

Getting the MOST out of your combustion system

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Getting the ***MOST***

- ***MOST*** Production
- ***MOST*** Quality
- ***MOST*** for your fuel \$/***MOST*** energy efficiency

- When you consider these issues, your combustion system in combination with your kiln/furnace is the key in achieving these objectives.

FIRST, take a good hard look at your present system/situation.

MAINTAIN YOUR EQUIPMENT

- Burner tuning
- Combustion air filtering
- Kiln maintenance
- Controller tuning
- Training/Record keeping

BURNER TUNING

Air/Fuel Ratio

- Over time burner settings (air/fuel ratio) will drift, because of component wear, temperature, etc..., this can ultimately affect:
 - Efficiency/Fuel Usage
 - Product Quality

BURNER TUNING



Example: A burner's air/fuel ratio drifts to 30% excess air from its initial setting of 10%. Readjustment back to 10% will result in a 15% energy savings.

Energy Saving

File Help

Current Units

US-Units SI-Units

Select Fuel

Case I

Average Natural Gas
Blast Furnace Gas
Butane

Case II

Average Natural Gas
Blast Furnace Gas
Butane

Enter Combustion Condition data for both cases

Combustion Air Temperature	60.0	F	60.0	F
Exhaust Temperature	1900	F	1900	F
Excess Air (%)	30		10	
Oxygen in Combustion Air (%)	20.9		20.9	
Flue Gas Recirculation (%)	0		0	
Flue Gas Recirculation Temperature	60.0	F	60.0	F
Fuel Preheat Temperature	60.0		60.0	

Calculate Energy Savings

Available Heat Case I (%) 38.3

Available Heat Case II (%) 45.2

Energy Saving in Case II (%) 15.3

Energy Cost Print Preview End

Combustion Air Filtering

- Unfiltered Systems
 - Overtime dust/particulate will build up in pipes/burners
 - Increased system pressure drop (ie. smaller pipe)
 - Less air to burner = Less air to system = Less input = Less production = Wasted energy
- Filtered Systems
 - Regular maintenance schedule based on operating conditions.

Kiln Maintenance

The objective: Contain heat in the kiln to heat product/minimize heat losses.

- Openings
 - Radiation losses = wasted energy
 - Air infiltration = wasted energy
- Refractory
 - Poor refractory maintenance=wall losses=wasted energy
- Pressure Control
 - Poor/No pressure control = wasted energy/poor uniformity



Controller Tuning

Tuning of controllers

- Tighter control = less fuel usage/tighter uniformity
 - Best controller can't overcome a poorly tuned/designed combustion system

Training/Record Keeping



Training

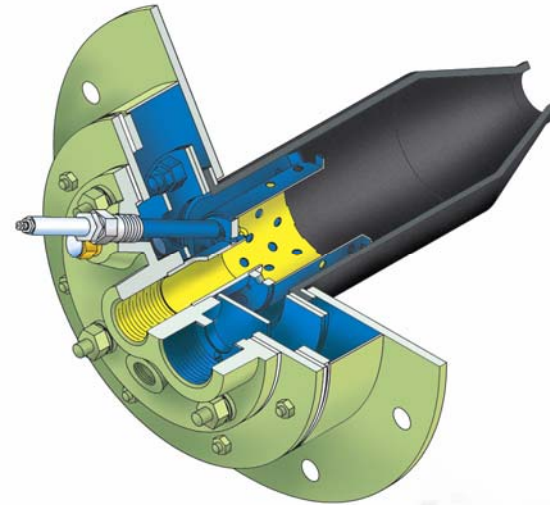
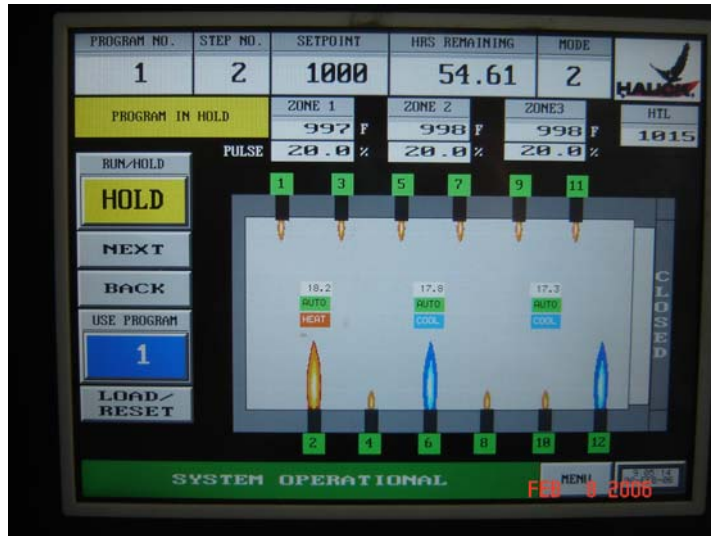
- Basic combustion training/knowledge

Record Keeping

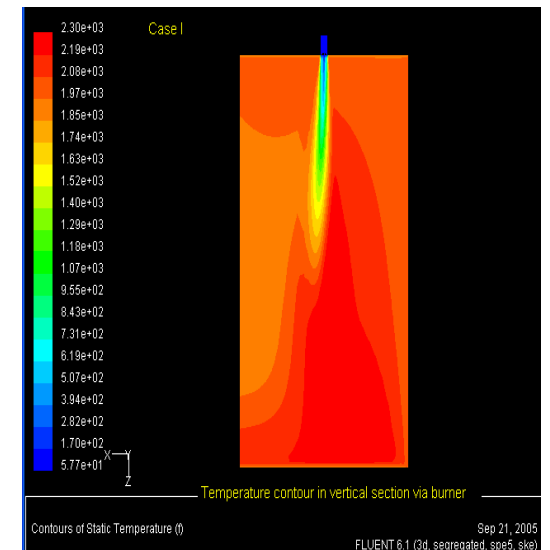
- Baseline reference for optimum operation.
- Easy to check/adjust to baseline.
- Analysis can be done.

	G	H	I	J	K	L
	BURNERS BIC	Gas Orifice ΔP ("w.c.)	Gas Flow (scfh)	Burner Inlet Air Pressure ("w.c.)	Air Flow (scfh)	% Excess Air
8	80L					
9	PREHEAT 3					
10	R11	3.0	262	16.1	2717	3.7
11	R12	3.0	262	16.1	2717	3.7
12	R13	3.0	262	16.1	2717	3.7
13	R14	3.0	262	16.1	2717	3.7
14	PREHEAT 4					
15	R15	6.0	371	32.1	3836	3.5
16	R16	6.0	371	32.1	3836	3.5
17	R17	6.0	371	32.1	3836	3.5
18	R18	6.0	371	32.1	3836	3.5
19	PREHEAT 5					
20	R19	6.0	371	32.1	3836	3.5
21	R20	6.0	371	32.1	3836	3.5
22	R21	6.0	371	32.1	3836	3.5
23	R22	6.0	371	32.1	3836	3.5
24	PREHEAT 6					
25	R23	6.0	371	32.1	3836	3.5
26	R24	6.0	371	32.1	3836	3.5
27	R25	6.0	371	32.1	3836	3.5
28	R26	6.0	371	32.1	3836	3.5
29	PREHEAT 7					
30	R27	6.0	371	32.1	3836	3.5
31	R28	6.0	371	32.1	3836	3.5
32	R29	6.0	371	32.1	3836	3.5
33	R30	6.0	371	32.1	3836	3.5

EQUIPMENT AND CONTROL



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Equipment and Hardware

Equipment/hardware on the kiln/furnace

- Is the equipment right for the job?
- Equipment age: Many combustion systems are 15 years or older.
- Burner and Component advancements/improvements:
 - Improved mixing
 - Improved emissions
 - Improved turndown
 - Improved heat transfer
 - Tighter air/fuel ratio control

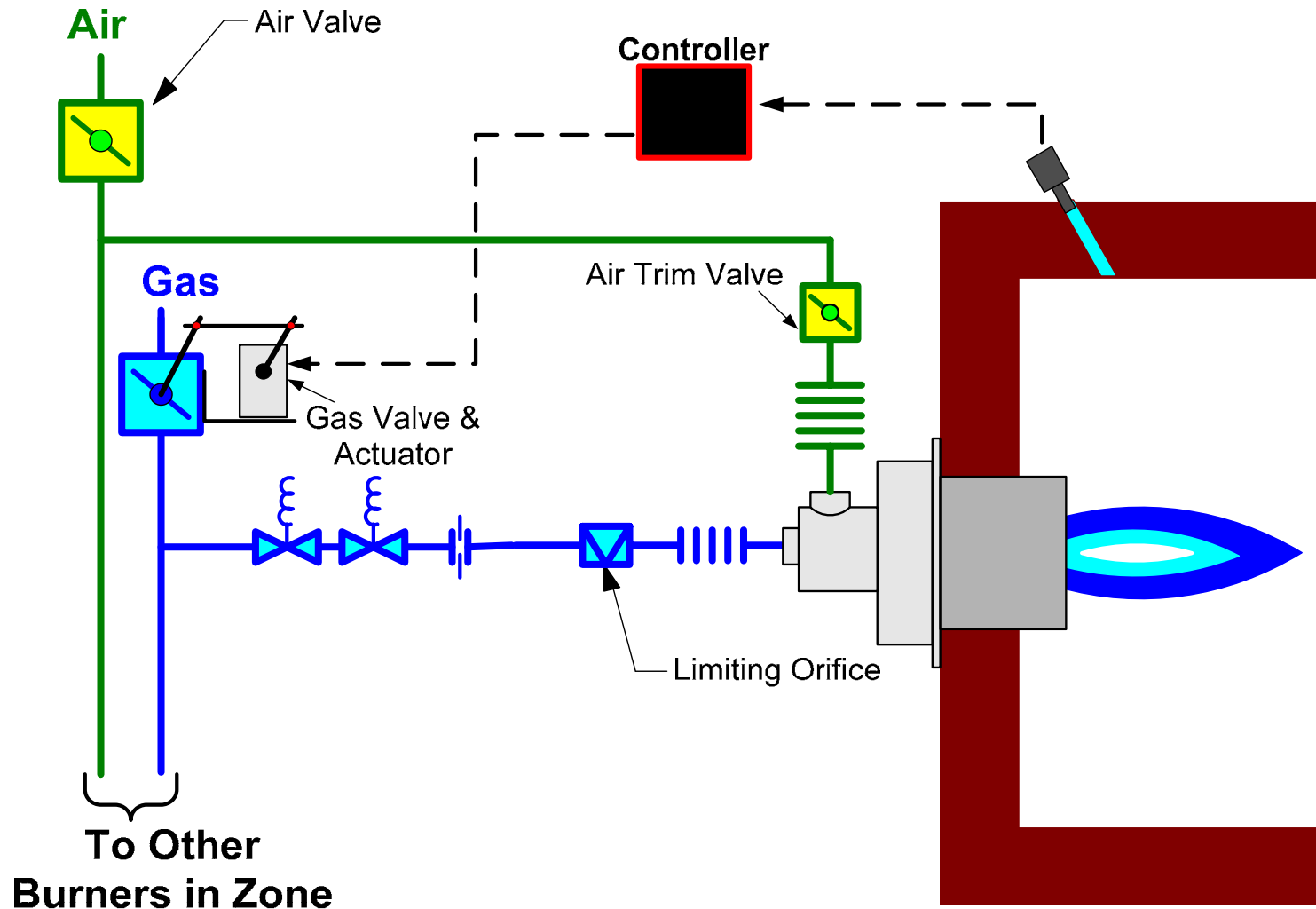
System Control



Control Systems/Methods

- Best burner + poor/inadequate control scheme = poor performance.
- Advancements in control technologies can assist in system control: Precision and reaction.
- Control of the combustion system has to address the application/product requirements. The design of the system will dictate:
 - Temperature Uniformity = Product Quality
 - Efficiency = Lower Fuel Costs
 - Maximum Heat Transfer = Optimum Production

Fuel-Only/Excess Air Control



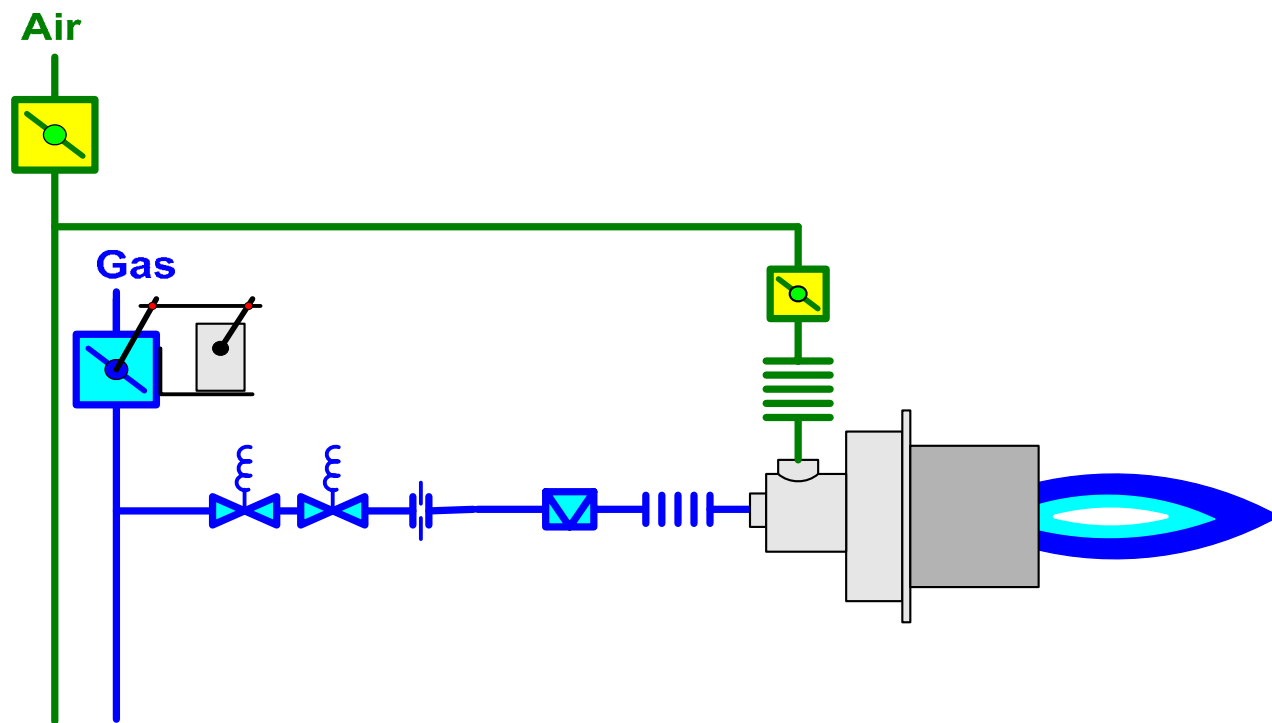
Fuel-Only/Excess Air Control

Advantages

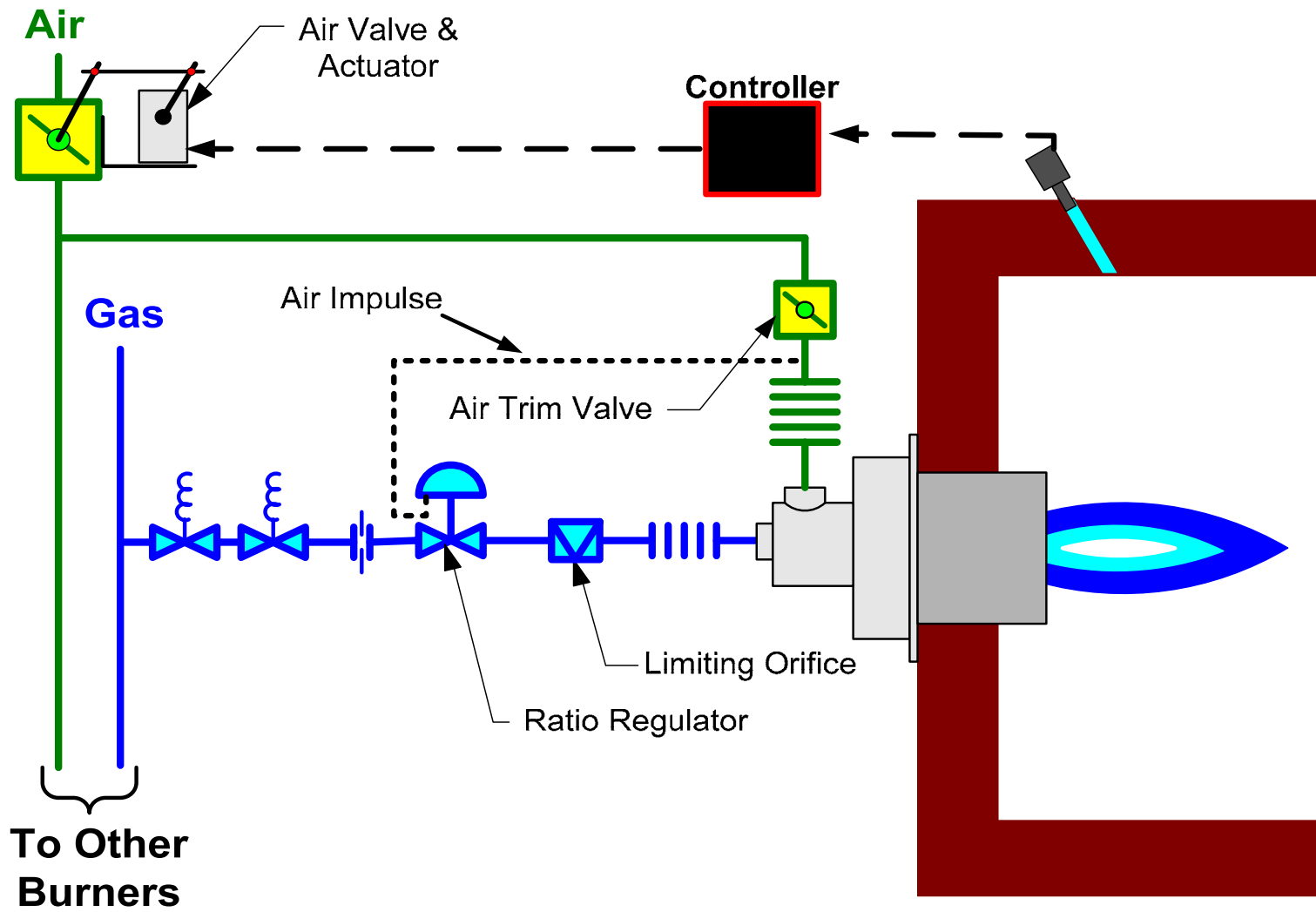
- Simple
- Less expensive
- Maintains high exit velocity/temperature uniformity

Disadvantages

- Versatility
- Thermally inefficient
- Burner must be excess air capable



Ratio/Cross-Connected/Pressure Balanced



Ratio/Cross-Connected

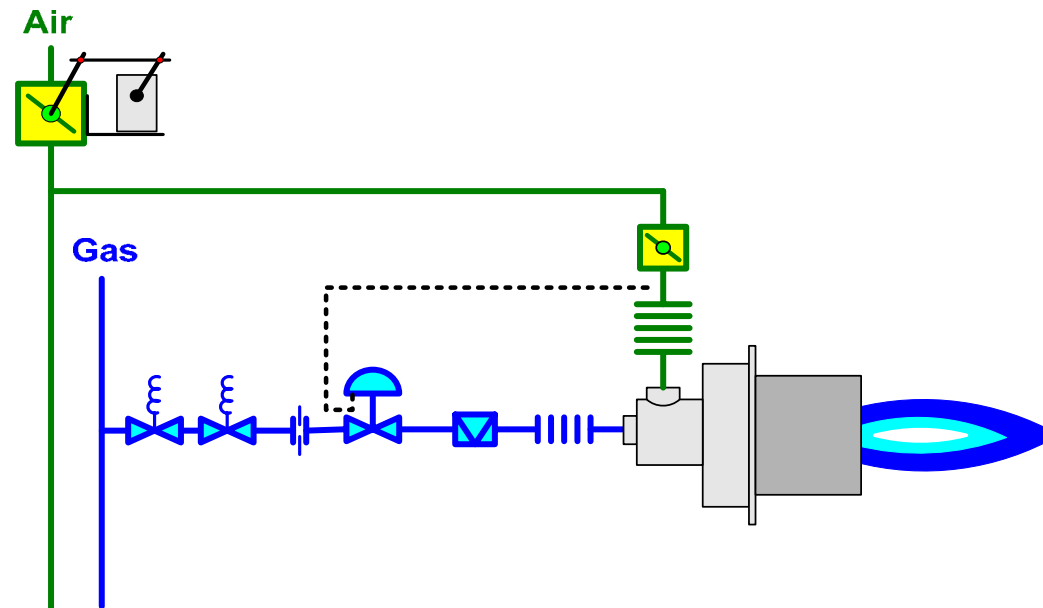


Advantages

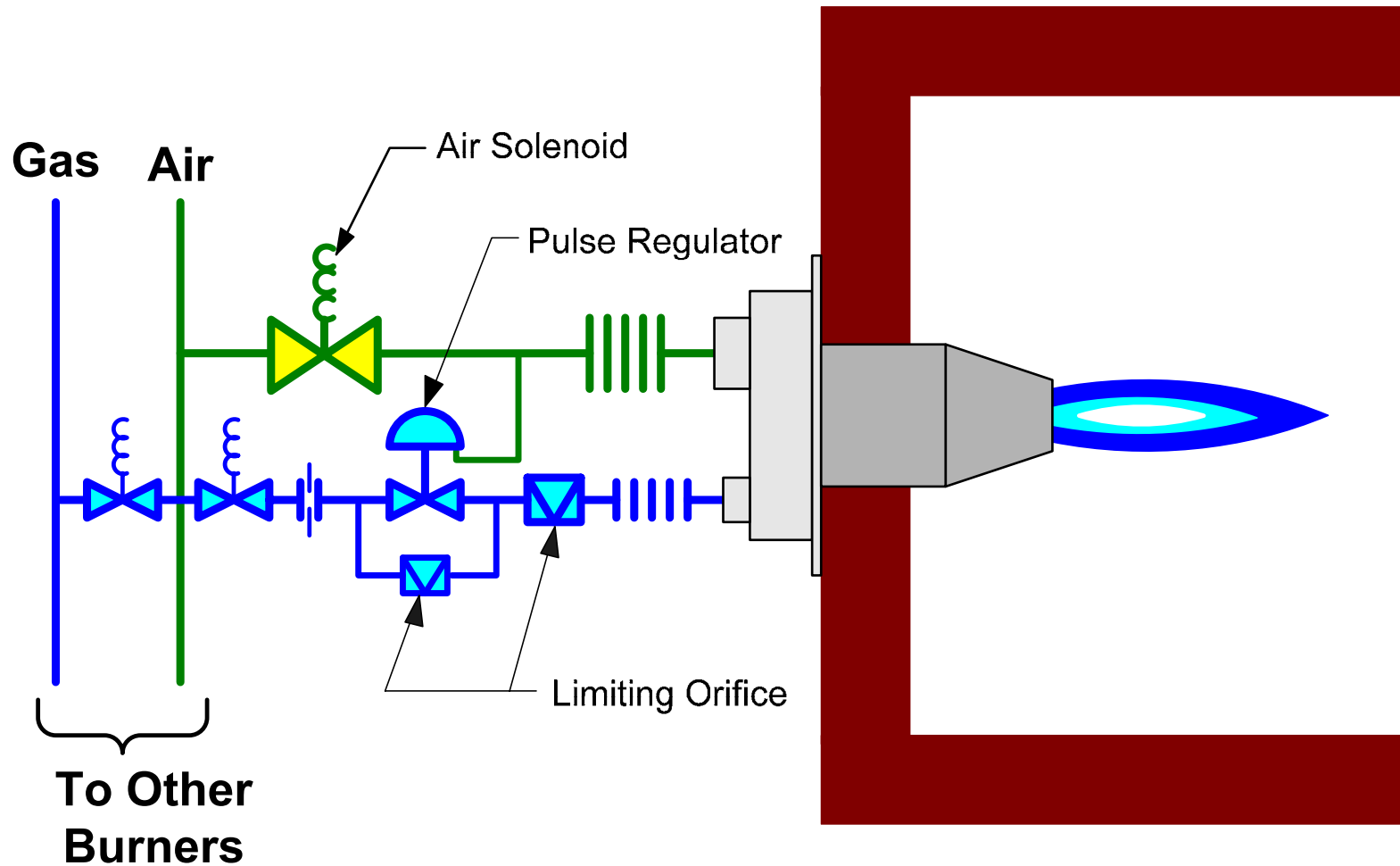
- Simple/relatively easy set-up
- Generally inexpensive
- Fuel efficient

Disadvantages

- Temperature uniformity will suffer with reduction in burner exit velocity with turndown



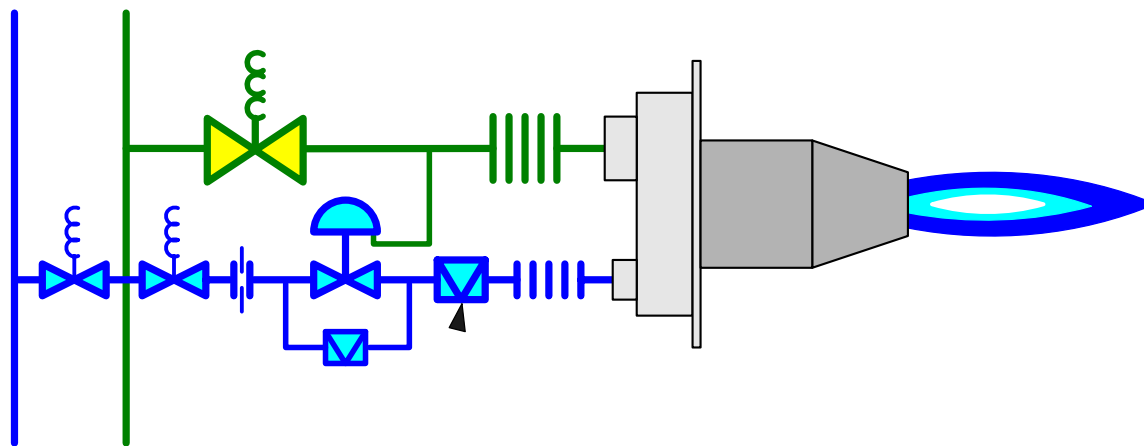
Pulse Fire Control



Pulse Fire Control



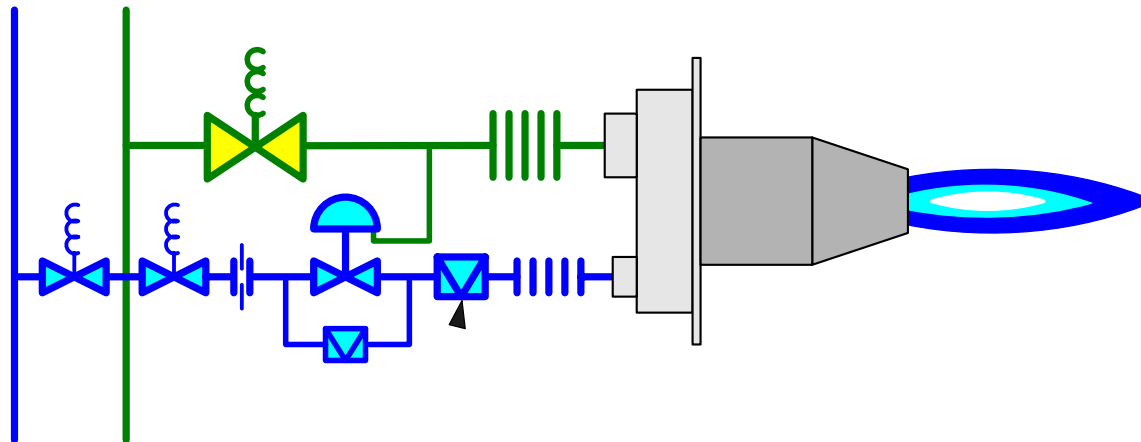
- Specialized type of cross-connected control
- Frequency modulation instead of amplitude modulation
- Special air solenoids and ratio regulators for each burner.
- Burners fire high-low or high-off
- Can be used with any burner capable of cycling



Pulse Fire Control



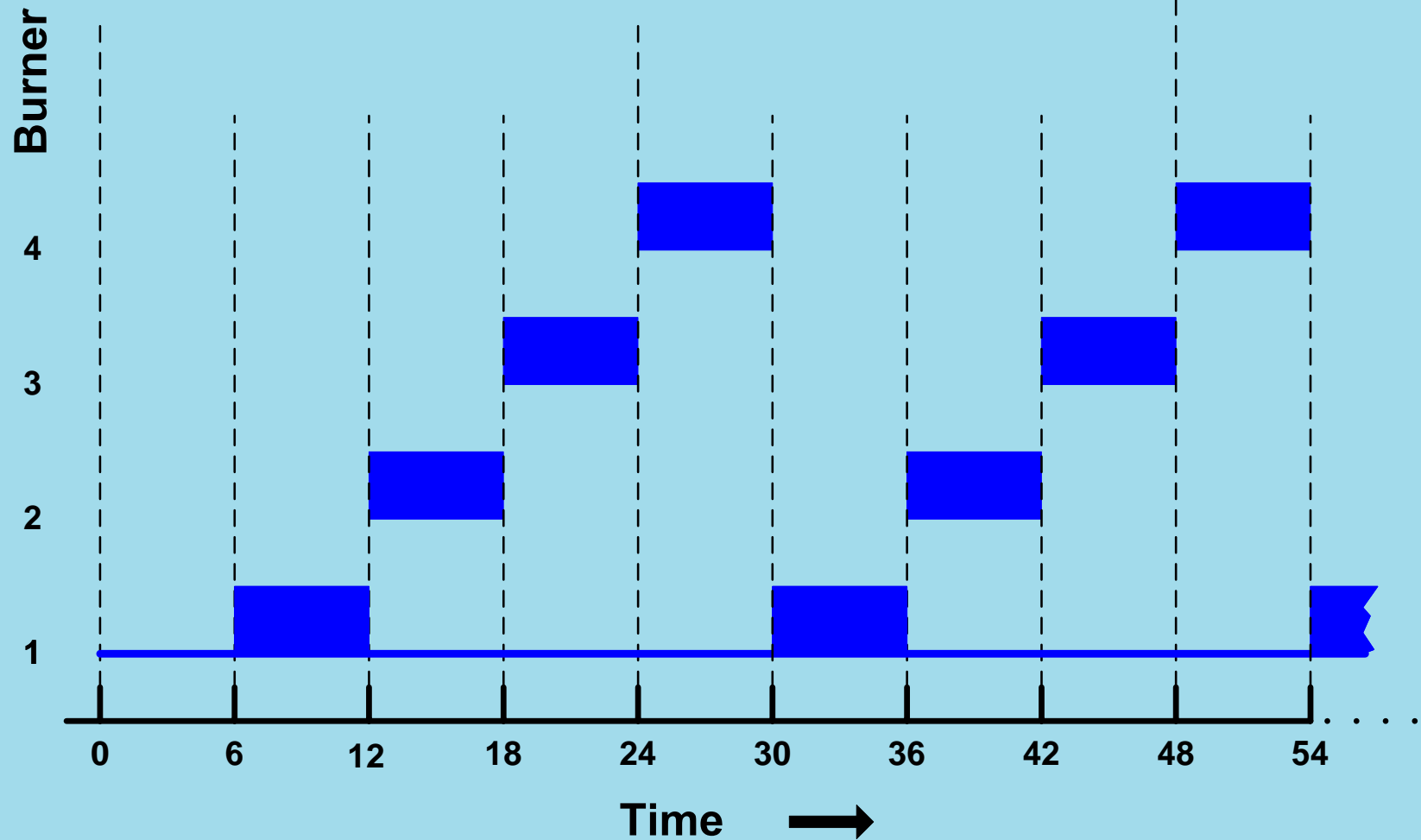
- Burners operate at either high fire or low fire.
 - High and low flows are fixed and repeatable (for reliable and almost unlimited turndown).
- Heat input is controlled by varying the amount of time the burners are pulsed off.
 - Individual burner “high fire ” times are sequenced so all burners “take their turn” at high fire.



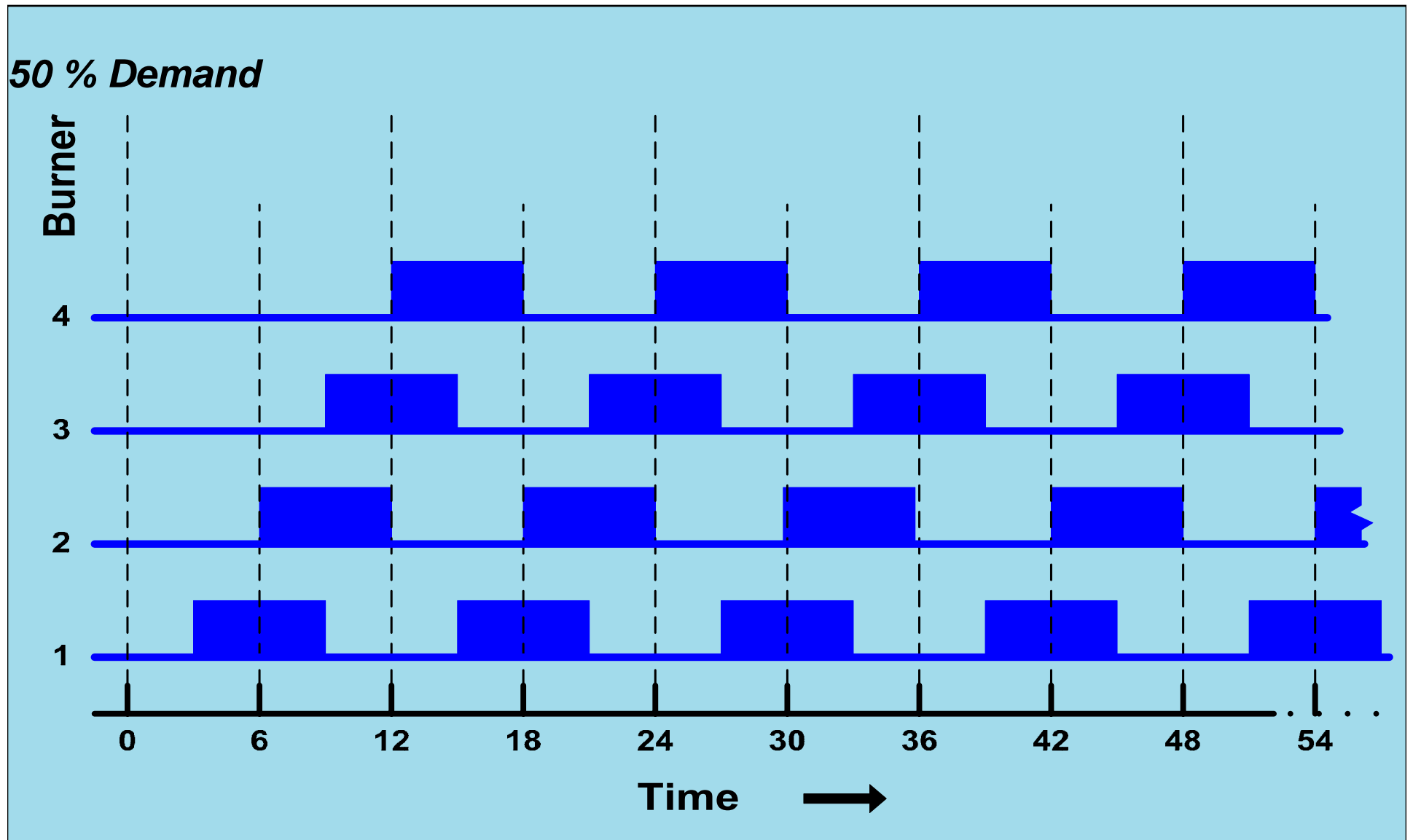
Pulse Fire Control



25 % Demand



Pulse Fire Control



Pulse Fire Control



Advantages

- Reduces fuel usage
 - Reduces excess air required for uniformity & turndown.
 - Increases heat transfer
- Reduces emissions
 - Less fuel input required = A lower emissions potential.
 - Better “natural” flue gas re-circulation.
- Increases/promotes temperature uniformity without excess air
- Uniform piping and equipment to every burner
- All burners are set identically (high/low fire)
- Electronic zoning makes changes easy
- Pulse logic can be tailored for application needs = Flexibility

Pulse Fire Control



Disadvantages

- Hardware costs
 - Each burner has air and gas controls valves so upfront capital costs are higher than traditional control systems
 - Control system can be more expensive

Efficiency



How can fuel usage be reduced further beyond the methods discussed?

Air Preheat

- How does heat recovery save fuel?
 - Preheating the air reduces the heat required to attain exit gas temperature.
 - Flame temperature is increased.
 - More heat is now available to heat the load instead of the air.

PREHEATED AIR

Energy Saving

File Help

Current Units

- US-Units
- SI-Units

Select Fuel

Case I	Case II
Average Natural Gas	Average Natural Gas
Blast Furnace Gas	Blast Furnace Gas
Butane	Butane

Enter Combustion Condition data for both cases

Parameter	Case I	Case II
Combustion Air Temperature	60.0 F	500 F
Exhaust Temperature	2000 F	2000 F
Excess Air (%)	10	10
Oxygen in Combustion Air (%)	20.9	20.9
Flue Gas Recirculation (%)	0	0
Flue Gas Recirculation Temperature	60.0 F	60.0 F
Fuel Preheat Temperature	60.0	60.0

Calculate Energy Savings

Available Heat Case I (%)	42.4
Available Heat Case II (%)	50.7
Energy Saving in Case II (%)	16.4

Energy Cost **Print Preview** **End**

PREHEATED AIR



How do you preheat the air?

Recuperation

- Centralized Recuperator/Heat Exchanger
- Self-recuperative burners

Regeneration

- Paired Regenerative burners

Air preheat will be seen more often as fuel prices continue to rise and CO₂ (carbon) emissions become increasingly regulated.

There is no one burner, one control method, or one system that will act as a magic wand for increased productivity, improved product quality and reduced fuel costs. There are advantages and limitations with all system types.

In the end, the question remains: What change, upgrade, or improvement will be the best choice to achieve your goals in your application?

Thank you

Questions??

