Replace Obsolete Burners with More Efficient Ones (Arc 2.1221)

(The analysis below was extracted from one of the assessment reports by the Clemson University Industrial Assessment Center (IAC). This is only an example recommendation and hence, not all the background information and sources for numbers are included here.)

Est. Energy Savings	= ***12,355.8 MMBtu/yr***
Est. Total Cost Savings	= ***$66,598/yr***
Est. Implementation Cost	= ***$22,500***
Simple Payback Period	= ***4 months***

Recommended Action:
It is recommended to replace the existing obsolete and low-efficiency burner with a new high-efficiency burner to reduce the boiler fuel use and energy consumption.

Background:
The facility currently owns three individual boilers all running continuously. Two Cleaver Brooks steam fueled boiler, and a Carotek oil fueled boiler. According to operations management, these boilers operate at 76% efficiency with a firing rate of 35%. Boiler replacement cost can range from at least $100,000 and above, making it a challenge for most facilities and plants that rely on boiler systems. The best option in such cases is to consider retrofits by replacing the current burner with a highly efficient burner, in the Carotek boiler's case. The burner is the true driver of fuel use and costs in boilers. A report from the DOE's Energy Efficiency and Renewable Energy Division (EERE) indicates [1], "The purpose of the burner is to mix molecules of fuel with molecules of air. A boiler will run only as well as the burner performs. A poorly designed boiler with an efficient burner may perform better than a well-designed boiler with a poor burner. Burners are designed to maximize combustion efficiency while minimizing the release of emissions." Given the provided information we recommend installing a smaller burner, with improved turndown, higher combustion efficiency, lower emissions, and precise control capability. In 2017, the plant spent $173.465 on Natural Gas, with a utility rate of $5.39/MMBtu. The plant further spent $72,344 on DFTO and $283,110 on landfill gas.

Anticipated Savings:
The result of the boiler combustion test conducted on the assessment day is presented in Figure 1 below. The gas-fired combustion efficiency of the boiler is 76%. According to some studies carried out by DOE for burner replacement in pulp and paper industries, installing an energy-efficient burner would typically improve the combustion efficiency between 1% and 3% [2]. Given the conditions of the boiler and burner in our case, we assume an efficiency improvement of 3% is easily attainable by replacing a high-efficiency burner.

O2	6.2 %
Eff	76 %
T-Stk	555 F
T-Air	75 F
Firing Rate	35 %

Figure 1. Combustion test results for the boiler

Average annual energy consumption of the boiler, *AEC*, can be determined as follows:

$$AEC = \text{Heat input (MMBtu/h)} \times \text{Steam Load (\%)} \times \text{Operational hours}$$

$$\boldsymbol{AEC = 52.505\ MMBtu/h \times 50\ \% \times 6240\ h = 163{,}814\ MMBtu}$$

According to the DOE sourcebook for Steam System Performance [3], we can estimate the amount of energy saving due to efficiency improvement from burner replacement, AES, as follows:

$$AES = AEC \times (1 - Eff_{old}/Eff_{new})$$

$$\boldsymbol{AES = 163{,}814\ MMBtu \times (1 - 0.760/.822) = 12{,}355.8\ MMBtu}$$

Finally, the estimated annual energy cost saving, *AECS*, can be determined based on the unit energy consumption charge for natural gas:

$$AECS = AES \times (\$5.39/MMBtu)$$

$$\boldsymbol{AECS = 12{,}355.8\ MMBtu \times (\$5.39/MMBtu) = \$66{,}597.80}$$

<u>Implementation Cost</u>:

Most of the older boilers can be retrofitted with new burners costing at most $50k, but to get an exact estimation of retrofit costs a comprehensive feasibility study should be done. We recommend consulting with some of the following companies that are actively involved with burner replacement solutions in industry: *PBBS Equipment & Corporation*, *Weishaupt*, *Cleaver Brooks*, *CB-Profire,* and *Limpsfield*. Based on some gatherings from abovementioned companies we estimate that boiler retrofit costs due to burner replacement would be between $15,000 and $30,000. Therefore, the implementation cost, *IC¸* would be approximately $22,500.

Implementation Cost (IC) = $22,500

Simple Payback Period:

The *simple payback period, SPP*, is the time required to pass before the estimated total cost savings equal the estimated implementation cost, and is calculated by:

$$SPP = \frac{IC}{AECS} \times \text{ 12 months/yr.}$$

$$SPP = \frac{\$22{,}500}{\$66{,}597.80} \times \text{ 12 months/yr.}$$

SPP = 4 months

References:

1. USDOE. ADVANCED MANUFACTURING PROGRAM. 2012; Available from: https://energy.gov/sites/prod/files/2014/05/f16/steam3_recovery.pdf.
2. OFFICE, U.A.M., Upgrade Boilers with Energy-Efficient Burners. 2017;
3. U.S. Department of Energy, A.M.O., Improving Steam System Performance: A Sourcebook for Industry. 2017.