



Greater efficiency supports patient care.

Boiler Combustion Analysis

All ECM content was independently developed and reviewed to be vendor-, product-, and service provider-neutral.

Description

Performing a combustion analysis on a boiler can help determine whether it is running at optimum efficiency. Making boiler combustion analysis part of a facility's preventive maintenance/continuous commissioning program will result in a low cost/no cost way to save energy.

Project Talking Points

- A boiler's efficiency is largely determined by the combustion process. Combustion requires oxygen, a fuel and an ignition source in certain ratios.
- The boiler can operate at a relatively wide range of ratios, but it will either burn too much fuel (rich) or with too much oxygen (lean), which will result in a decline in efficiency of the boiler system.
- Most boilers are designed to supply between 12 and 15 parts of air for each part of gas (10 is "ideal" for combustion but unsafe to operate).
- Advanced control strategies can actively "trim" the amount of oxygen to optimize combustion.

Triple Bottom Line Benefits

- **Cost benefits:** Optimizing boiler combustion will result in decreased energy use and avoided utility costs.
- **Environmental benefits:** Boilers running "rich" (too much fuel) will have increased emissions and decreased efficiency. Fixing this issue will result in fewer greenhouse gases and a lower carbon footprint
- **Social benefits:** Boilers with improper air to fuel ratios can be dangerous, a regular combustion analysis will prevent any danger to occupants

Purchasing Considerations

There may be controls upgrades necessary to execute some of the advanced strategies to optimize combustion. Be sure to have your controls contractor perform a payback analysis

How-To

1. Engage the members of the facilities team including the controls expert, boiler operator and mechanical contractor (if not performing analysis in house)
2. If this will be the first combustion analysis performed and you wish to track results, note the date of the changes to see the resulting energy savings.
3. Wait until the boiler is near full load so you can wait long enough (approximately 10 minutes) to get the proper readings before the boiler cycles off.
4. Depending on your boiler type, there are different procedures for completing the combustion analysis. [See this ACHR article](#) for step-by-step instructions.
5. Analyze the results of the combustion analysis to see if any adjustments need to be made to the air-fuel ratio (AFR). (take note of the CO (Carbon Monoxide) readings, as its presence will need to be addressed immediately)
 - Typical Readings:
 - Oxygen – depends on boiler type
 - Carbon Dioxide – between 8.5 and 10 percent
 - Carbon Monoxide – must be below 400 ppm “air free” (ideally below 150 ppm) measured as follows:
$$CO_{Air\ Free\ ppm} = \left(\frac{20.9}{20.9 - O_2} \right) \times CO_{Measured\ ppm}$$
 - Excess Air – between 20 and 50%
 - Draft – slightly negative (approximately -0.05 in wc)
6. Ensure boiler and controls are compatible before making any controls changes that could affect operation.

Tools

Several boiler and tool manufacturers have their own calculators.

Regulations, Codes and Standards, Policies

- [ANSI/AHRI Standard 1500](#) – 2015 Standard for Performance Rating of Commercial Space Heating Boilers
- [Department of Energy](#) - Energy Conservation Program for Appliance Standards: Energy Conservation Standards for Residential Furnaces and Commercial Water Heaters
- [ASHRAE Handbook](#) – HVAC Systems and Equipment - Boilers

ECM Synergies

- Practice Preventive Maintenance of Major HVAC Equipment
- Establish a Baseline for Current Energy Consumption

Educational Resources

- Bergmann, Jim; [Performing a Combustion Analysis](#). ACHR News, March 3rd, 2008
- Wohlfarth, Ray; [Tips for Combustion Analysis of Commercial Boilers](#). PM Mag, February 17th, 2016
- Wohlfarth, Ray; [Should you own a Combustion Analyzer?](#). PM Mag, September 1st, 2017
- Fey, Carol; [Combustion Analysis is Serious Business](#). Contractor Magazine, March 2nd, 2012
- Engineering Toolbox - [Combustion Efficiency and Excess Air](#)
- Energy University Course – [Boiler Types and Opportunities for Energy Efficiency](#)

ECM Descriptors

Energy

Category List:

- Building and Maintenance
- Commissioning
- HVAC
- Operations

ECM Attributes:

- Optimize Operations
- Repair or Optimize Existing Systems (fix what you have)

Improvement Type:

- Commission/Retro-Commission
- Retrofit/Renovations
- New Buildings
- Operations and Maintenance

Department:

- Engineering/Facilities Management

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