

Improving Combustion Efficiency Through Better Process Control

CIBO Policy & Technical Issues Conference

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Enero Solutions



Presentation Overview

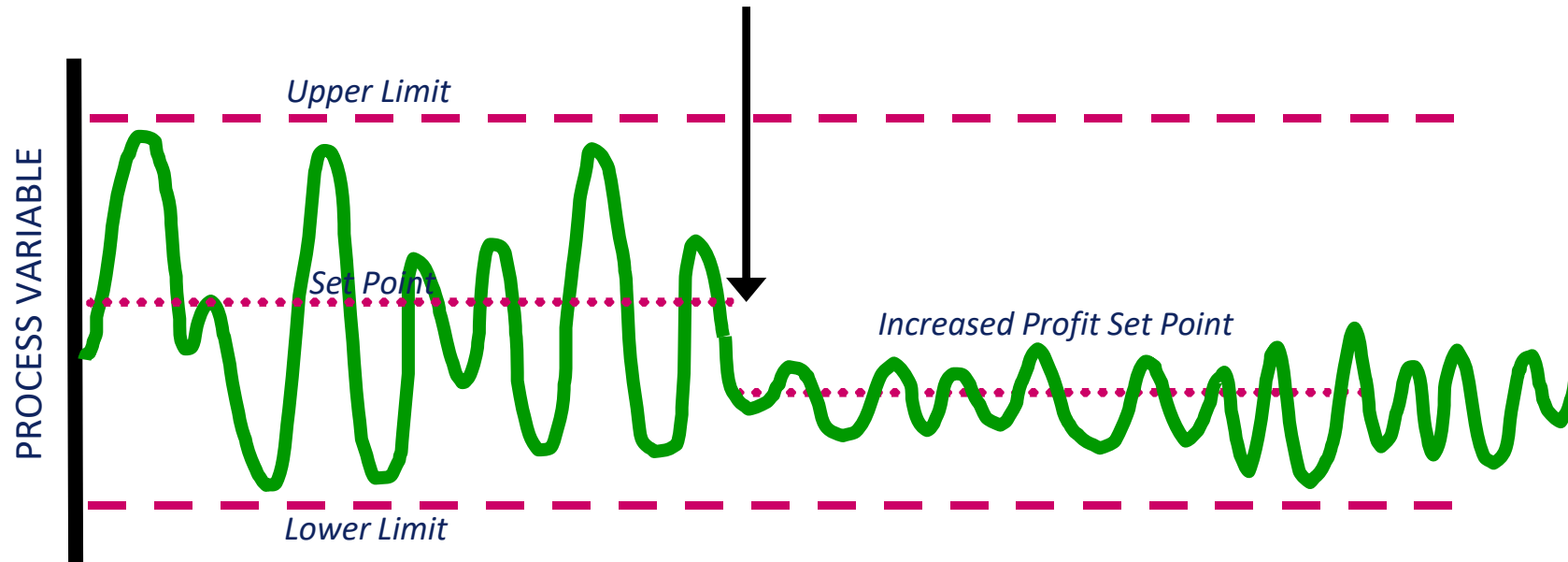
1. About Enero Solutions
2. Combustion process and Excess Air
3. Combustion controls and percent O₂ control
4. Importance of damper performance
5. Case Studies
6. Questions

About Enero Solutions

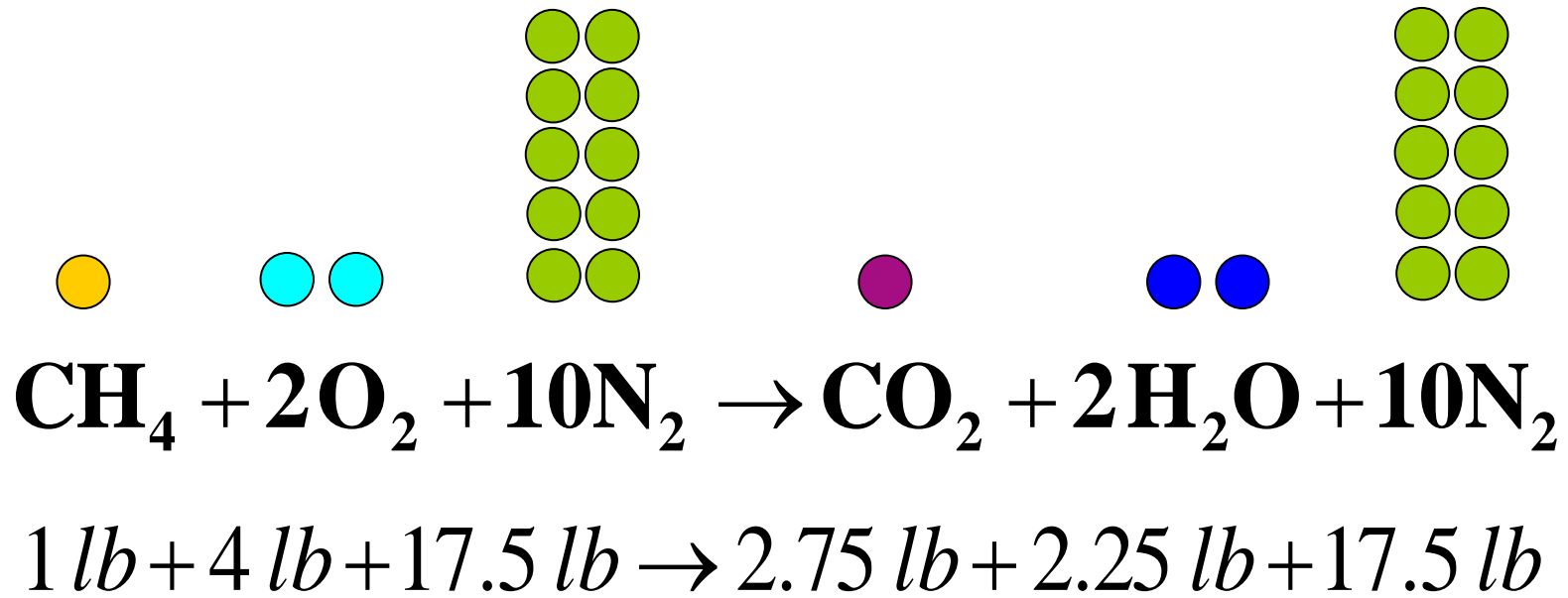
- Engineering company founded in 2004, headquarters in Montreal, office in Lyon, Houston
- Projects tied to performance guarantees.
- Products and Services:
 - Energy process control optimization project
 - Advanced Controls: Steam APC, Biomass APC, Evap APC, Kiln APC, Washer APC, etc.
 - Energy Dashboard,
 - Digital Twin
 - Turnkey automation projects

Why Process Control and Optimization?

Process & Control Optimisation

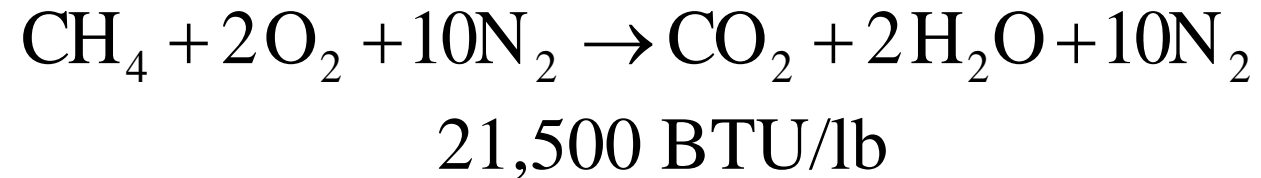


Chemistry of Combustion

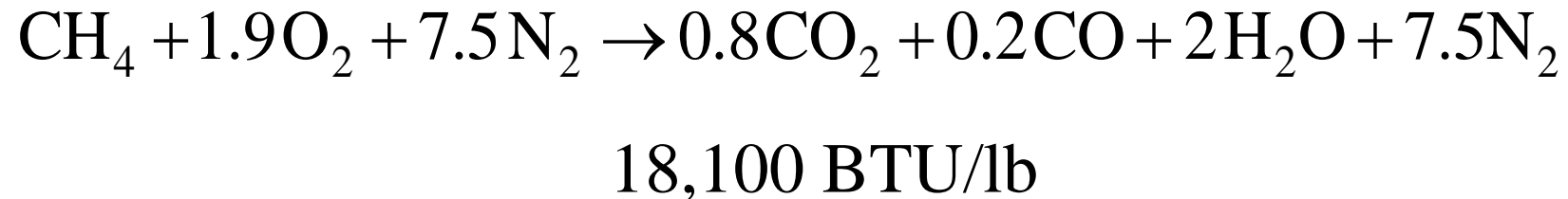


Why we need more air than needed...

Complete Combustion (enough oxygen)



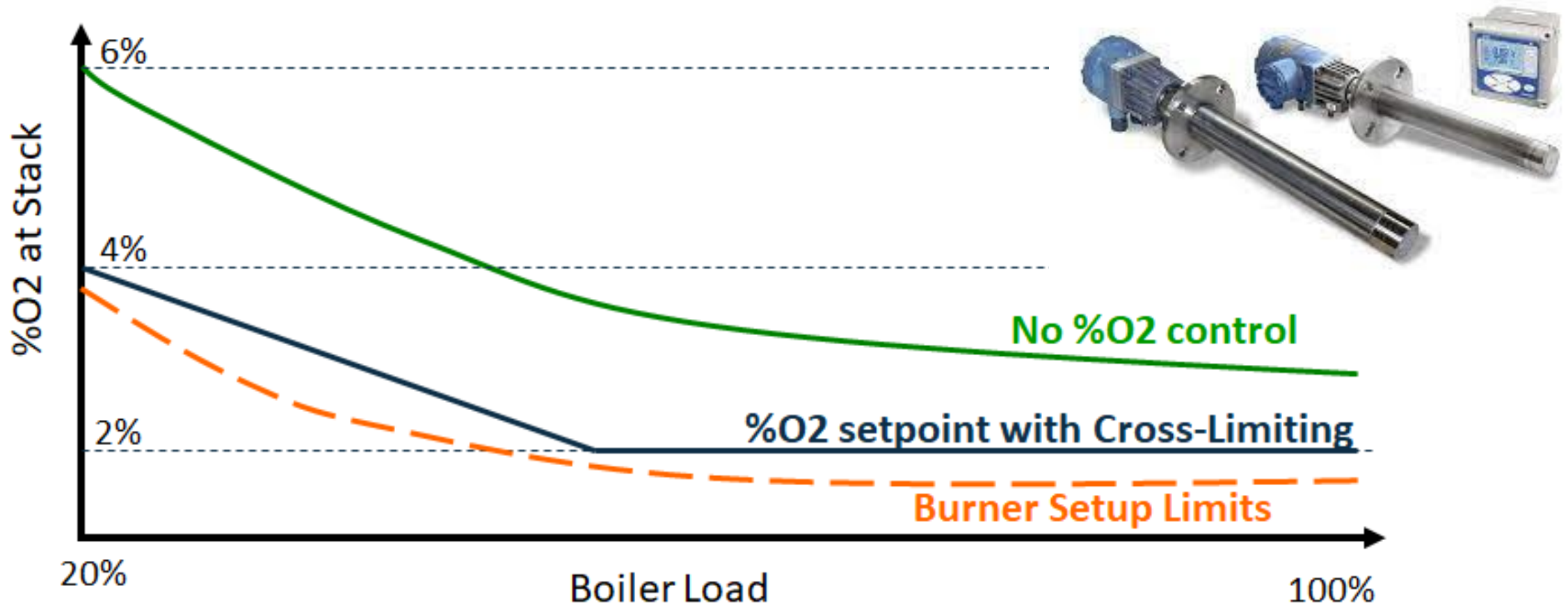
Incomplete Combustion (not enough oxygen)



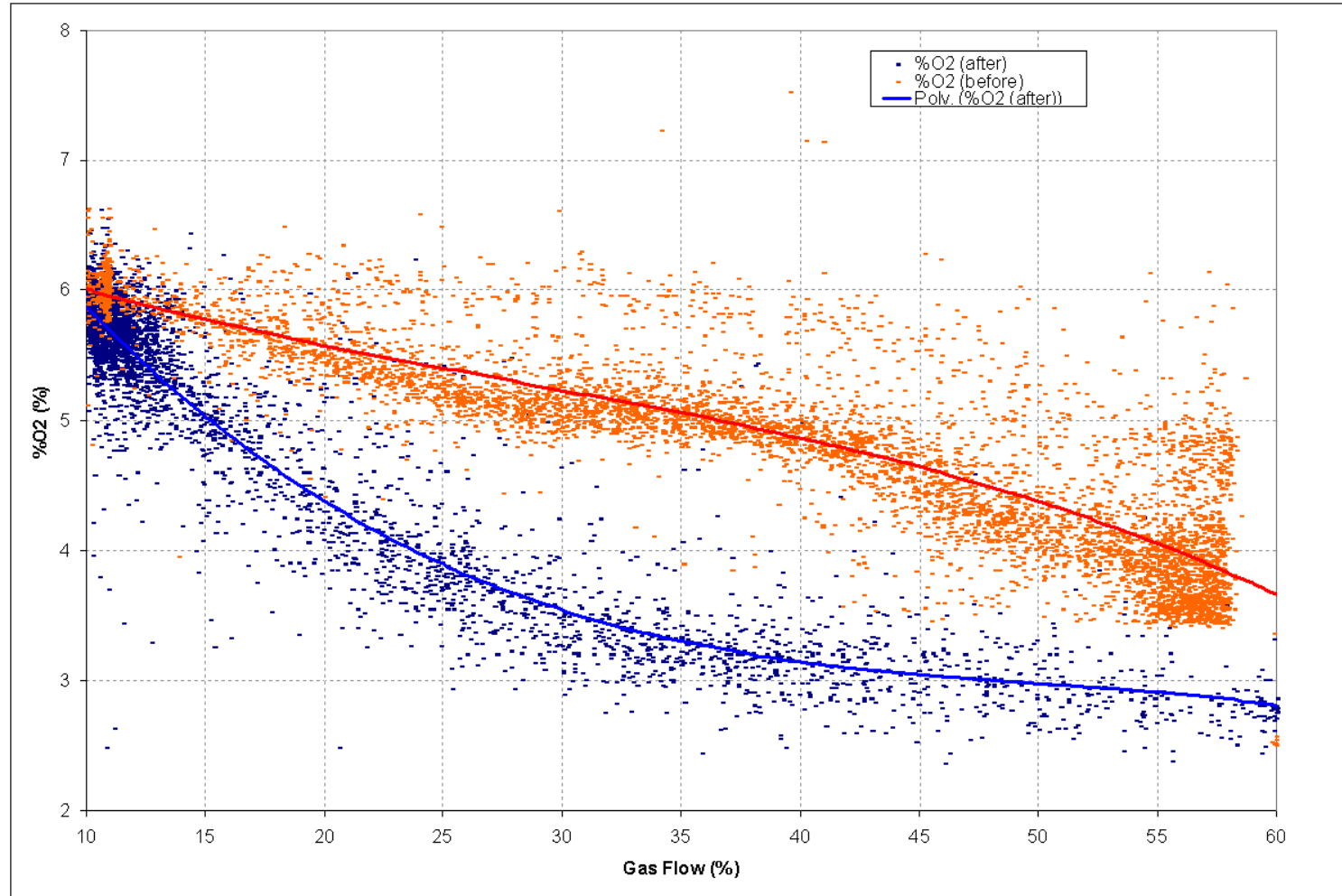
Combustion Efficiency and Excess Air

- Too much excess air:
 - Reduces boiler combustion efficiency: - 1% O₂ = + 0.5/1.0% Efficiency
 - Can decrease boiler throughput when fan limited
 - NO_x
- Not enough air can be unsafe: excessive formation of carbon monoxide (CO) + Opacity

Controlling Excess air through %O2 control

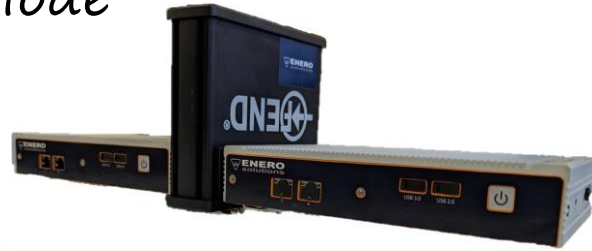


Reduction in %O2 from a combustion efficiency initiative

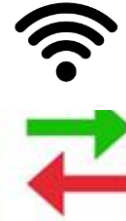
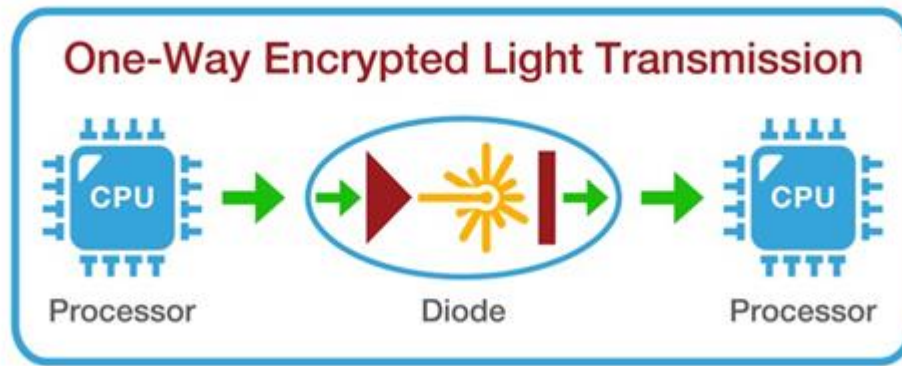


Maintaining Performance & Remote Monitoring

DataDiode



Plant



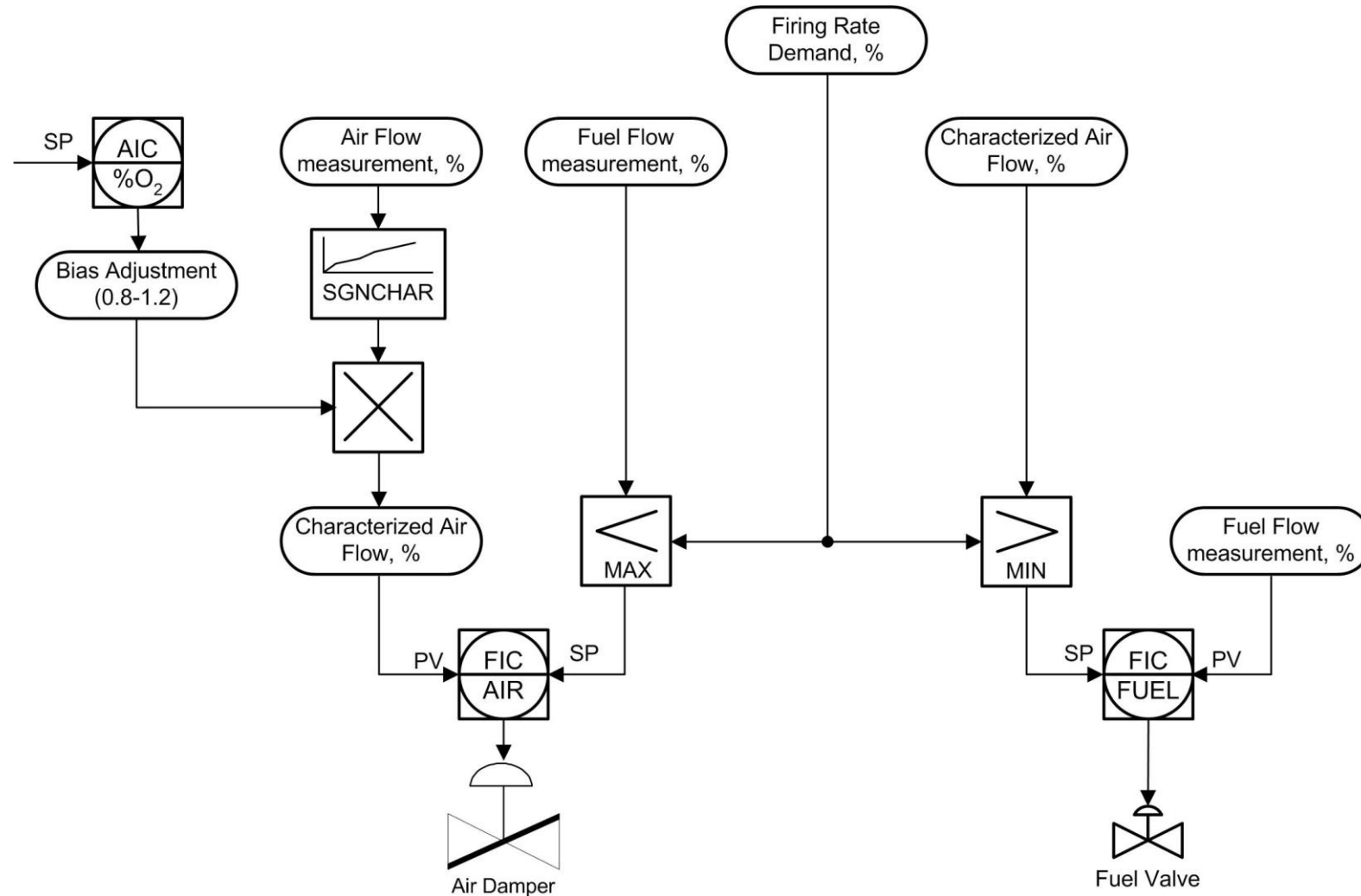
Remote Performance Dashboard



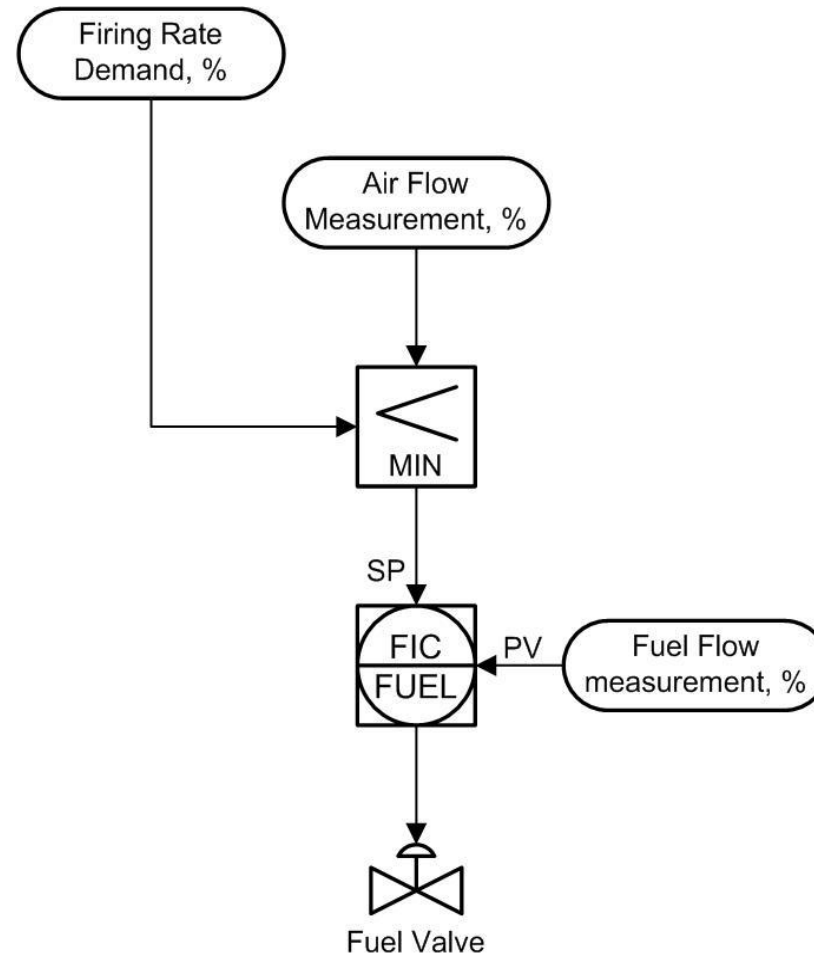
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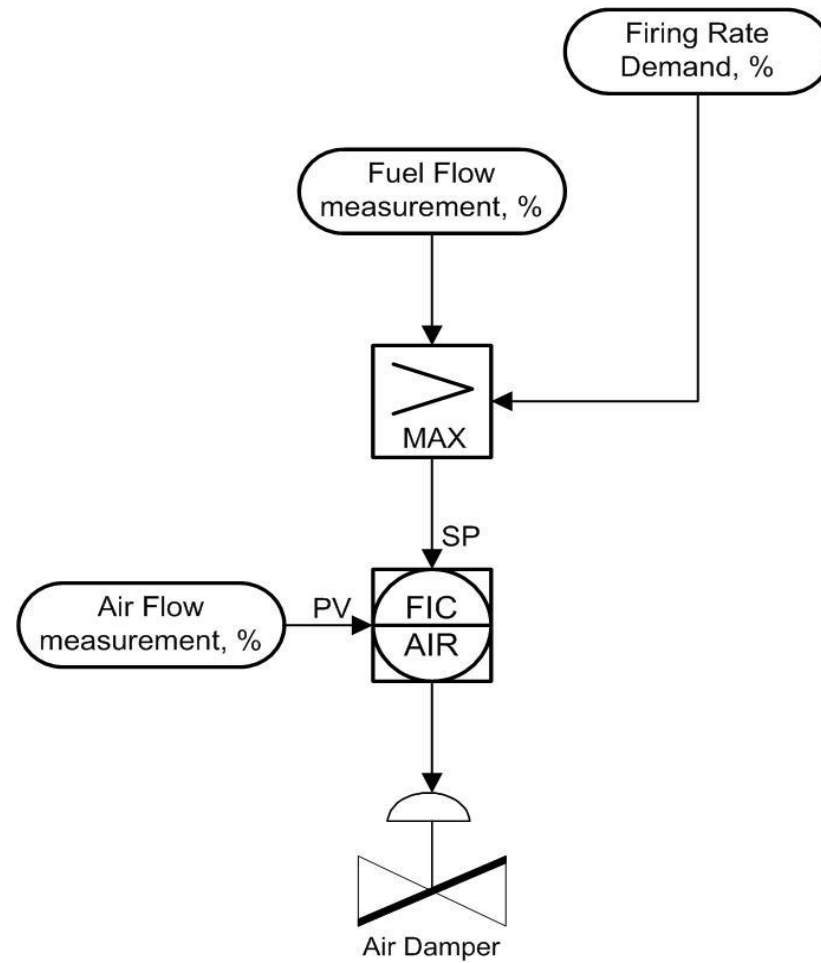
How does %O₂ control work? The Cross-Limiting Logic



Fuel Flow Cross-Limiting Logic

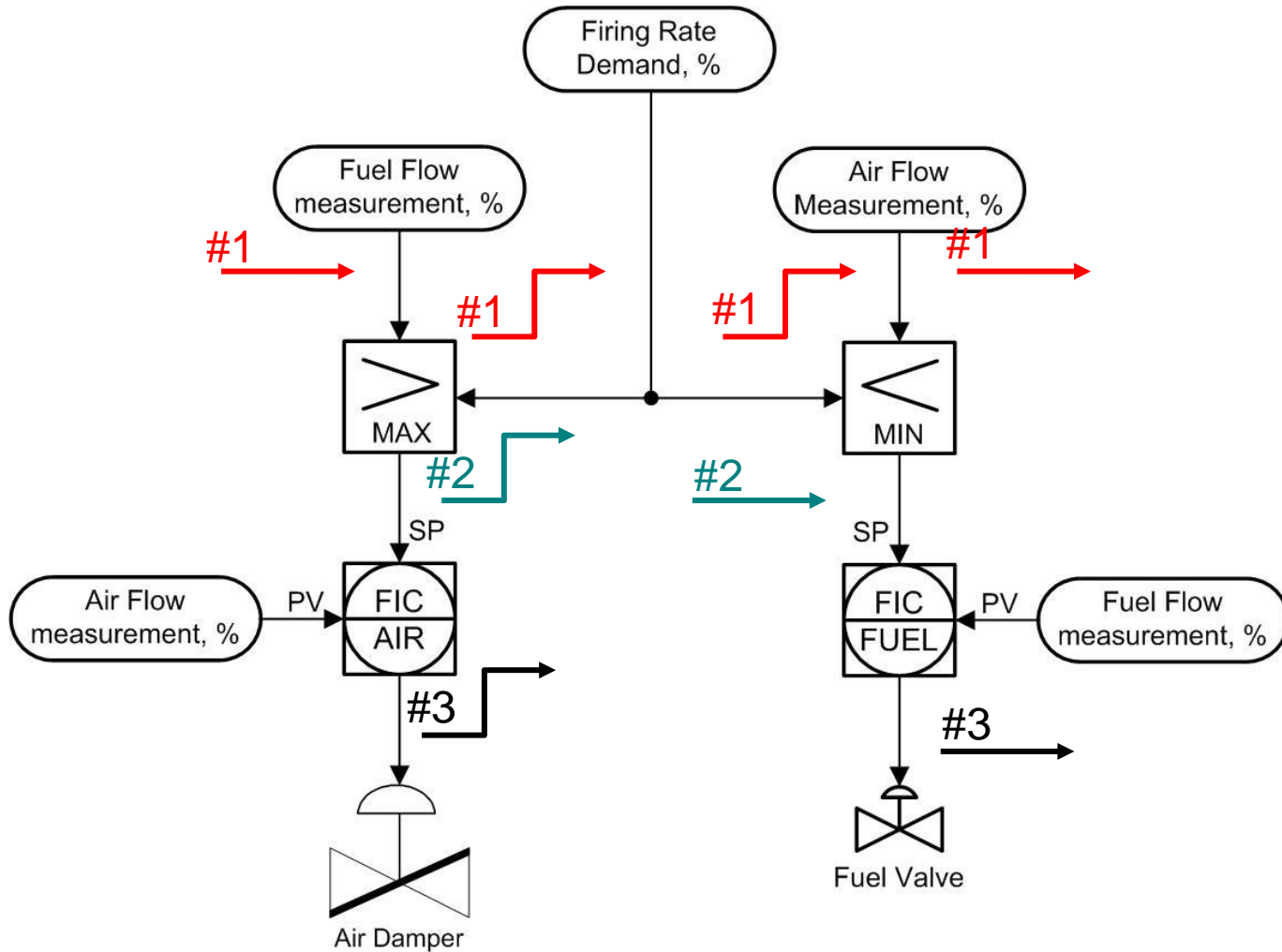


Air Flow Cross-Limiting Logic



Increase in load with Cross-Limiting

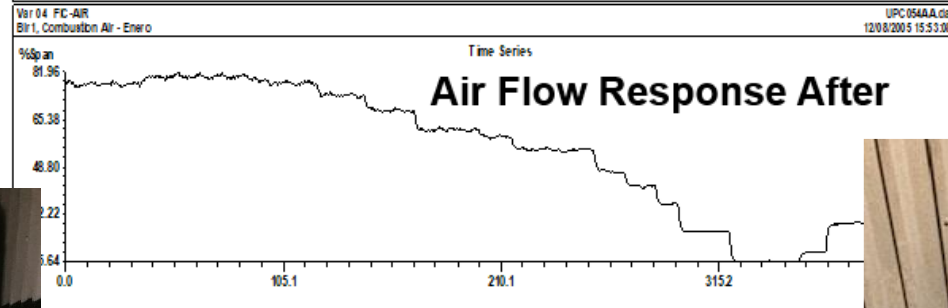
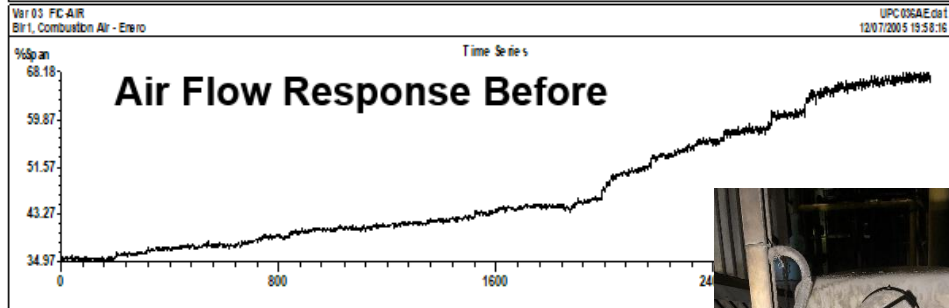
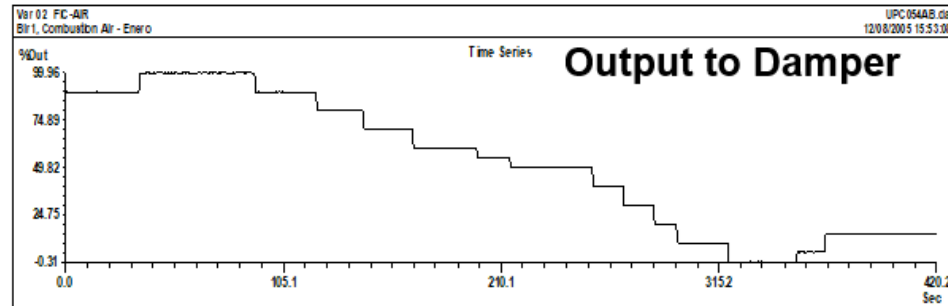
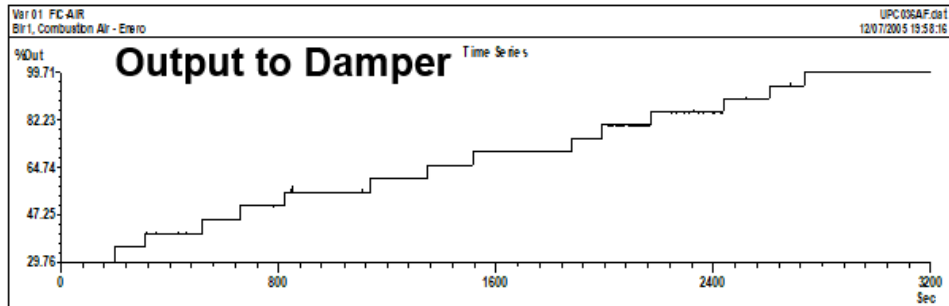
Fuel is locked by air



Damper Drive: Performance Improvement

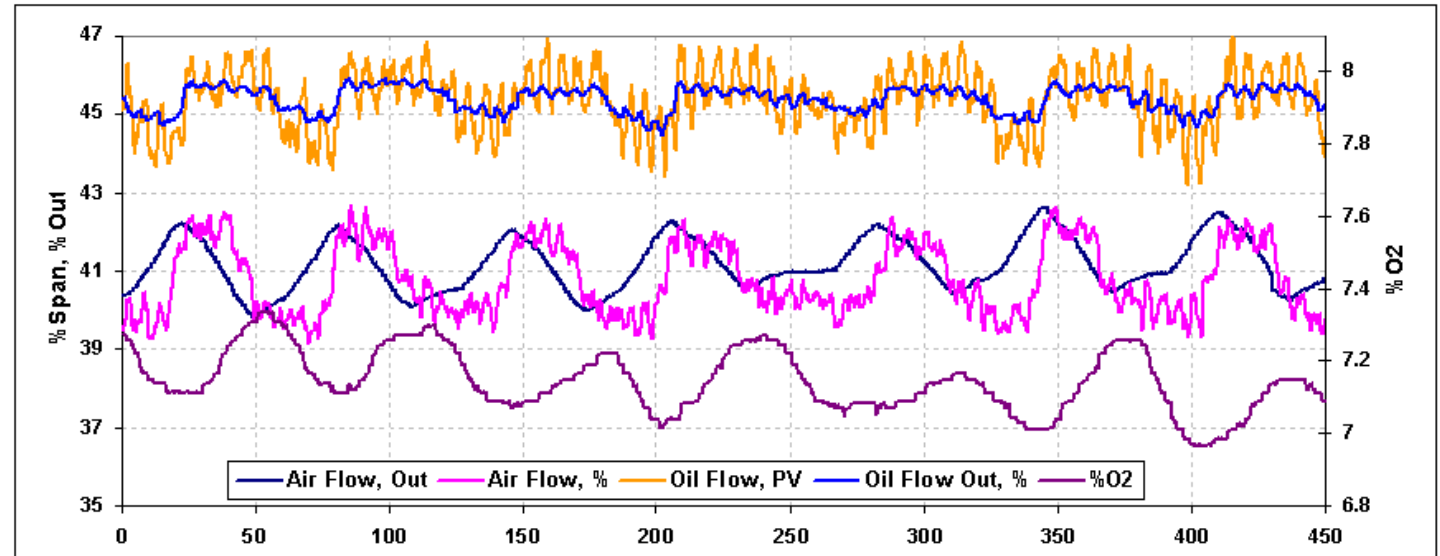
Before: Long Deadtime, Backlash

After: Min. Deadtime, Min. Backlash

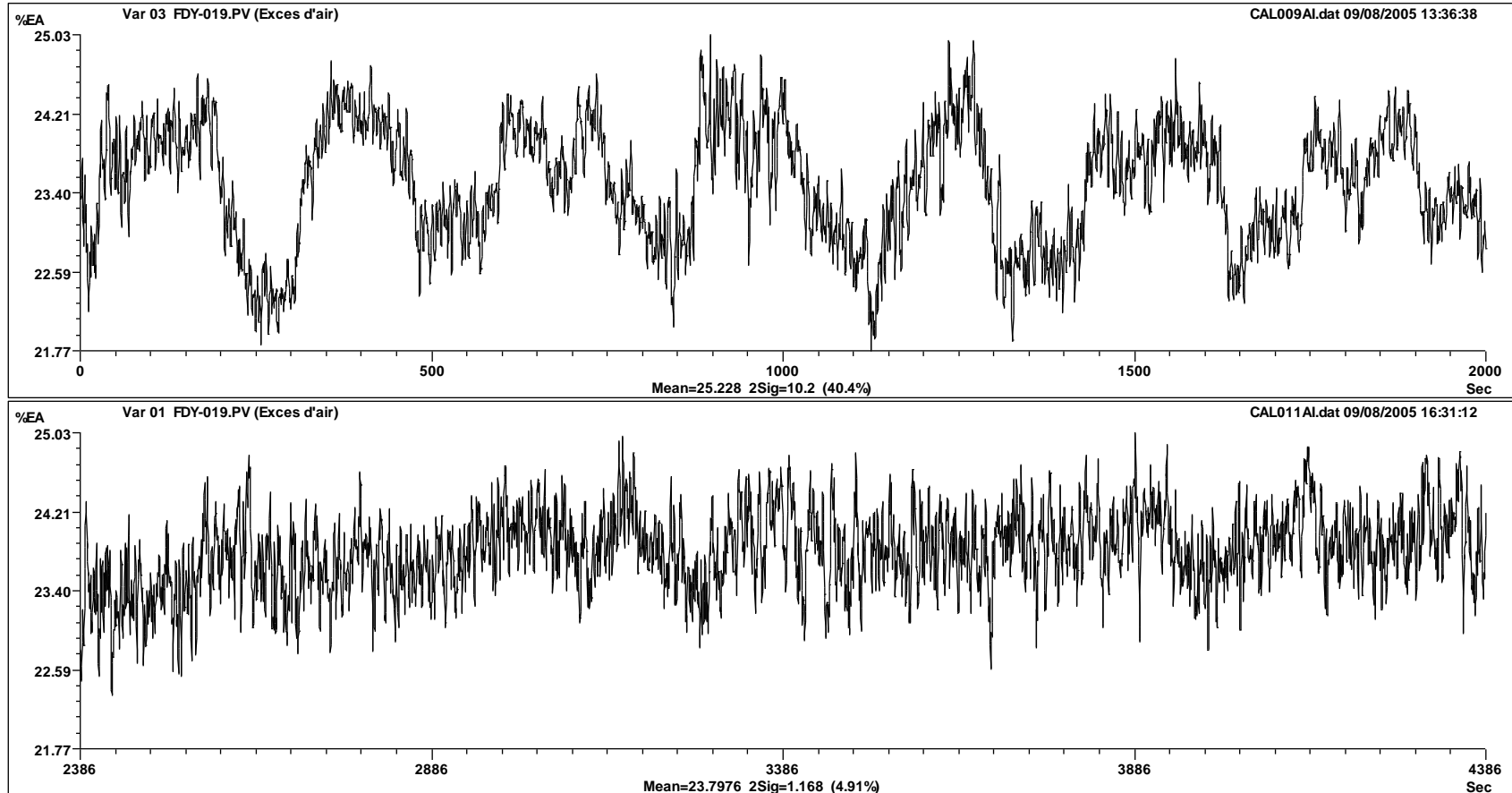


Impact of a sticky valve/damper on the stability of the combustion process

- A sticky damper will continuously bump the setpoint of the fuel flow controller.
- A sticky fuel valve will continuously bump the setpoint of the air flow controller
- Poor combustion control and variability will result in lower production and lower quality...



Excess air variability Automatic vs. Manual



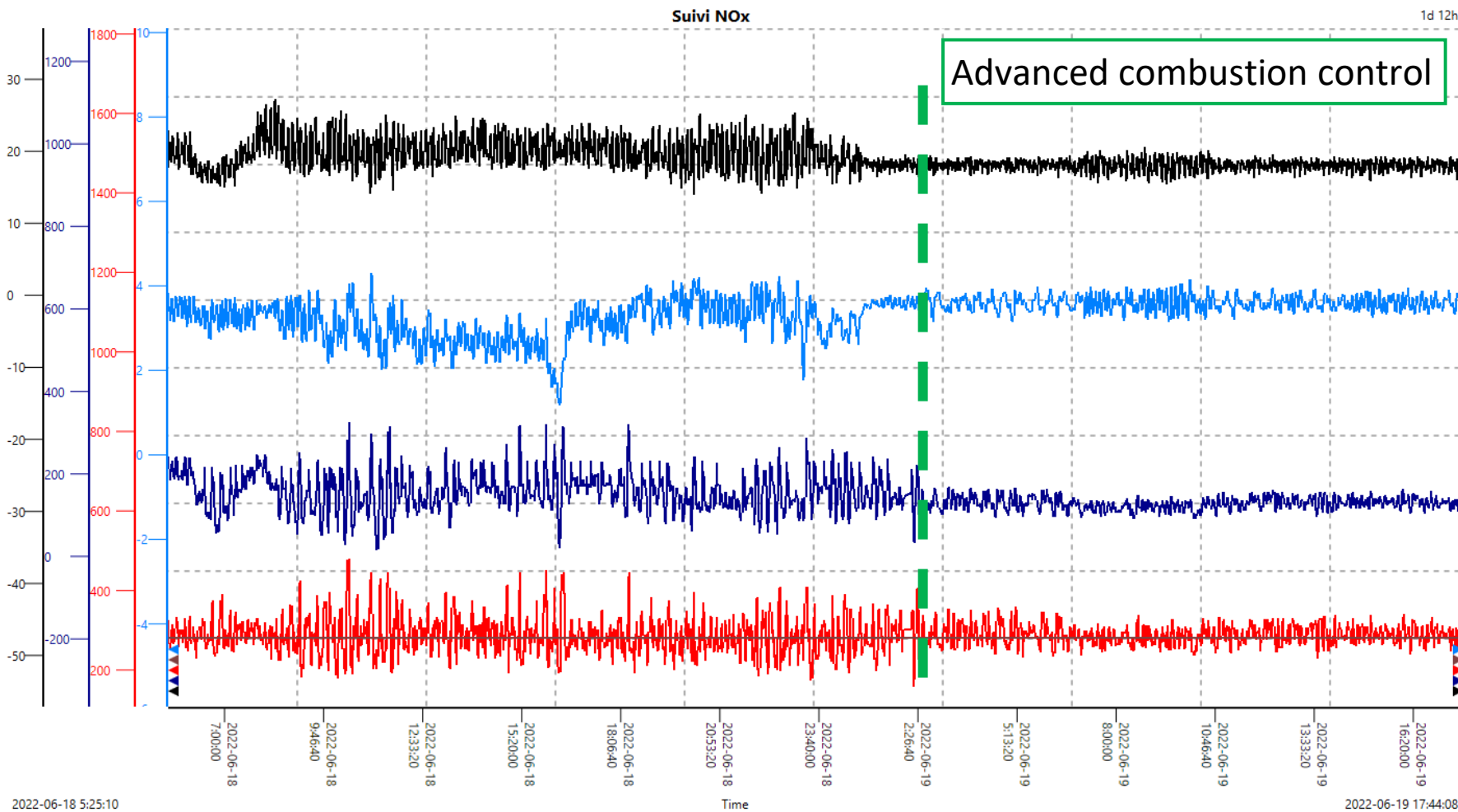
Biomass combustion improvement from an APC/Damper Project

Boiler load (kg/s)

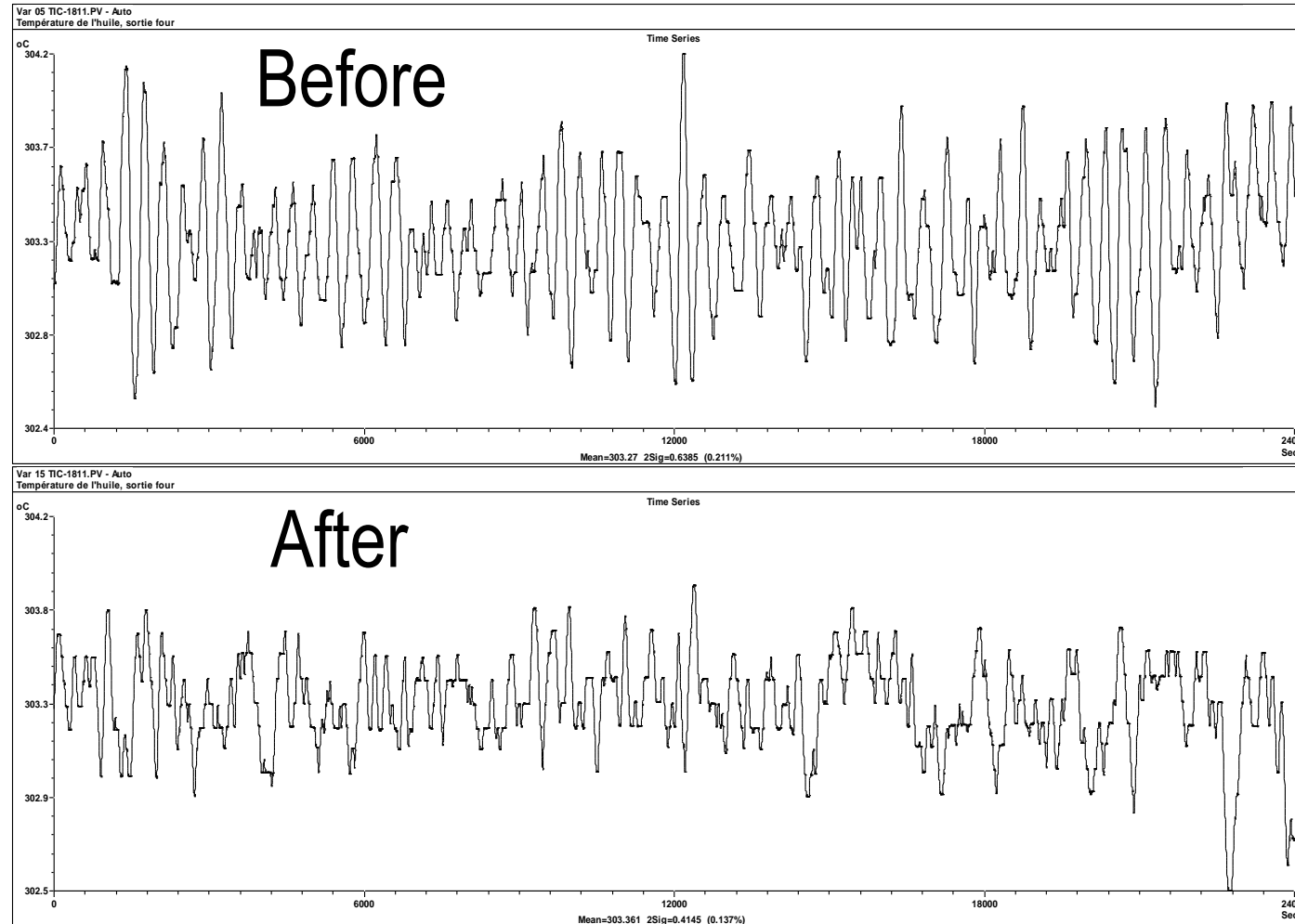
Oxygen (%O₂)

Ammonia flow (l/h)

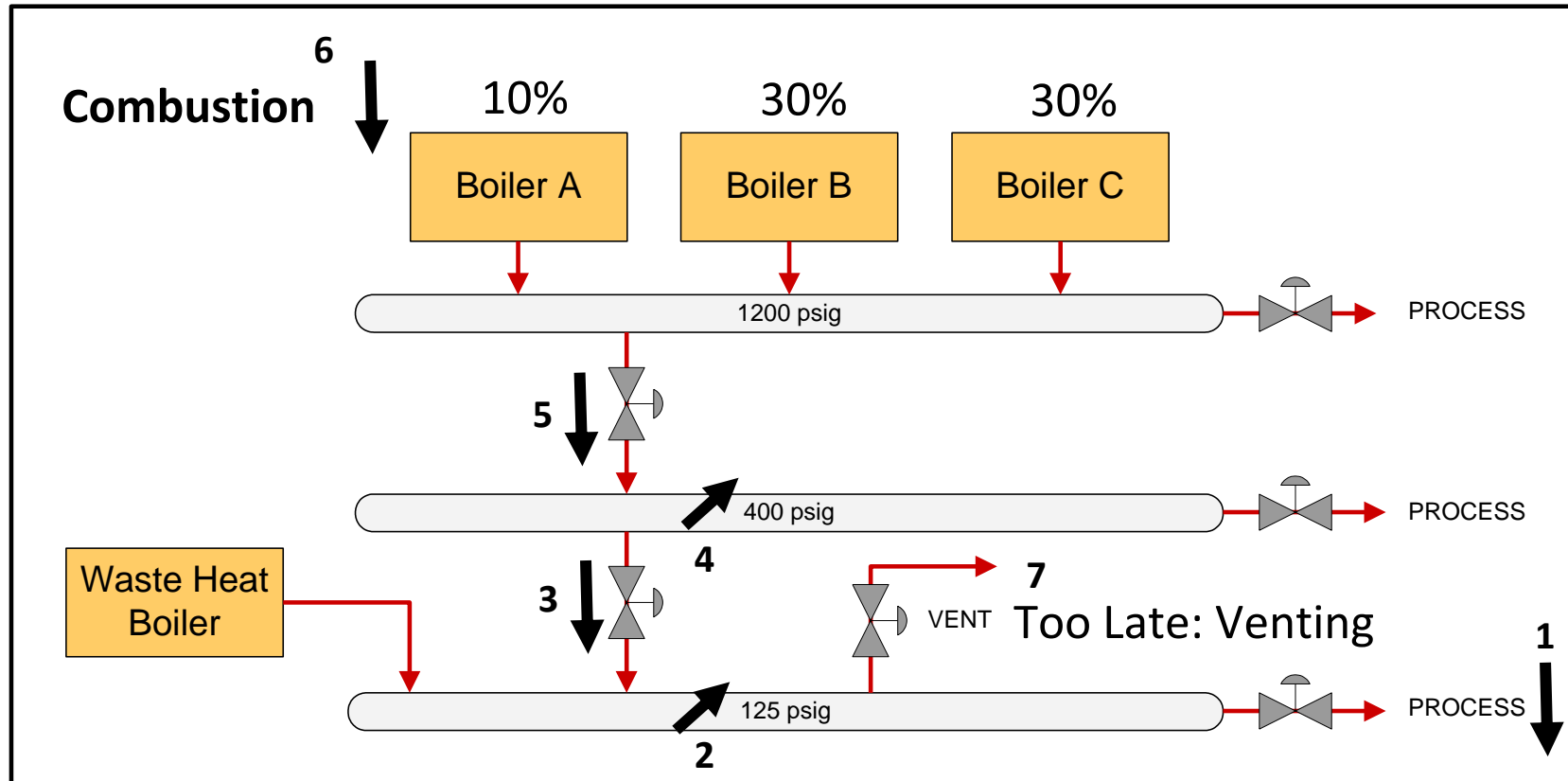
NO_x (mg/Nm³)



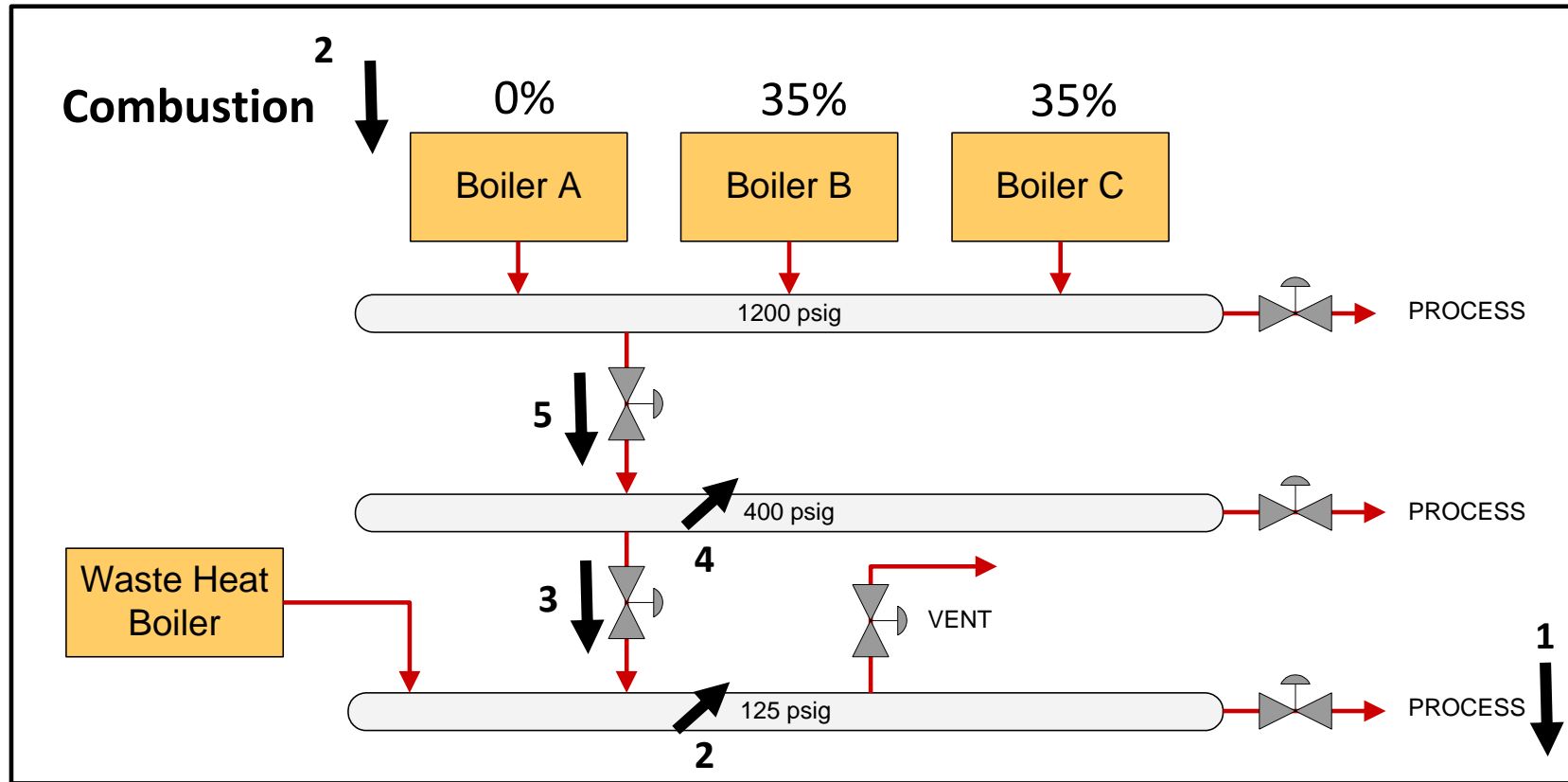
Improvement in Furnace temperature control



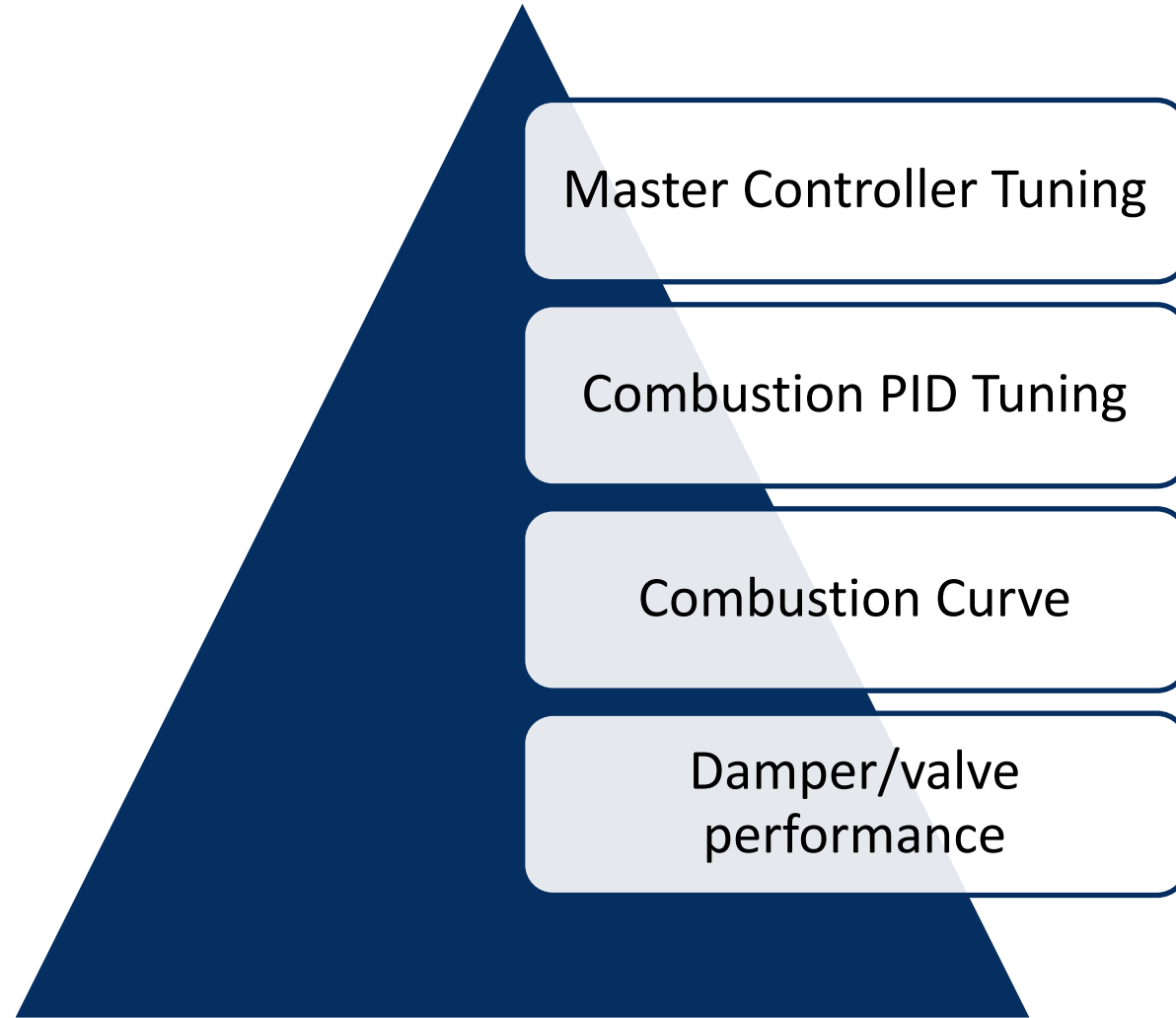
Steam Plant Response with poor combustion controls



Steam Plant Response with fast combustion controls



Conclusions – Improving combustion efficiency



Questions

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President

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