Fuel Tech's Comprehensive Fireside Slag and Fouling Control Programs for Wood and Biomass Fired Boilers

Introduction

Wood and biomass (agri-waste) fired boilers burn a mixture of fuels that are often prone to slag and fouling problems. Typical fuel combinations are waste wood and #6 oil, tire derived fuel (TDF) or paper-making sludge. Fuel combinations such as these, as well as pure agri-waste, contain low melting point ash compounds that travel through the furnace in a molten state, and quickly freeze/harden after contacting cooler tube surfaces. This results in tenacious and difficult to remove slag deposits. As the deposits grow, they can cause the following problems:

- loss of heat transfer as indicated by falling superheater steam temperatures and increasing stack temperatures
- increased fuel usage to maintain steam temperatures
- restricted air flows leading to increasing draft losses, gas velocities, tube erosion, and eventual tube failure
- formation of large clinkers that fall and damage boiler grates

These problems frequently lead to unscheduled boiler outages for cleanings and increased tube replacement due to erosion and under-deposit corrosion. Fuels are sometimes switched to non-slagging fuels, but often these fuels have a much higher cost. The best alternative is a Fuel Tech FUEL CHEM® treatment program.

FUEL CHEM® Program Description

Fuel Tech reduces or eliminates fireside slagging, fouling, and erosion problems with its comprehensive FUEL CHEM® treatment programs.

Figure 1: *Conventional Treatment*

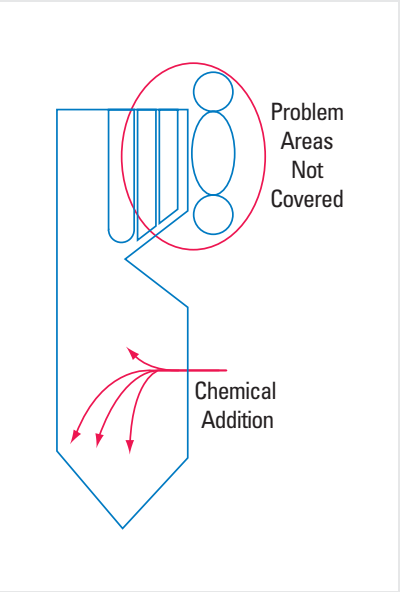
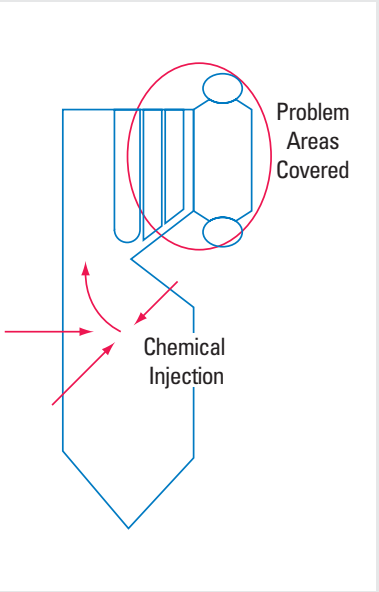


Figure 2: *Targeted In-Furnace Injection*



FUEL TECH®
Technology for a renewed environment™

FUEL CHEM® programs include:

- Problem analysis
- Computational Fluid Dynamics (CFD) Computer Modeling
- Process Design
- Customized Equipment
- Project Engineering
- Application Specific Reagent
- An On-Going Service Program to Insure the Program's Long-Term Performance

Conventional Fuel Treatment Programs versus FUEL CHEM® Targeted In-Furnace Injection Programs

Conventional fuel treatment programs attempt to reduce slagging and fouling by spraying liquid or dry chemicals onto the fuel or grate, or blowing dry chemical randomly into the boiler.

As illustrated in Figure 1, the problem areas receive minimal treatment. These conventional programs rarely achieve their performance objectives, and as a result are often uneconomical.

FUEL CHEM® "Targeted In-Furnace Injection" programs driven by CFD computer models, spray liquid reagent directly into the furnace gases, targeting the problem areas. As Figure 2 illustrates, FUEL CHEM® programs result in maximum problem area coverage, excellent program performance, and economics that yield a return on investment.

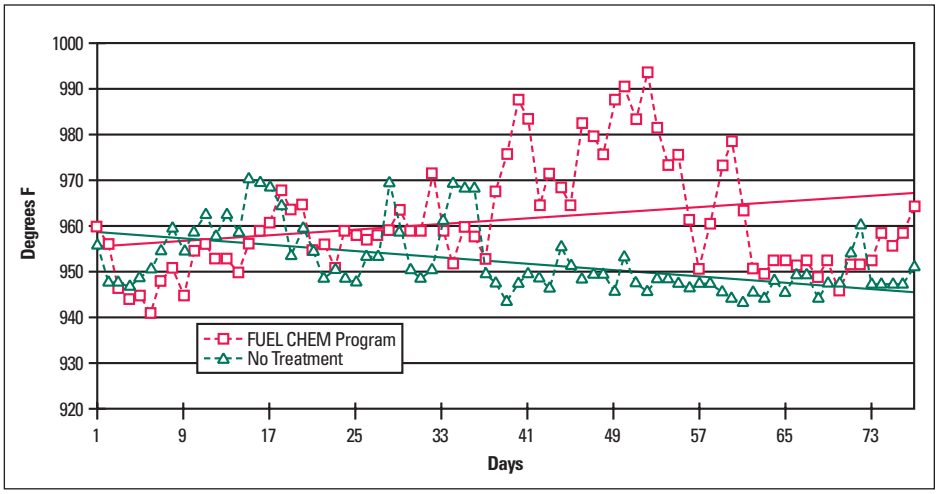
After gaining a thorough understanding of the customer's fireside problems and goals, the FUEL CHEM® team begins the problem analysis phase. Unit operational data are collected for the CFD computer model inputs. This data, combined with unit mapping information locating the slag problem areas, enables the model to develop potential injection locations and reagent injection characteristics. The FUEL CHEM® team uses this information to develop the process design, equipment specifications and layout, reagent demand, expected program performance and performance parameters, and the program's cost and resulting return on investment. The next step is a commercial application or demonstration.

FUEL CHEM® Program Demonstrations

The following are results from two wood waste-fired boiler demonstrations that were carried out after the above analyses; one a wood waste/TDF boiler, and the other on a wood waste/fuel oil boiler.
The first boiler produces 550,000 lb/hr of steam by burning 1,000 tons/day of wood waste and 35-50 tons/day of TDF. Although the slagging components that caused most of the operational problems were more prevalent in the TDF, it would have cost approximately $450,000/year to replace the TDF's higher BTU value (with wood waste). The FUEL CHEM® program allowed the plant to burn this optimum fuel mix and save hundreds of thousands of dollars in fuel costs. The goal of the FUEL CHEM® program was to inhibit slag formation while burning the TDF, maintain the unit's heat transfer capability, and keep the boiler on-line.

Data was analyzed for a six month period prior to treatment to establish the baseline operation conditions. In this untreated phase, slag build-up on tube surfaces inhibited heat transfer while fouled gas passes increased draft losses, ID fan speeds and flue gas velocity. During this untreated run, the average superheater steam temperature was 930°F, and dropped to 895°F by the end of the run. With the FUEL CHEM® program, the superheater temperature was able to be maintained at or above 950°F. Figure 3 compares the superheater temperature for the first 75 days of both the FUEL CHEM® program and the baseline, untreated run. The regression lines clearly show the difference in the temperature trend. The 20° F average temperature

Figure 3: *Superheater Temperature Regression Comparison*

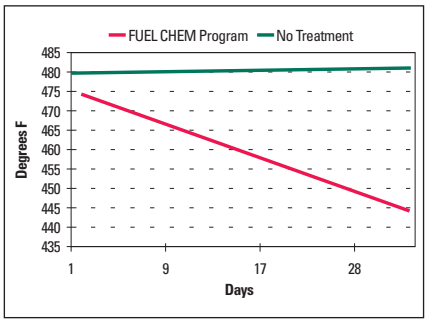


difference represents a significant BTU loss. It has been estimated to cost over $300,000 to replace these lost BTU's with an alternative energy source such as natural gas.

Table 1 shows significant improvements in several variables that indicate how the unit's slagging and fouling were controlled during the FUEL CHEM® program. During the untreated run, high gas velocities through the superheater and generating bank led to serious tube erosion and the replacement of eight tubes. The drop in draft loses (see Table 1) indicates much cleaner gas passes and lower gas velocities, thus reducing the risk and expense of tube erosion and replacement. Boiler inspections conformed these results and revealed minimal amounts of slag in the generating section with clear gas passes and no bridging.

The second unit was a wood waste boiler that burned approximately 400 tons of hog fuel and 99,000 gallons of #6 oil per day. This unit had been experiencing loss of superheater temperature and increasing stack temperature, which would eventually lead to a unit shutdown. This FUEL CHEM® program began on a dirty unit that had been undergoing a trial of a conventional chemical program. This program was unsuccessful, but the FUEL CHEM® Targeted In-Furnace Injection program actually helped remove built-up slag and reversed the trends of this previous program. Upon inspection, shift operators commented on the cleanliness of the fireside and the ease of the water wash after the FUEL CHEM® program. There were no large clinkers or slag debris that were normally present after untreated runs or conventional programs.

***Figure 4**: Stack Temperature Regressions*



The lines in Figure 4 are regressions of stack temperature data taken from the plant's DCS system - one for the FUEL CHEM® program and one for the untreated baseline condition. During both periods, the gross heat input (GHI) as calculated from the contribution of both fuels, was equal. The time period shown for the untreated condition was the last 30 days of that run. The FUEL CHEM® program data starts immediately thereafter, again lasts for 30 days, and shows a substantial decrease in stack temperature. This data is reinforced by boiler efficiency calculations (steam heat in mmBTU/day divided by GHI) that show rising efficiency during the treatment period, which is expected since more heat is being transferred to the steam instead of being lost out the stack. The increased heat transfer and unit efficiency lead to lower fuel costs and increased unit availability.

Other Fuel Tech Programs

Fuel Tech also offers FUEL CHEM® programs to reduce the effects of slag and corrosion on black liquor recovery boilers and municipal waste combustors, as well as programs for biomass and hazardous waste units. Other programs include plume abatement, NO_X, SO_X, and HCl stack emissions reduction, and a host of other preflame and fireside problem prevention programs.

Table 1

	Untreated Baseline	FUEL CHEM Program	Percent Reduction
Superheater Draft Loss (Inches H_2O)	0.0966	0.0737	23%
Gen Bank Draft Loss (Inches H_2O)	1.186	0.678	43%
ID Fan (rpm)	699	583	17%

For more information, call, fax, or write us at:

Fuel Tech, Inc. • 512 Kingsland Drive • Batavia, IL 60510
Phone 800.666.9688 • 630.845.4500 • Fax 630.845.4501
www.fueltechnv.com • webmaster@fueltechnv.com

FUEL TECH®
Technology for a renewed environment™

FT9116-FC