Combustion Equipment Selection For Efficiency & Emission

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Presentation Outline

- NOx Generation
- Combustion Efficiency
- Burner and Control Selection
- Conclusion

NOx Generation

- THERMAL NO_x - from N_2 and O_2 in air used for combustion (>2780 ^oF, the Zel'dovich temperature)
- FUEL NO_x - from nitrogen chemically bonded in the fuel reacting with O_2 in air
- PROMPT NO_x - from air's N_2 reacting with fuel radicals during initial reactions

Combustion of Methane Simplified Equation:

$$CH_4 + O_2 + N_2 \longrightarrow CO_2 + H_2O + N_2 + HEAT$$

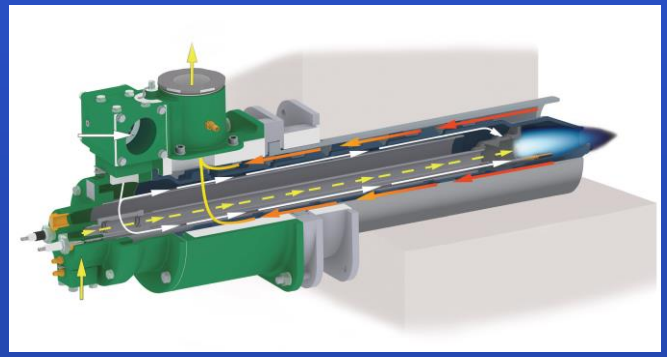
NOx Generation

- The driving mechanisms that turn reactants into products of combustion are:
  - Time
  - Temperature
  - Turbulence
- These mechanisms, as well as the amount of available reactants (Air to Fuel Ratio) dictate the equilibrium of the equation, i.e., how much of the air and fuel stays air and fuel, and how much reacts and becomes products of combustion.

Combustion Efficiency

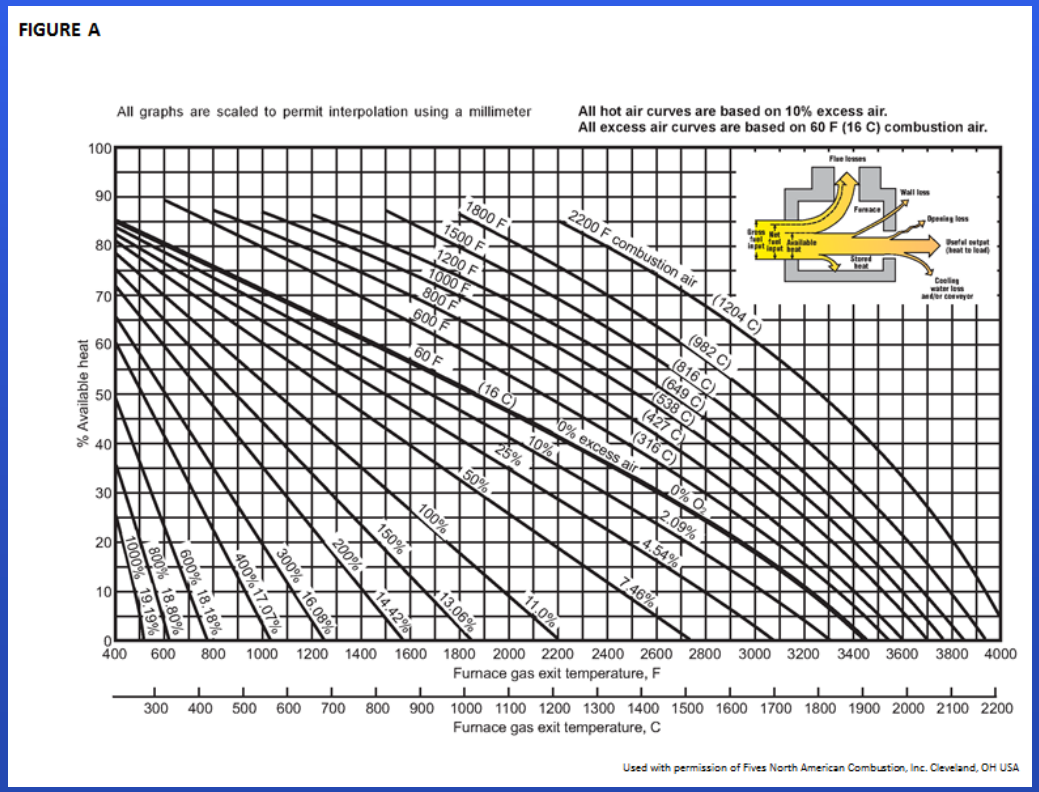
- **Fuel/Air Ratio**
  - Fixed Air
  - Ratio Regulated
  - Position Proportional

- **Combustion Air Preheat**
  - External
  - Internal



Combustion Efficiency

- Available Heat Chart

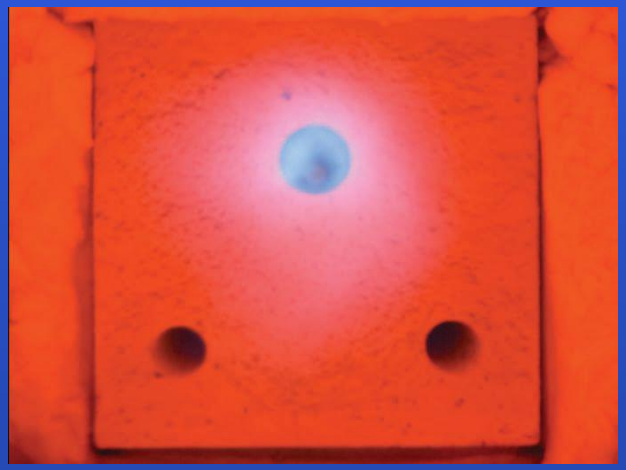


Burner & Control Selection

- **Lean Premix**
  - **Modular Burner**
  - **Low temp ultra low emissions**

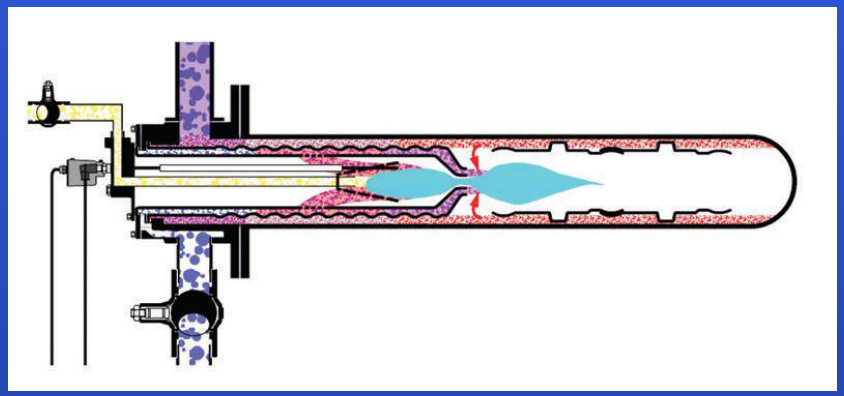
Burner & Control Selection

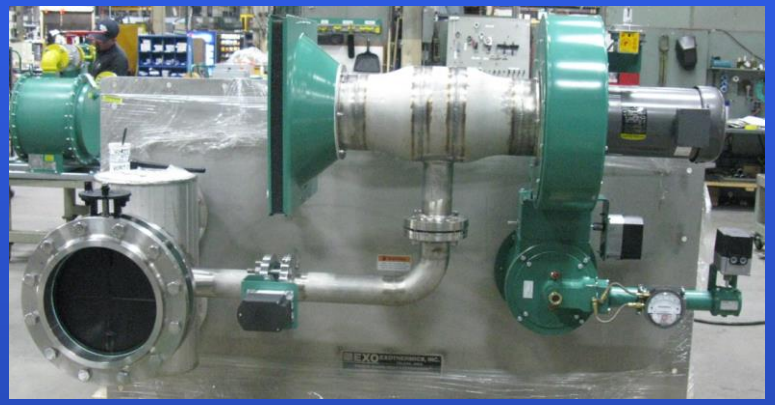
- **Staged Combustion**
  - Has to be above auto ignition
  - Fuel rich primary air staged



Burner & Control Selection

- **FGR**
  - **Low and High temp Applications**





Burner & Control Selection

- **Flameless Combustion**
  - Has to be above auto ignition temp
  - Defined Chamber Requirement

Conclusion and Summary

- NOx
  - Prompt and Thermal NOx
- Efficiency
  - Preheated Air
  - Excess Air
- Burner & Controls
  - Precise Control