Dollars and Sense- Boiler and Process Heater Tuning as a Best Management Practice

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Presentation Objectives

- Why perform boiler and process heater tune ups?
- Background on Our Study
- MACT DDDDD Tune Up Requirements
- Tuning as a Best Management Practice
- Case Studies
- Limitations
- Key Takeaways

Why Perform Boiler & Process Heater Tune Ups?

- MACT DDDDD Compliance/HAP Reductions;
- Cost Savings;
- Emission Reduction Credits;
- Best Management Practices;
  - Aligns with Corporate Mission, Vision, and Values;
  - Safety, Environmental, and Sustainability Practices;
- Recommended by the U.S.D.O.E. as a means to improve process efficiency, equipment reliability, and safety;
- Simple payback can be realized in months.

Background

- Team has been compiling data from MACT DDDDD tune-ups since 2014;
- Over 650 boilers and process heaters tuned to date (583 evaluated in the current study);
- Data being used to calculate cost savings based on improvements in combustion efficiency as well as simple payback on services;
- Results give us a glimpse into the benefits of tuning as a best management practice, not just for regulatory compliance.

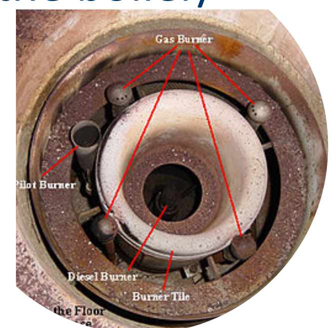
MACT DDDDD Tune-Up Requirements

Based on USDOE guidance which include:

- A visual inspection of the burner, burner assembly, air registers and fan louvres, and the main fuel control valve and header;
- A visual inspection of the flames, burner tiles, adjacent refractory, and process piping inside the boiler/heater;
- Measurement of CO, and NO_x concentrations in the flue gas effluent stream, in parts per million by volume dry (ppm_{vd}) and excess O_2 in volume percent before and after adjustments are made, as applicable;

MACT DDDDD Tune Up Requirements (cont'd)

- Optimization of total emissions of CO consistent with the manufacturer's specifications and with any NO_x requirements to which the unit is subject;
  - This is achieved by adjusting the combustion air control inlets of the boiler/ heater while it is at high fire, or typical operating load.



The purpose:

Improve combustion efficiency which in turn:

- Optimizes CO emissions;
- Optimizes NO_x emissions;
- Beyond the Rule, is the important fact that this also reduces fuel consumption.

Boiler and Process Heater Tuning as a Best Management Practice

Savings from Tune-ups

True optimization can be overshadowed by the goal of the compliance demonstration.

Optimization to 3-5% O_2 (for Gas 1 fuels) can generate additional savings.

Based on the observed relationship between O2 and efficiency, a linear extrapolation is being used to estimate potential efficiency.

Results vary between individual boilers or process heaters.

Actual Savings from Tune-ups

- MACT DDDDD focuses on improving combustion efficiency with the primary goal of reducing CO (and in theory HAPS)
- Data indicates notable savings are being realized for the Boiler MACT compliance tune-ups.

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Potential Savings from Tune-ups

- Tuning as a best management practice focuses on optimizing the boiler/ heater from a combustion and process efficiency perspective
- Data indicates additional savings can being realized from tune-ups performed with these attributes as the end goal.

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Potential Savings- Assumptions

For Gas 1 fuels, the range for safe and practical combustion is assumed to be 3-5% excess O_2 in the flue gas stream.

A boiler/heater that is operating at baseline conditions >5% O_2 can be reasonably tuned to the top end of the (safe and practical) range at 5% O_2.

A boiler/heater that is operating at <5% O2 can be reasonably tuned to the bottom end of the (safe and practical) range of 3% O_2.

Actual & Potential Savings from Tune-Ups

Rated Firing Capacity of Source (MMBtu/Hr)	Number of Units Tuned	Avg. Cost Savings from Actual Tuning Per Unit ($(1)/Unit-Yr)	Avg. Total Potential Savings Per Unit ($(1)/Unit-Yr)
< 10	45	$4,191	$16,978
$10 \leq x < 25$	85	$7,055	$44,262
$25 \leq x < 40$	73	$12,365	$36,437
$40 \leq x < 80$	138	$14,085	$55,598
$80 \leq x < 100$	54	$15,933	$71,053
$100 \leq x < 150$	55	$12,229	$25,835
$150 \leq x < 200$	28	$57,950	$107,159
>200	105	$27,429	$109,733

1) Cost savings based on U.S. Energy Information Administration 12-month rolling average of natural gas from May 2017 to April 2018 at $3.96/MMBtu. Updated info from FY2019 tune-ups to be incorporated in Summer 2019.

Case Studies

Case Study #1

- A fertilizer plant utilizes two steam boilers and one process heater in their manufacturing process;
- Each source is >10 MMBtu/hr and must be tuned annually;

Unit ID	Rated Firing Capacity (MMBtu/Hr)	Actual Savings ($/Year)	Simple Payback Period (Months)
B-01	227	$188,989	0.26
B-02	227	$78,745	0.63
H-01	40	$16,651	2.99
Facility Total(1) or Average(2)	--	**$284,385(1)**	**0.53(2)**

Case Study #2

- A plastics material and resin manufacturing plant utilizes four boilers in their manufacturing process;
- Each source is >10 MMBtu/hr and must be tuned annually;

Unit ID	Rated Firing Capacity (MMBtu/Hr)	Actual Savings ($/Year)	Simple Payback Period (Months)
B-01	417	$72,328	0.61
B-02	417	$101,259	0.44
B-03	150	Already Optimized	--
B-04	150	$94,561	0.47
Facility Total(1) or Average(2)	**--**	**$268,148(1)**	**0.66(2)**

Limitations of Study

Natural Gas

Study focused on savings relative to natural gas;

$3.96/MMBtu used in these calculations (rolling average for timeframe of data), but savings vary with the price of natural gas.

Similar efficiency improvements are possible where units burn refinery fuel gas, but….

RFG values may not be recognized by an organization, or tracked, so actual savings are up for debate.

Efficiency

- Limited data available to correlate efficiency to excess oxygen;
- A linear extrapolation is a general estimation at best;
- Actual possible savings estimates become less accurate for larger O2 adjustments (e.g. tuning from 10% O_2 down to 5% O_2);
  - One way to address this is to utilize known interpolation tables to estimate efficiency improvements in units which are operating at excessively high O_2 levels.
- Adjustments to airflow also affect temperature, which impacts efficiency results as calculated by the combustion analyzer;
- A growing body of data, some refinement, and more detailed efficiency studies will improve these estimates.

Firing Rate

MACT DDDDD only requires tuning at high-fire or typical operating load;

Units with highly variable loads/fueling rates may not operate optimally throughout their cycle;

One way to address this is to establish optimized conditions at each variable load within the cycle;

Full realization of savings is dependent on and requires continual adjustment which may be impractical without the proper controls.

Key Takeaways

Key Takeaways

Based on the dataset, notable cost savings are being observed in association with the annual and biennial MACT DDDDD tune-ups, but there are additional benefits to tuning more regularly;

Going beyond the minimum compliance requirements can realize even greater savings with just a few hours of extra labor;

Simple payback on a MACT DDDDD tune-up can be realized in a matter of months;

Greatest savings potential observed in relation to natural gas fired boilers and process heaters, but savings can also be calculated for other fuel types, too;

A growing body of data and more detailed efficiency studies will improve the accuracy of these savings estimates.

Thank You

Congratulations on 50 Years CAPCA!

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