Saving Boiler Fuel

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On average, approximately 75% of the operational costs for a boiler is fuel cost, as shown in Figure 1. Water management, sewer, and water respectively rank a far distant 5th, 6th, and 7th on this list, totaling a mere 4.25% of operating costs. This "mere 4.25%" can have a respectable impact on the boiler fuel costs.

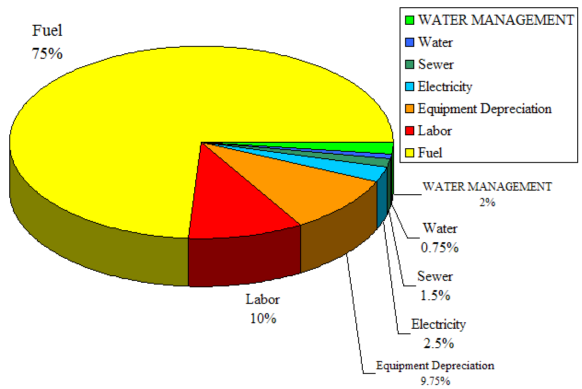

Figure 1: Boiler System Operation Costs

How can water management reduce fuel costs? There are multiple ways, including:

- Maximize cycles of concentration
  - Improve boiler makeup quality
  - Improve condensate return
- Improve blowdown control
- Install economizers
- Install blowdown heat recovery equipment

Case Study

Consider the example of a 100,000 lb/hr natural gas boiler running at 20 cycles of concentration, 70% efficiency, 50% condensate return, and soft water makeup. How would each fuel saving category listed above affect this system? We will answer this question in the following sections.

Maximize Cycles of Concentration

By maximizing the cycles of concentration (cycles) that a boiler can operate, makeup and blowdown requirements are reduced. This not only saves water, but also directly saves fuel. With less makeup, less water has to be heated up to the 366°F system temperature. With less blowdown, less water and subsequently less heat is sent down the drain.

Let's consider the fuel savings benefits a reverse osmosis system (RO) would have on the system. With higher quality makeup water, the boiler will be able to run higher cycles. RO's can produce high quality water. The American Institute of Mechanical Engineers boiler water guidelines recommend a maximum of 100 cycles. To be conservative, let's assume the boiler can be increased from 20 cycles to 90 cycles. This would save 11,434,000,000 BTU/year in fuel consumption. The overall boiler efficiency in turning fuel into steam would increase from 70% to 70.8%. The maximum efficiency possible out of the boiler if the blowdown requirements were 0 gpm, which is impossible, and all other parameters are left the same, is 71%. With natural gas prices at $7.00/MCF, this equates to $129,500/year savings when the new efficiency is factored in. (Analysts predict that natural gas prices could increase to $10-$15/MCF this winter. At an average of $12.50/MCF, the savings increase to $231,200/year.) Such savings can make the Return on Investment for an RO very short. This is only fuel savings and does not take into account actual water, sewer, and chemical savings.

Increasing the amount of condensate returned to the boiler will reduce makeup, blowdown, chemical usage, and fuel consumption and increase the cycles of concentration. If we increase the condensate return in this example from 50% to 75% and use RO for pretreatment, the boiler system would save 84,122,000,000 BTU/year in fuel consumption. The overall boiler efficiency would increase from 70% to 76%. With natural gas prices at $7.00/MCF, this equates to $162,700/year savings when the new efficiency is factored in. (At $12.50/MCF, this savings is $290,500/year.)

Crown Two-Station Blowdown Controller with Sample Coolers

Crown Series 86
Reverse Osmosis System

Improve Blowdown Control

Boilers are dynamic machines with swinging steam loads and changing parameters. Maintaining the water quality at the proper cycles of concentration can be a labor-intensive process. Automatic blowdown control can be a real money saving process. If the boiler is manually controlled at an average conductivity below the setpoint, then money is being wasted with increased blowdown, chemical usage, makeup, and fuel consumption.

Consider the example we've been evaluating. The boiler is being manually controlled at an average of 20 cycles. What if this boiler could actually be run at 22 cycles, but the best the operators can do manually was 20. Installing an automatic blowdown controller to control the cycles at 22 would save $6,900/year at $7/MCF (and $12,400 at $12.50/MCF). The boiler efficiency would be increased by 0.05%.

Install Economizers

Not all the heat energy from the combusted fuel is absorbed by the water in the boiler itself. Some of the energy is lost out the stack. An economizer allows some of this otherwise lost energy to be recovered by using a heat exchanger located on the stack to heat boiler feedwater. For every 40° to 50°F drop in stack temperature, a 1% gain in boiler efficiency is realized. Manufacturers claim an economizer can often reduce fuel requirements by 5 to 10%. Continuing our example of RO pretreatment, 75% condensate return, and 90 cycles, installing an economizer to achieve 5% fuel savings could save an additional $400,000/year at $7.00/MCF (and $718,700 at $12.50/MCF). Also, using 5% less fuel increases the overall boiler efficiency to 80%.

Table 1: Case Study of Boiler Fuel Savings

Description	Annual Savings @ $7.00/MCF Natural Gas	Annual Savings @ $12.50/MCF Natural Gas
Maximize Cycles:		
Reverse Osmosis	$129,500	$231,200
Increase Condensate Return	$162,700	$290,500
Improve Blowdown Control	$6,900	$12,400
Install Economizers	$400,000	$718,700
Install Blowdown Heat Recover Equipment	$21,700	$38,800
Total	**$720,800**	**$1,291,600**

Install Blowdown Heat Recovery Equipment

Even at the 90 cycles in our example, a boiler has some blowdown to control dissolved solids. This blowdown contains a significant amount of heat energy that can be recovered. A blowdown flash tank allows the high-pressure blowdown to flash to a lower pressure steam that can be used as a steam source to the deaerator. Once the blowdown passes through the flash tank, more energy can be recovered from the remaining liquid with a heat exchanger to preheat the makeup water. Typically, 80% of the waste heat in blowdown can be recovered with such a flash steam heat exchange system. Continuing our example with RO pretreatment, 75% condensate return, 90 cycles, and an economizer, a blowdown heat recovery system would save $21,700/year and infinitesimally increase the boiler efficiency. At $12.50/MCF, the savings increase to $38,800. (If we run this calculation under the original example conditions without the other improvements, this savings are $116,300/year with a 1% efficiency improvement.)

Conclusions

Even though the water aspect of boiler operations only comprises a "mere 4.25%" of the total operating costs, it can have a large impact on the fuel costs of a boiler. Concluding our example with a 100,000 lb/hr boiler now running at 90 cycles with automatic blowdown control, 75% condensate return, RO pretreatment, an economizer, a blowdown heat recovery system, and 80% overall boiler efficiency, an estimated total of $720,800/year can be saved at a natural gas price of $7.00/MCF. At a natural gas price of $12.50/MCF, the savings increase to $1,291,600/year. **This is an 8% decrease in the original fuel costs.** Not too bad for a category that only comprises a "mere 4.25%" of the total operating costs.

This article only examines the **fuel savings** that can be realized with improved water management. It does not include the water, sewer, and chemical savings. It also does not cover the non-water-related efficiency concepts of burner performance, combustion efficiency, combustion air preheating, etc.

The savings estimated in the example were cumulative and based upon the operating parameters stated. Each improvement implemented will affect the savings realized by the other improvements. When evaluated alone, each improvement concept would likely have an even bigger individual savings than calculated in this article. Please contact your local Water Management professional for advice and help in calculating savings.

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