OXIDATION TECHNOLOGIES
www.pcc-group.com
FOR A BETTER ENVIRONMENT

# Flameless Oxidizer Discussion

Presented to:

AQMD
South Coast Air Quality Management District

World Leader of Custom Designed, Integrated Solutions for Industrial Pollution.



OXIDATION TECHNOLOGIES
www.pcc-group.com
FOR A BETTER ENVIRONMENT

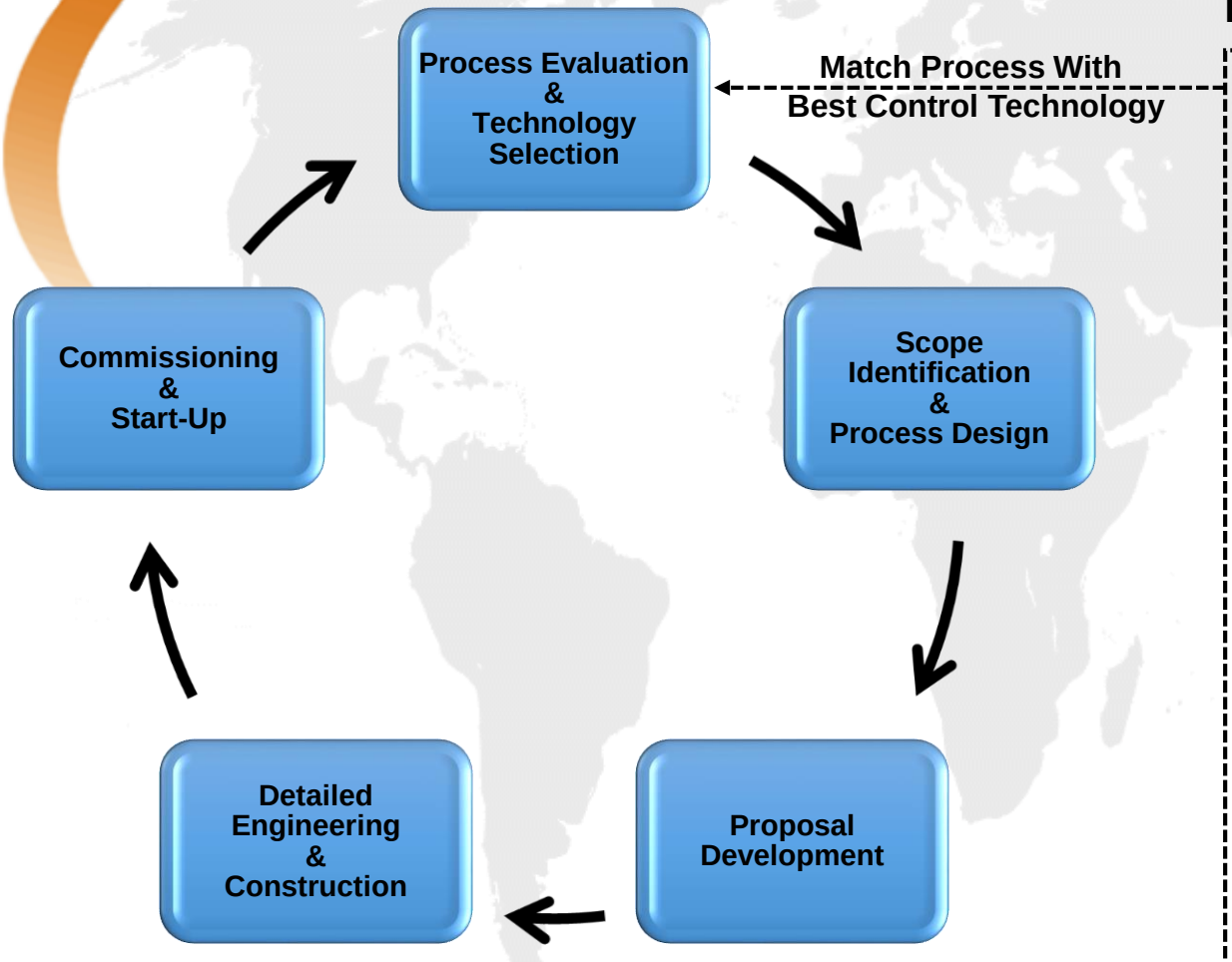
# Introductions

- Mike Foggia – PCC Business Development Manager
- Nick DiSanti – Flameless Thermal Oxidizer Product Manager
- Scott Fernbach – Southland Environmental, Inc.

# A New Era: PCC is Employee Owned

- PCC formed in 1969 as joint venture
  - ✓ Bloom Engineering Company (USA)
  - ✓ Urquhart Engineering Company (UK)
- Sterling Industries PLC (UK) Acquired PCC, Urquhart, and Bloom in 1984
- In 2012 Management initiated Product Line Expansion
- In 2017 PCC became an Employee Owned Company via a Management buyout

# Custom Designed & Fully Integrated Air Pollution Control Solution Provider



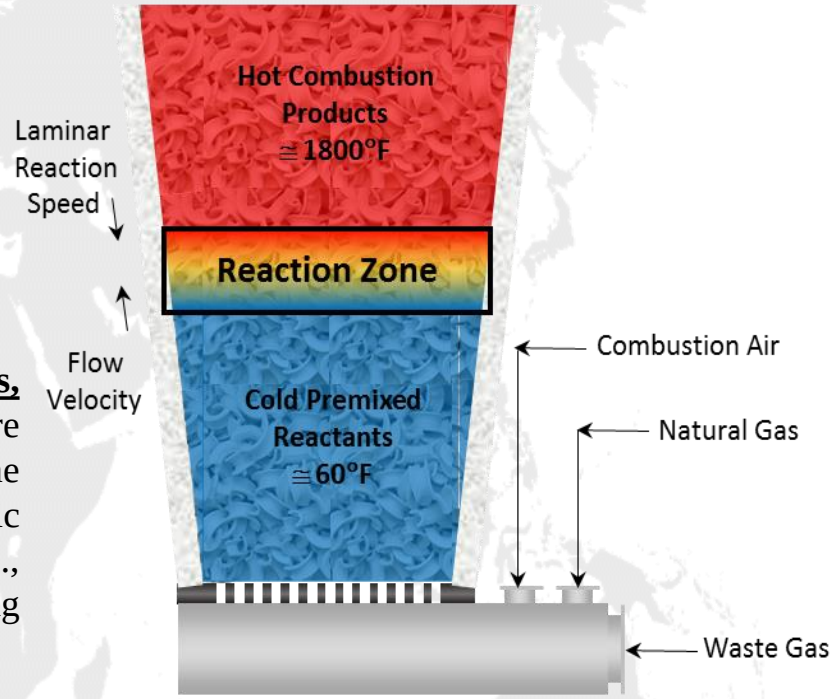

**PCC's "Technical Offering"**

**Thermal Oxidation**

**Bio Oxidation**

# What is Flameless Oxidation?

**Flameless Oxidation Temperature Profile**




Flameless oxidation is a thermal treatment that **premixes waste gas, ambient air, and auxiliary fuel** prior to passing the gaseous mixture through a **preheated inert ceramic media bed**. Through the transfer of heat from the media to the gaseous mixture the organic compounds in the gas are oxidized to innocuous byproducts, i.e., carbon dioxide ($CO_2$) and water vapor ($H_2O$) while also releasing heat into the ceramic media bed.

The reason why a flame is not generated in the media bed is because the gas mixture is kept **below the lower flammability limit** based on the percentages of each organic species present.

Waste gas streams experience multiple seconds of residence time at high temperatures leading to measured **destruction removal efficiencies that exceed 99.9999%**. Premixing all of the gases prior to treatment eliminates localized high temperatures which leads to **thermal NOx as low as 1 ppmv.**

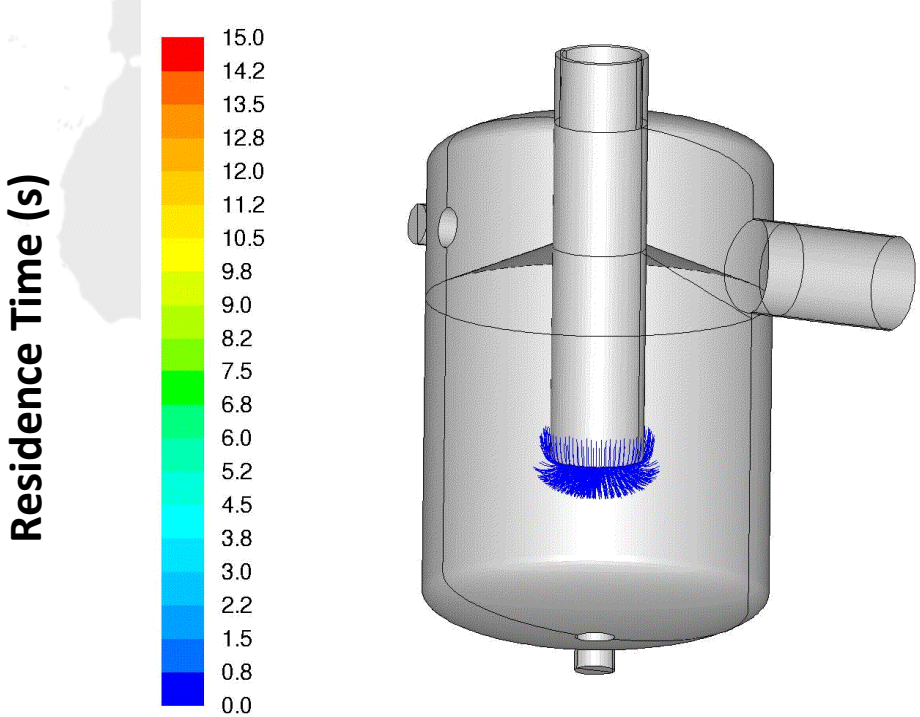
# Where is the FTO Technology best used?

| Project Parameter | Regenerative Thermal Oxidizer (RTO) | Catalytic Oxidizer (CO) | Thermal Oxidizer (TO) | Carbon Adsorption Technology | Bio Oxidizer | FLAMELESS OXIDATION |
|---|---|---|---|---|---|---|
| High Concentration | | | X | | | X |
| Low Concentration | X | X | X | X | X | X |
| Halogenated Service – Cl, Fl, Br | | | X | X | | X |
| Sulfur, Mercaptans, thiols, etc. | | | X | X | X | X |
| DRE 99.99% + | | | X | | | X |
| Continuous Process | | | X | | | X |
| Batch Process | | | X | | | X |
| NOx < 1 ppmv | | | | X | X | X |

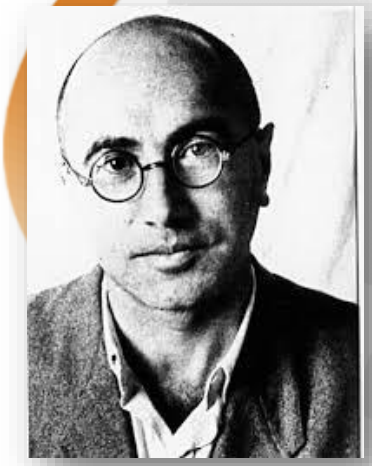
# How do we achieve a DRE of 99.9999%?

**3 T's of Destruction: Time, Turbulence (mixing), Temperature**

- Premixing of waste gas, natural gas, and oxidizing air
- Bed operating temperature ~1800°F (1500 kJ/Nm³)
- Excess oxygen level of ~12%
- Multiple seconds of residence time at high temperatures

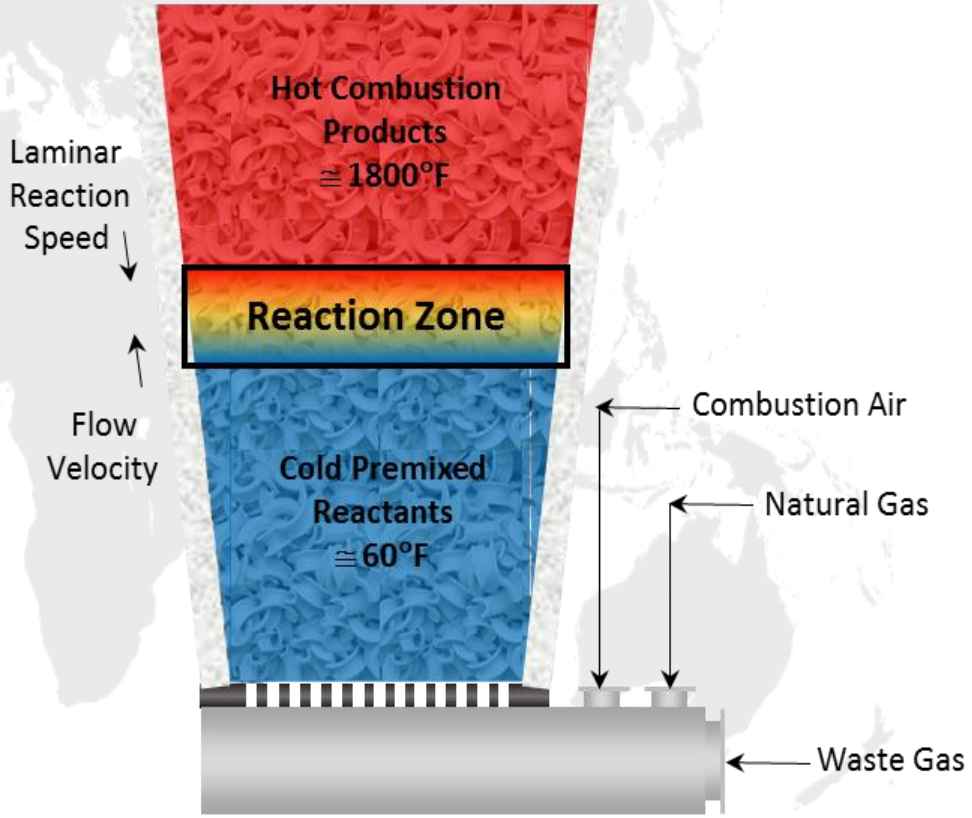


# How do we achieve NOX emissions < 1 ppm?

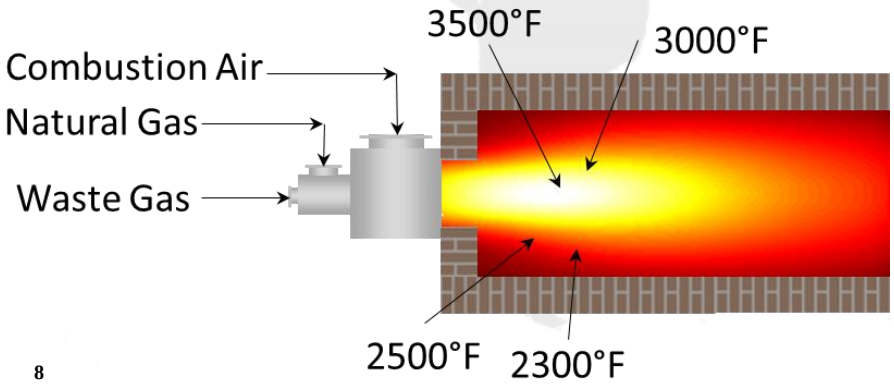


**Yakov Zel'dovich**
Determined the correlation between temperature and NOx formation in a combustion system. Temperatures >2300F cause an exponential growth rate in NOx generation.

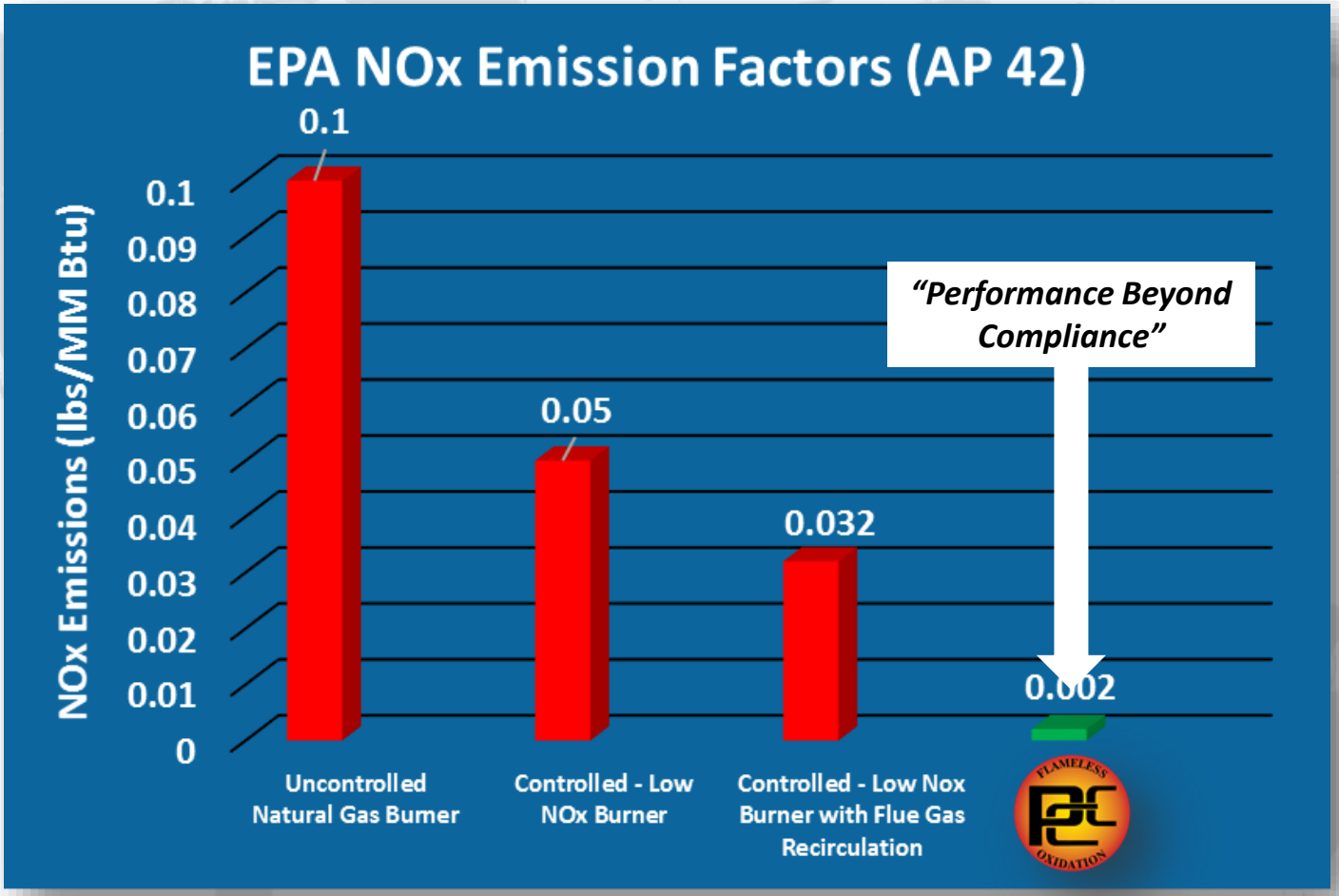
**Flameless Oxidation Temperature Profile**




**Thermal Oxidizer Flame Temperature Profile**

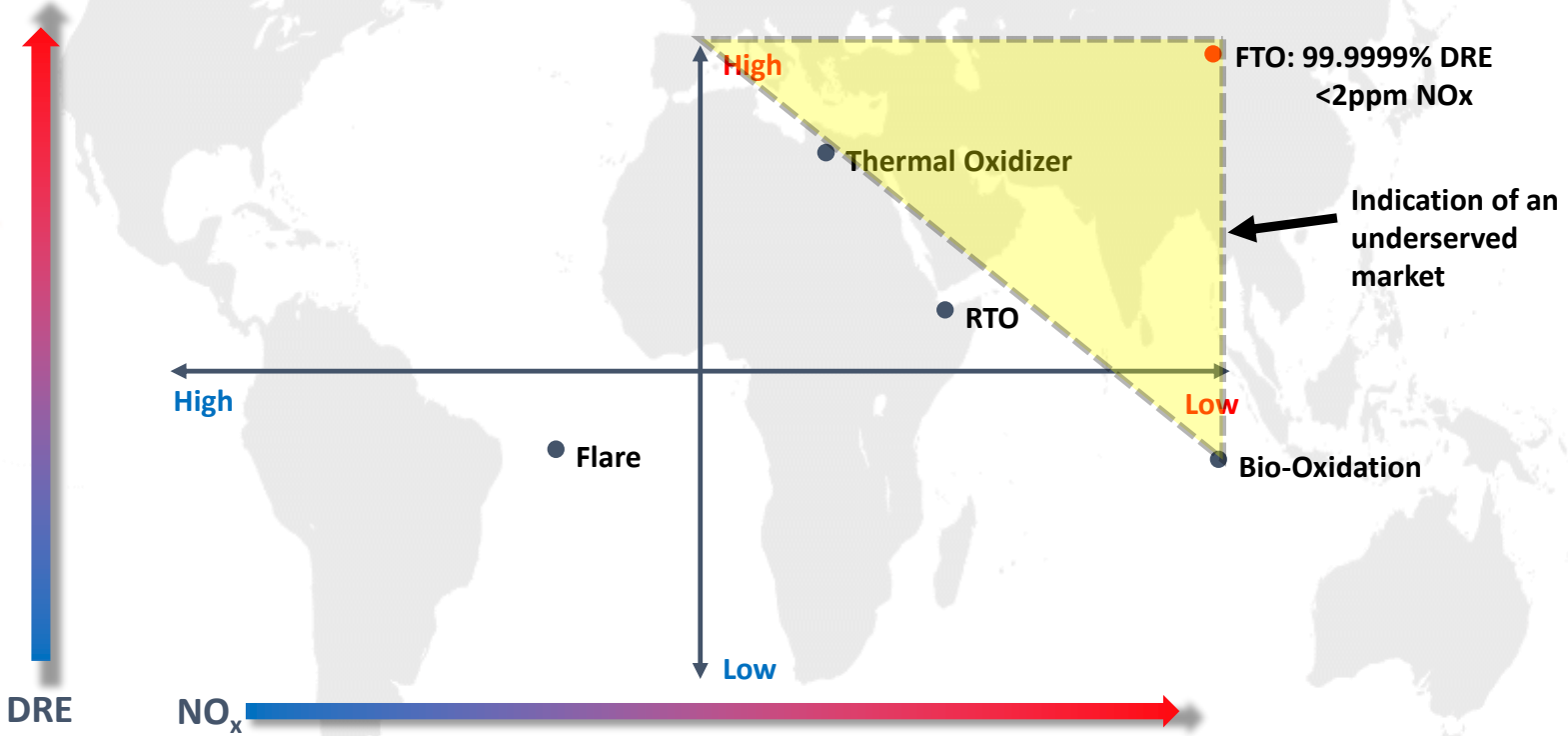


# Comparative NOx Performance

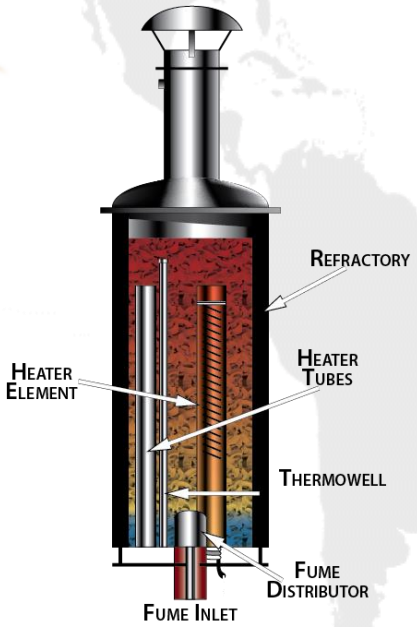



**The PCC FTO achieves 50x less NOx than the Industry Standard Burner!**

# Competing Control Technologies
# NOx v.s. DRE

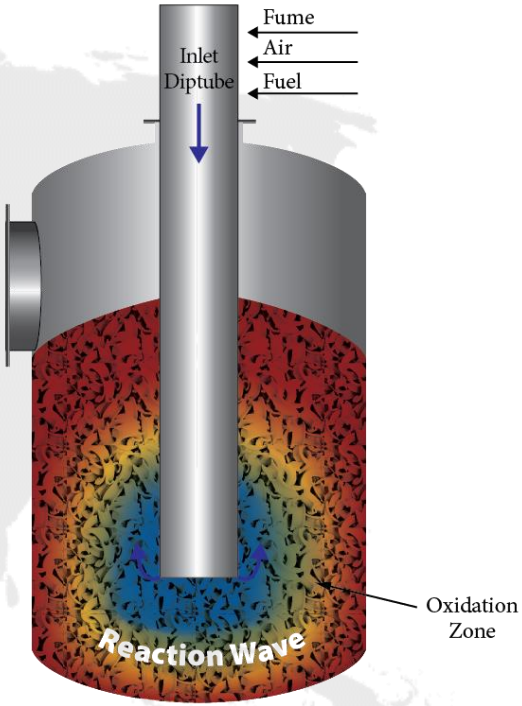


# Flameless Technology Evolution



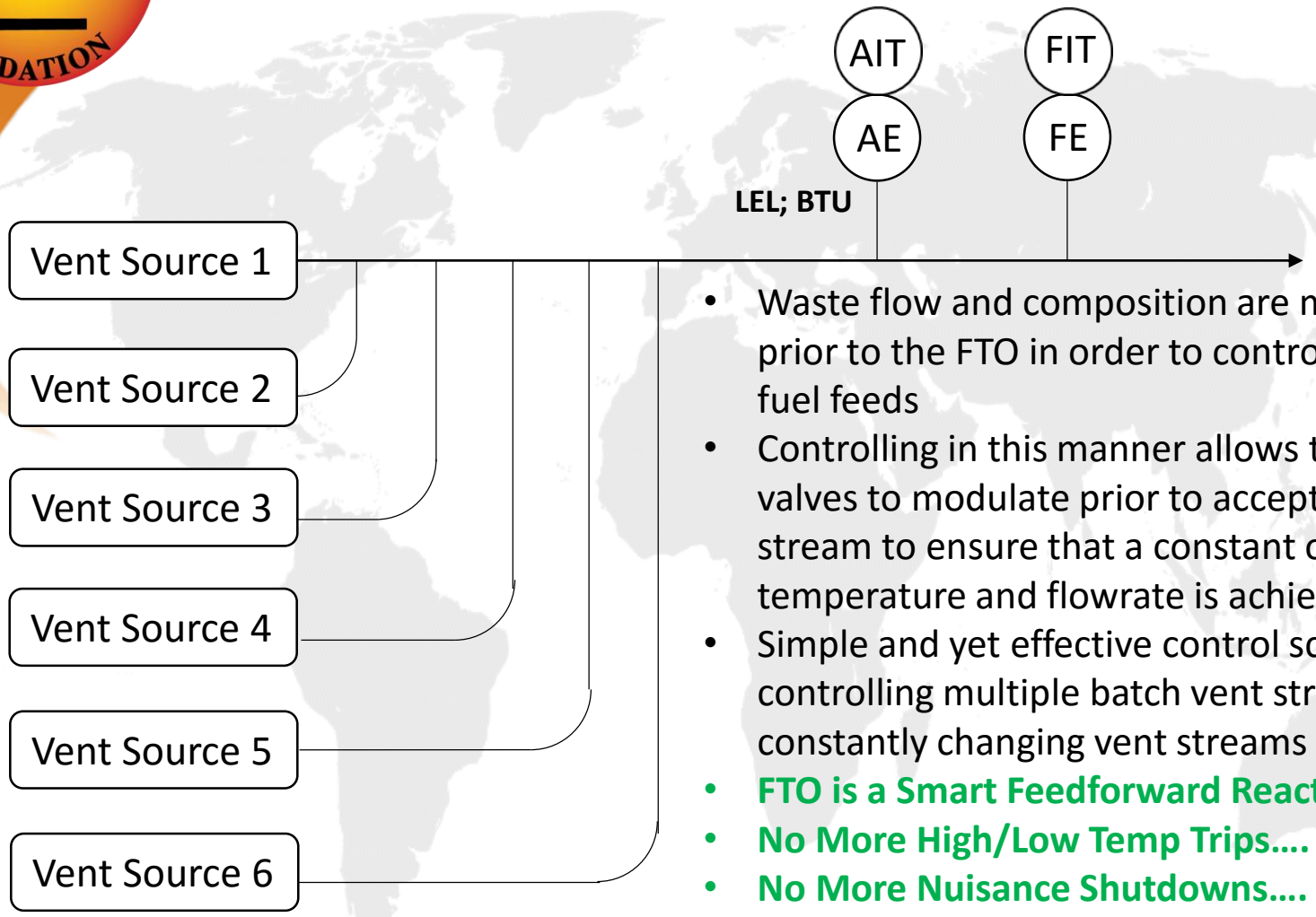

**Electric Model**
**Intended for small emission sources**


**Planar Model**
**Cylinder Reaction Wave**




**Elliptical Model**
**Spherical Reaction Wave**
**4x the reaction surface area of a Planar FTO**
**Hot Shell Design**
**(Invented by PCC owner Will Huebner)**

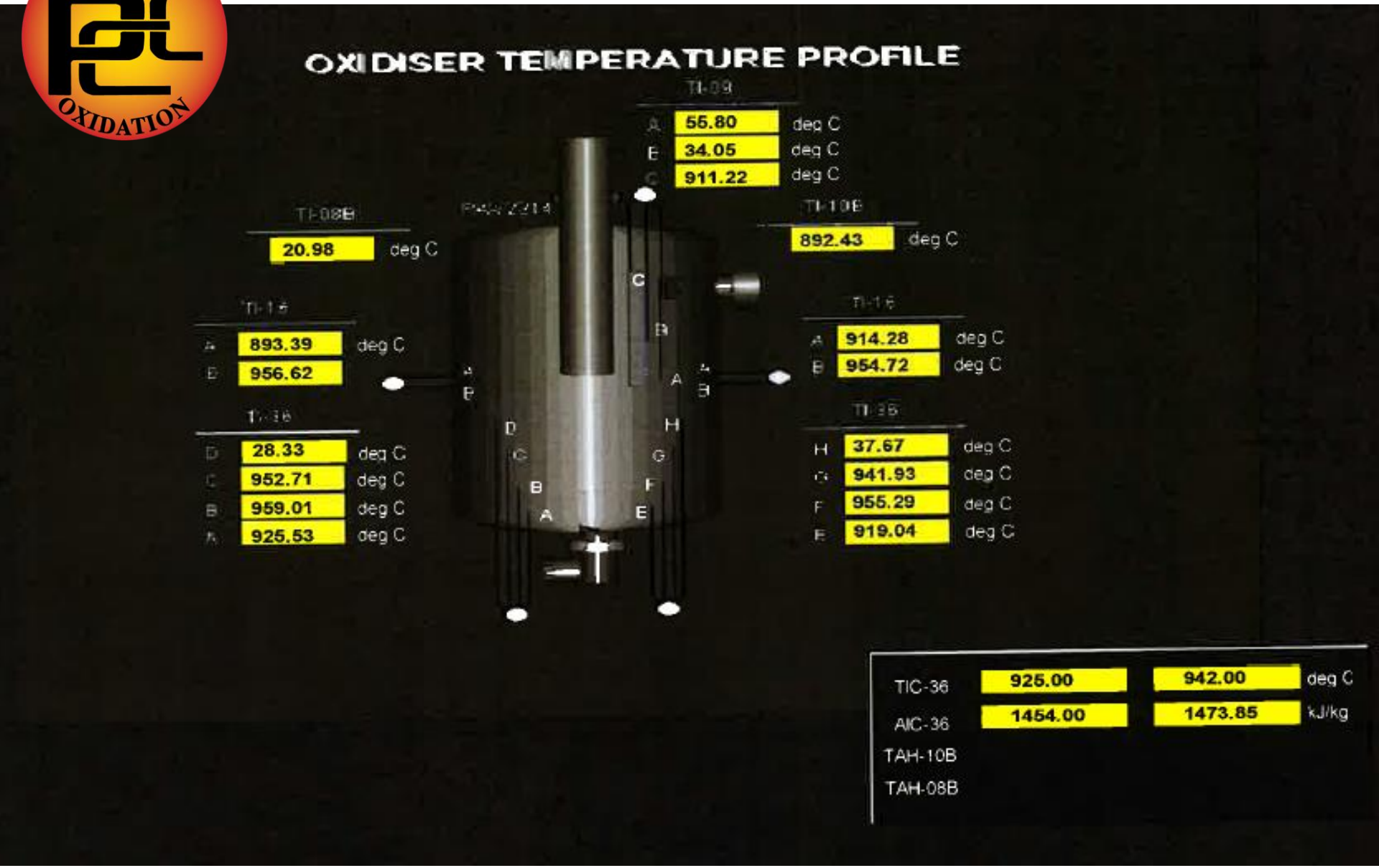
# PCC FTO: Proactive Control

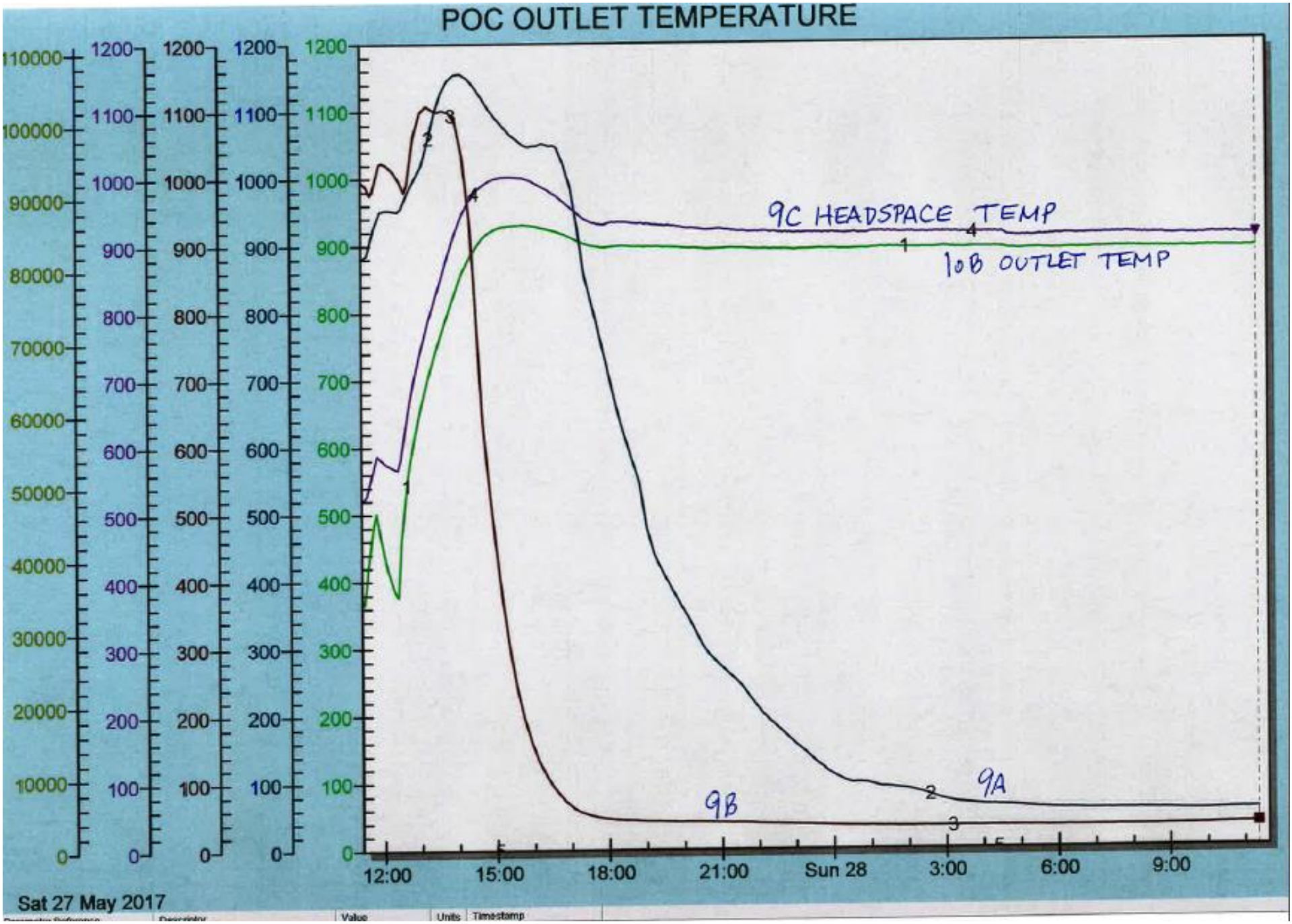



- Waste flow and composition are measured prior to the FTO in order to control the air and fuel feeds
- Controlling in this manner allows the control valves to modulate prior to accepting fume stream to ensure that a constant operating temperature and flowrate is achieved
- Simple and yet effective control scheme for controlling multiple batch vent streams or constantly changing vent streams
- **FTO is a Smart Feedforward Reactor**
- **No More High/Low Temp Trips….**
- **No More Nuisance Shutdowns….**
- **Great for Sold Out Products!**
- **Maximize Production Time!**

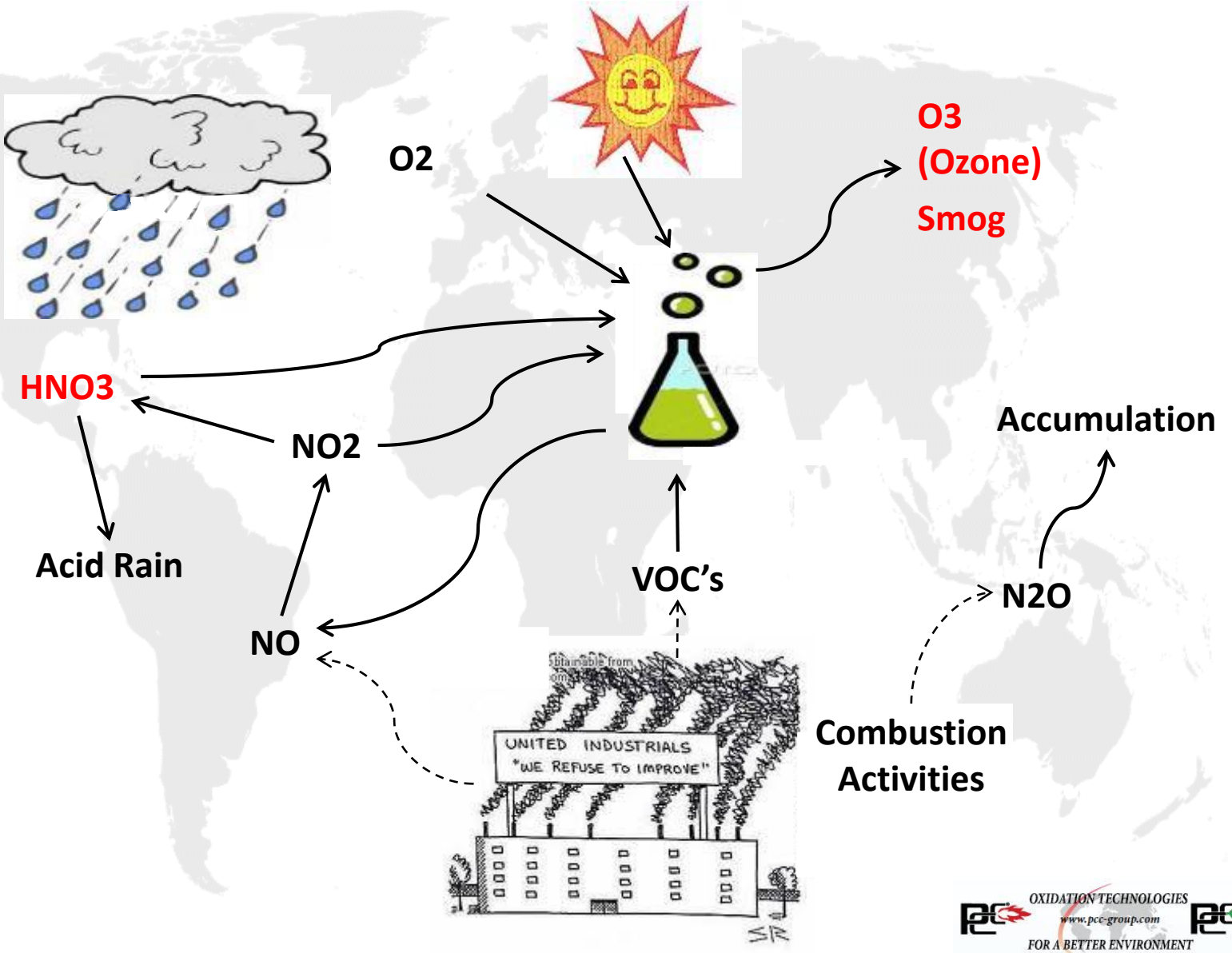
# Example FTO Installations


**14’ Ø Elliptical FTO**
**(Ireland)**

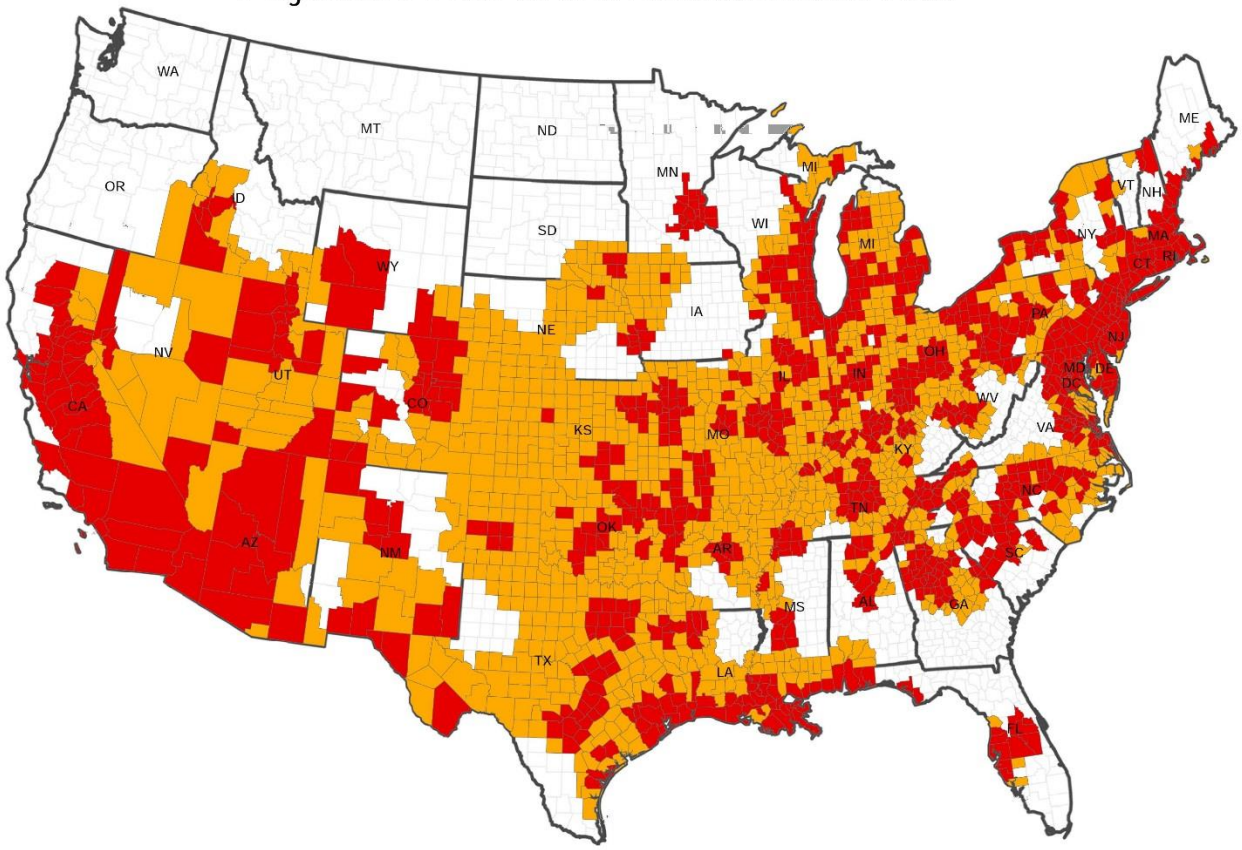

OXIDISER TEMPERATURE PROFILE
TI-09
A 55.80 deg C
B 34.05 deg C
C 911.22 deg C
TI-08B
20.98 deg C
TI-10B
892.43 deg C
TI-15
A 893.39 deg C
B 956.62 deg C
TI-16
A 914.28 deg C
B 954.72 deg C
TI-36
D 28.33 deg C
C 952.71 deg C
B 959.01 deg C
A 925.53 deg C
TI-35
H 37.67 deg C
G 941.93 deg C
F 955.29 deg C
E 919.04 deg C
TIC-36 925.00 942.00 deg C
AIC-36 1454.00 1473.85 kJ/kg
TAH-10B
TAH-08B


POC OUTLET TEMPERATURE
9C HEADSPACE TEMP
10B OUTLET TEMP
9A
9B
12:00
15:00
18:00
21:00
Sun 28
3:00
6:00
9:00
Sat 27 May 2017

# Chemical Reactions In Air




## Projected 8-Hour Ozone Nonattainment Areas



# Performance Beyond Compliance

- Installing a high performance Flameless Thermal Oxidizer will generate Emission Reduction Credits (ERC's)
- ERC's can be used to offset new emissions for a site expansion

**Typically ERC's are sold for ~$40,000 per ton but can be as high as $400,000 per ton in non-attainment areas!**

**Treating emission sources with a PCC FTO will:**

1) **Generate emission credit revenue for your manufacturing site**
2) **Allow for plant expansions without modifying an existing air permit**

# PCC FTO
# Your Environmental Competitive Advantage

| *Flameless Oxidation* | | |
|---|---|---|
| **Values** | **Feature** | **Benefit** |
| **Low NOX** | Low Temperature Premixed Oxidation | <1 ppmv NOx |
| **High DRE** | Premixed Oxidation; 3-4 seconds RT; | 99.9999% DRE |
| **Up-Time** | Stable/Resilient Oxidation Environment; Feed forward control; No Moving Parts; No thermal cycling of media bed (Long ceramic Life) | > 99% Uptime |
| **Easy Permitting** | Eliminate requirement for CEMS (High Performance Oxidizer Reactor) | Less time to permit |
| **ROI** | Lower emissions; Emission Trading opportunity; Ease of site expansion | Lower Permitting Costs, Emission Credits, Added Reliability (More Production) |
| **Operational Flexibility** | Multiple control set points; 100% Waste gas turndown; Accept varying waste compositions | "Ready-Idle" mode to limit fuel use & Stable Operation |