfill cost. It has also become a positive for the community since Fraser has reduced its environmental emissions, and significantly reduced its landfill contribution. This spring, all performance and EPA compliance testing will be performed.



How Clean Is Your Steam?

By: Jack Brown, Mechanical Engineering Manager, ESI

How clean is your steam? If you know your boiler plant's steam quality and steam purity, then you already have the answer to this question. However, do you know what causes and effects are involved with these steam characteristics?

First, let's define these parameters.

Steam quality is a measure of the amount of free moisture being carried by the steam.

Steam purity is the measure of solid, liquid, or vapor steam contamination.

Obviously, the impurities in the steam at the boiler outlet have to come from the boiler water. Therefore, the amount of impurities in the steam is related to and limited by the amount of impurities in the boiler water. Impurities that are contained in the steam are the result of carryover. There are basically two types of carryover: mechanical and vaporous.

Mechanical carryover involves the entrainment of small boiler water droplets in the steam. These droplets have the same solids concentration as the boiler water. Therefore, the amount of impurities in the steam contributed by mechanical carryover is the product of the boiler water impurities times the steam moisture content. Factors related to the boiler which affect mechanical carryover are: design generating rate, design pressure, arrangement of riser tubes and downcomer tubes, circulation rate, and the type and condition of mechanical moisture separation equipment. The design generating rate is associated with steam drum water surface area (drum size). A drum that is too small for the designated generating rate will be so turbulent that moisture carryover will occur. Design pressure is also a factor related to drum size and turbulence (steam density and volume change). Proper design and arrangement of riser tubes, downcomer tubes, and internal baffles, along with the appropriate circulation rate are essential to insure predictable circulation patterns which result in a stable and consistent water level. ESI has recorded front-to-back steam drum water level variations of 16" when these items were not appropriately designed. Moisture separation equipment will vary depending on operating conditions and the required steam quality. It can be as simple as a wet pan at the boiler outlet, or can incorporate multiple separators and baffles. Obviously, these devices must be kept in good condition to operate properly.

Vaporous carryover is self-explanatory since it is the contamination of steam with vapors. These are normally the vapors of boiler water salts and typically occur only in the higher pressure-temperature boilers. This type of carryover can be difficult to control. The most straightforward approach is to lower the solids concentration in the boiler water.

The ABMA maximum recommended total solids concentration (in boiler water) to the boiler operating pressure is presented in Table I. Operation of the boiler below these limits should eliminate foaming and the associated high carryover rate except under conditions of high boiler water alkalinity when foaming might occur at a lower level.

Equipment and operating problems associated with carryover include deposits in or on: (1) nonreturn and stop valves, (2) control valves, (3) turbine blades, (4) turbine governor valves, (5) superheaters and other downstream systems and components. Turbine blade deposit efficiency losses alone can be as high as 5%, and deposits on valves often cause sticking or erratic motion.

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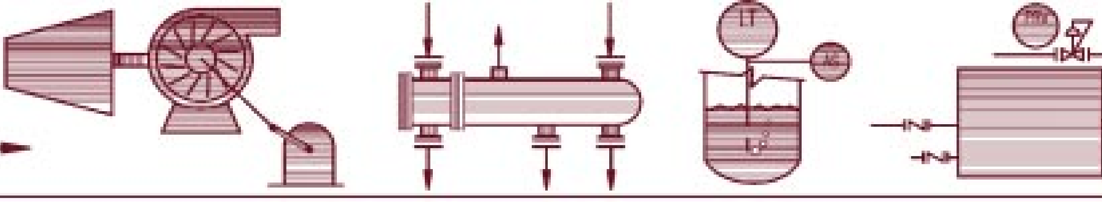


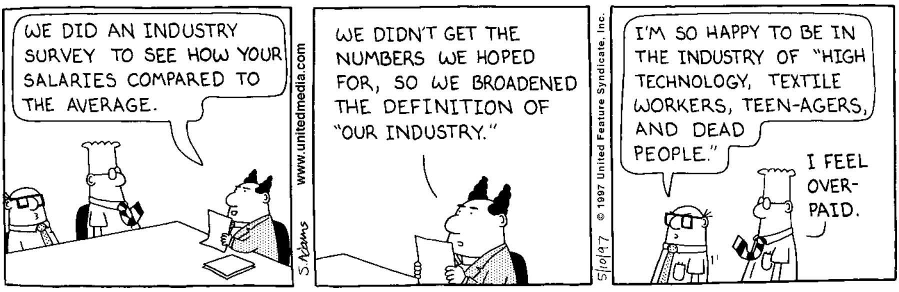
Test methods for quality and purity are defined in ASME Performance Test Code 19.11 and most commonly include: (1) sodium tracer, (2) electrical conductivity (for dissolved solids), (3) throttling calorimeter (direct determination of quality), and (4) gravimetric (for total solids).

Table I. ABMA Maximum Recommended Concentration Limits in the Water of an Operating Boiler

DRUM OPERATING PRESSURE (PSIG)	TOTAL DISSOLVED SOLIDS (PPM)	TOTAL ALKALINITY (PPM)	SILICA (PPM SiO_2)	TOTAL SUSPENDED SOLIDS (PPM)
0-300	3500	700	150	15
301-450	3000	600	90	10
451-600	2500	500	40	8
601-750	1000	200	30	3
751-900	750	150	20	2
901-1000	625	125	8	1

Every plant should assess their system requirements regarding steam quality and purity. With a properly selected and designed boiler that is properly operated and maintained, these levels should be attainable throughout the life of the unit. Your plant water treatment specialists (chemical supplier) should be able to answer more specific questions about your facility.

This article was written in response to a question by Gary Myers, Utilities Superintendent at Bayer Corporation in Orange, Texas. If you have any technical questions that you would like addressed in the *ENERGY SOURCE*, please contact Deanna Melvin at 770/427-6200 or through e-mail at energysource@esitenn.com.



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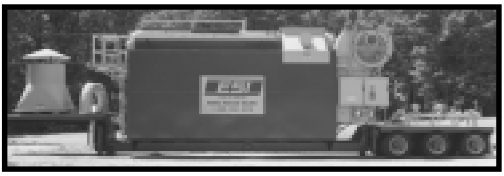

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