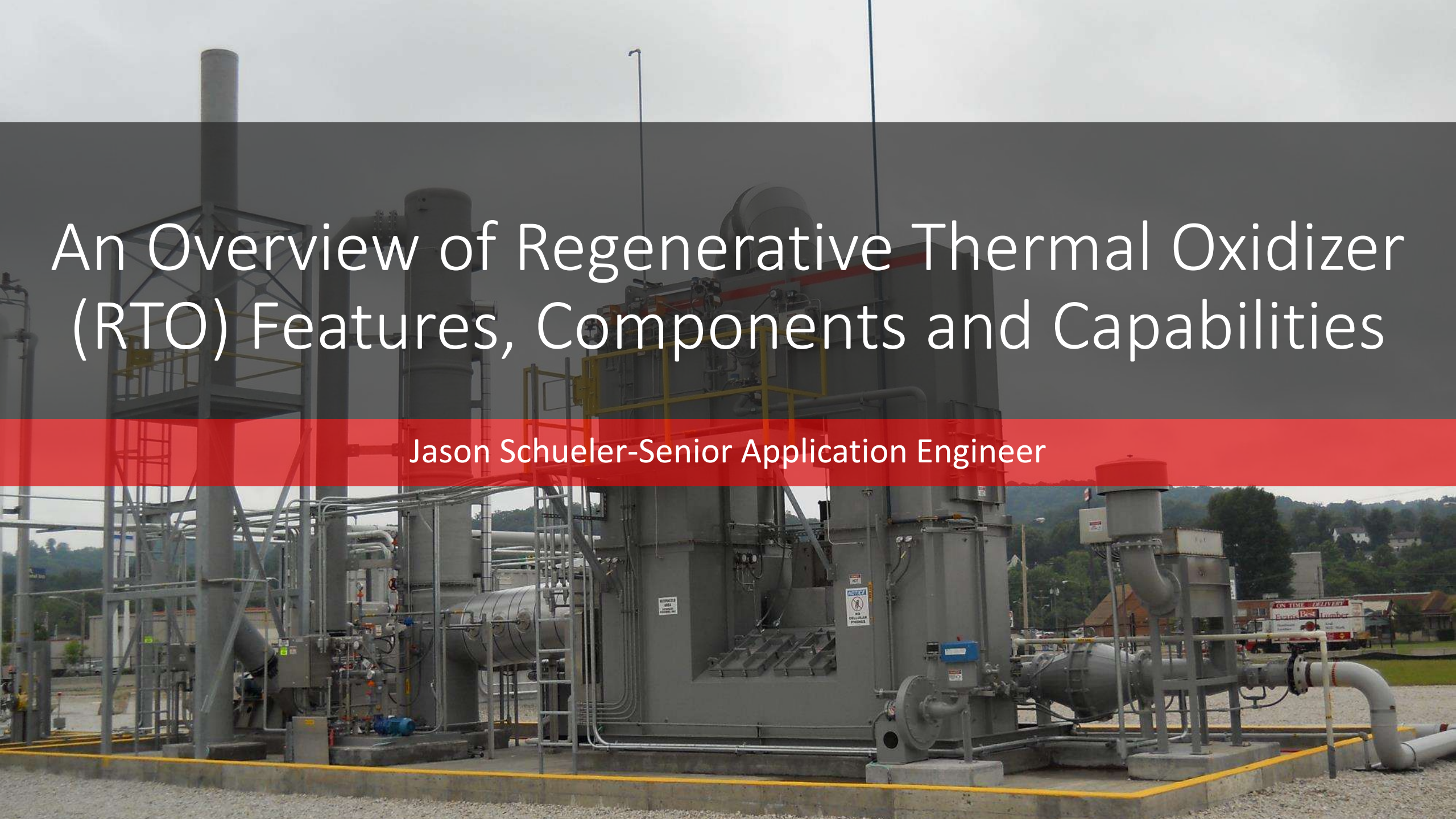
An Overview of Regenerative Thermal Oxidizer (RTO) Features, Components and Capabilities

Jason Schueler-Senior Application Engineer



AGENDA

September 8th, 2021

- **Oxidation Technology Overview**
- **Regenerative Thermal Oxidizer (RTO) Technology Design Considerations and Options**
- **RTO Efficiency Enhancements**
- **Questions & Discussion**

What is Oxidation?

$C_nH_{2m} + (n + m/2) O_2 \Rightarrow n CO_2 + mH_2O + heat$

TIME

Relates to how long a compound needs to be at a certain temperature in order for it to be oxidized.

TEMPERATURE

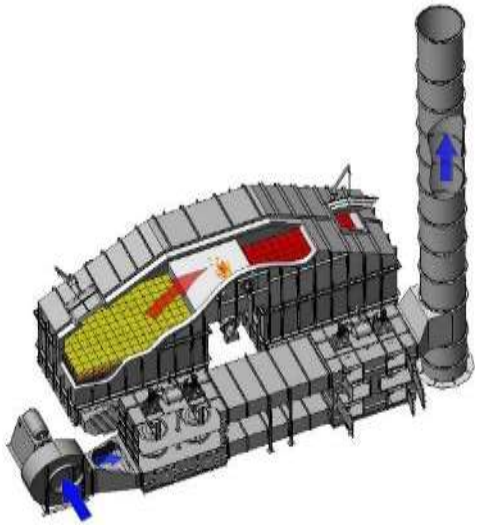
Based on the VOCs that need to be destroyed, there is a temperature at which the compounds can be oxidized.

TURBULENCE

A fixed condition built into the equipment design that ensures a proper mixture of VOCs and oxygen for combustion.

Specific compounds and desired destruction rate efficiency determine temperature and residence time.

Oxidizer Technology Overview

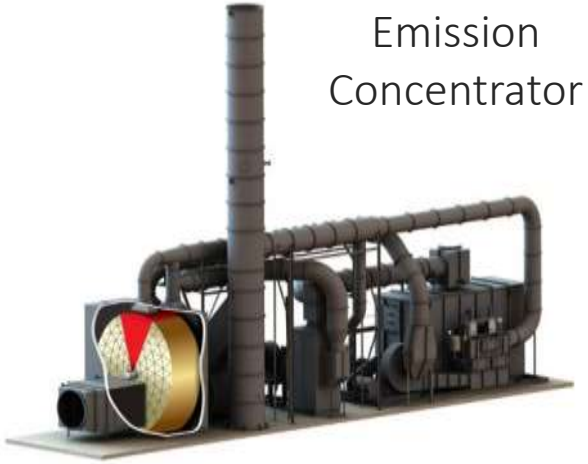


Regenerative Thermal Oxidizer (RTO)

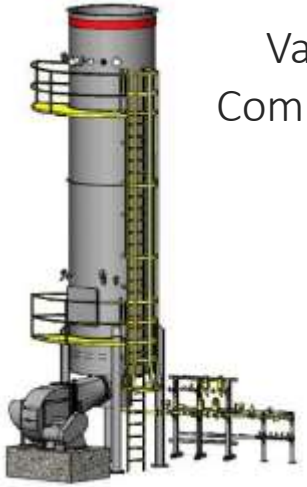
Thermal Recuperative Oxidizer

Direct-Fired Thermal Oxidizer (DFTO)

Catalytic Recuperative Oxidizer

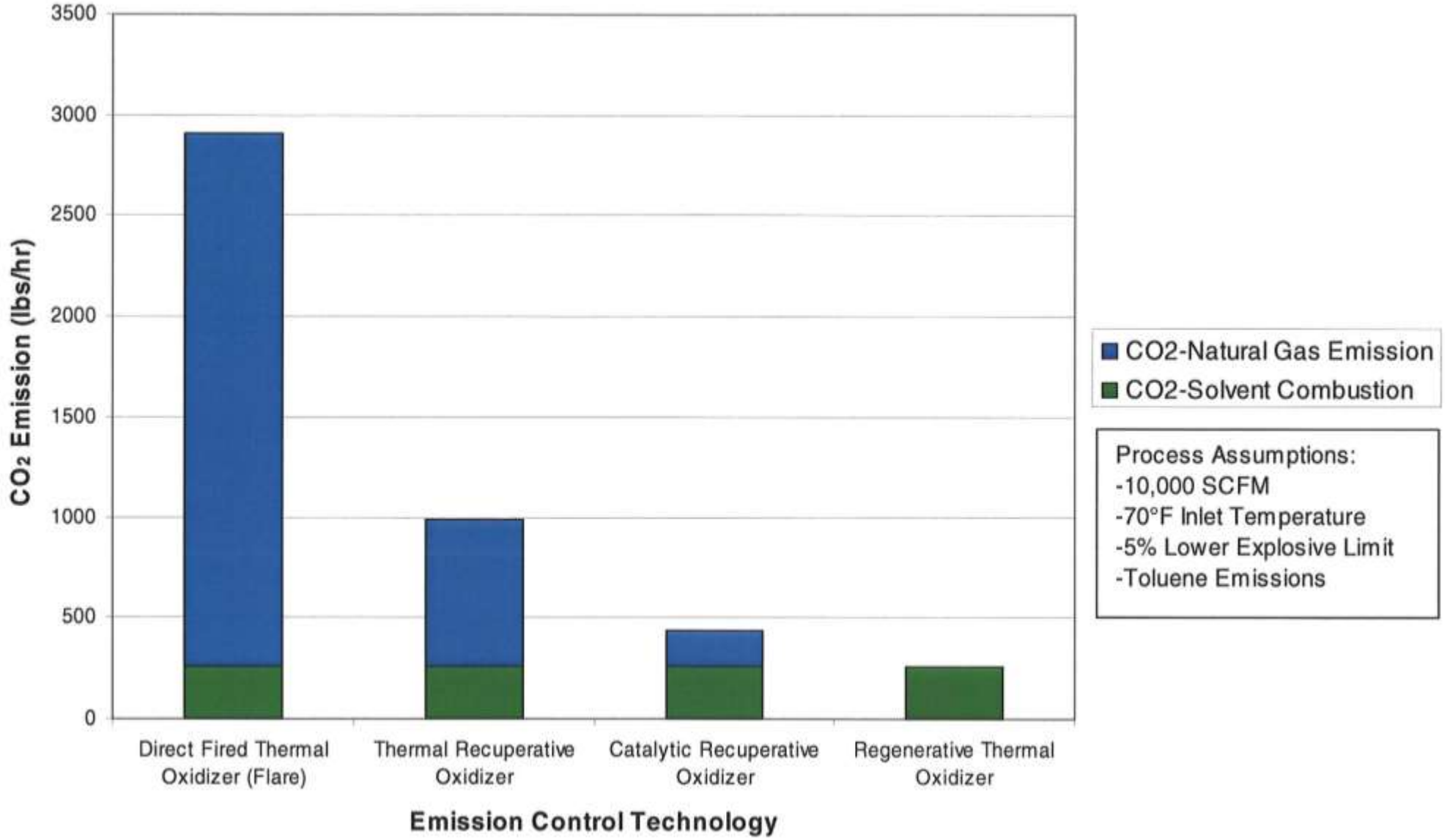


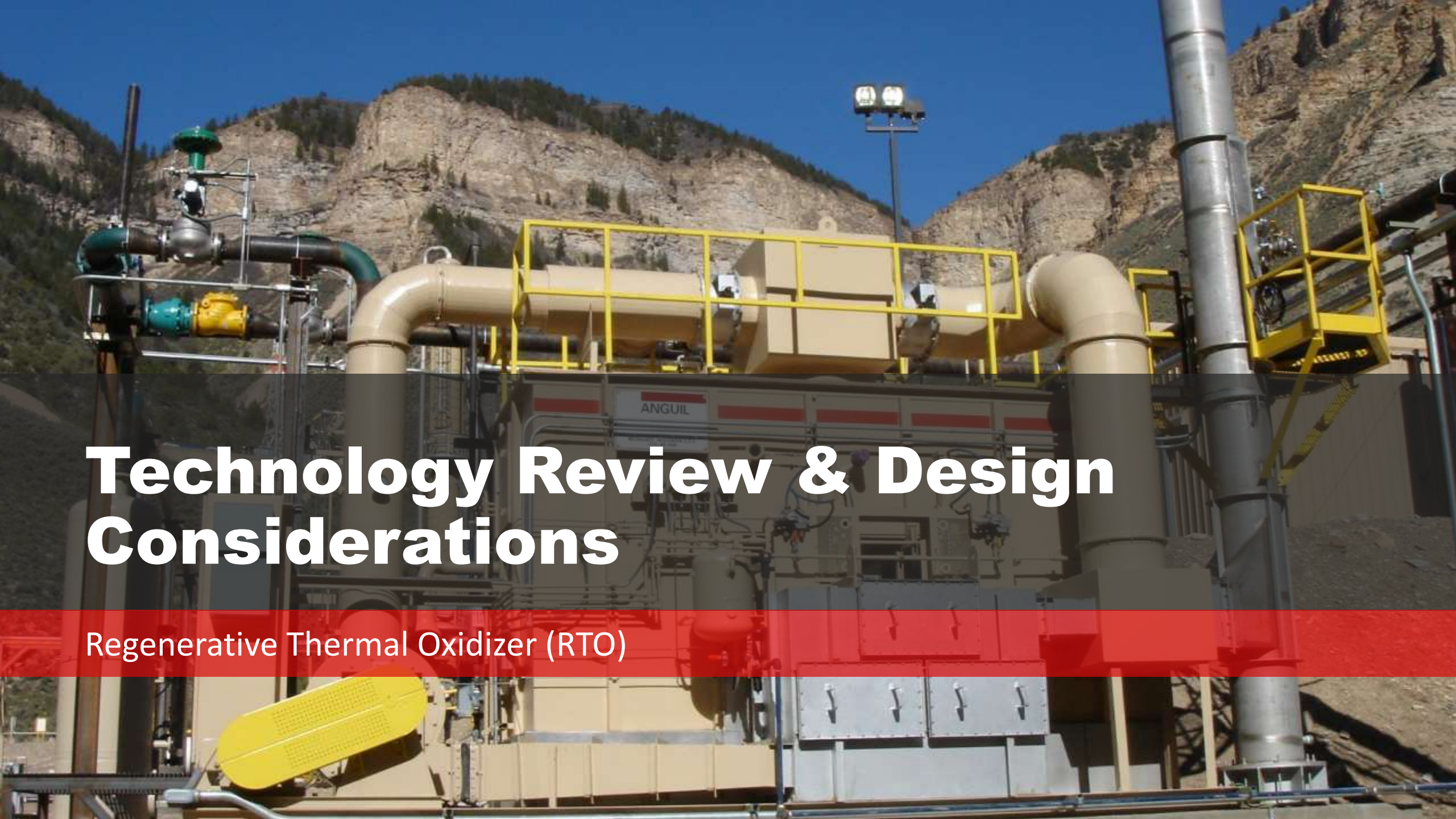
Emission Concentrator



Vapor Combustor

Oxidizer Gas Consumption & CO2 Output Comparison





Technology Review & Design Considerations

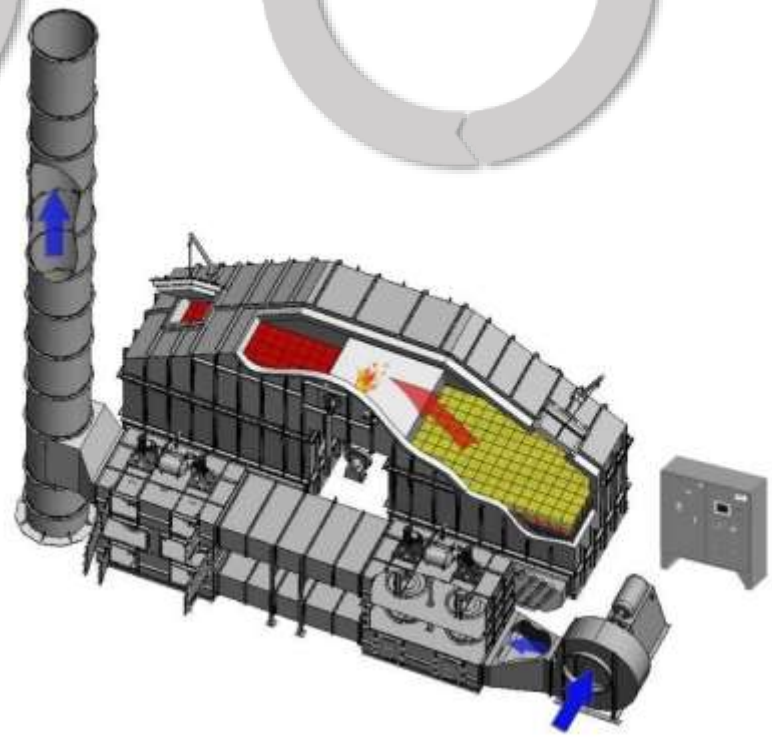
Regenerative Thermal Oxidizer (RTO)

Regenerative Thermal Oxidizer (RTO) Overview

AIR FLOW RANGE	CONCENTRATION RANGE	THERMAL ENERGY RECOVERY	DESTRUCTION RATE EFFICIENCY (DRE)
2,500-70,000 SCFM Single Unit	0 – 25% LEL	True 95%+	99%+

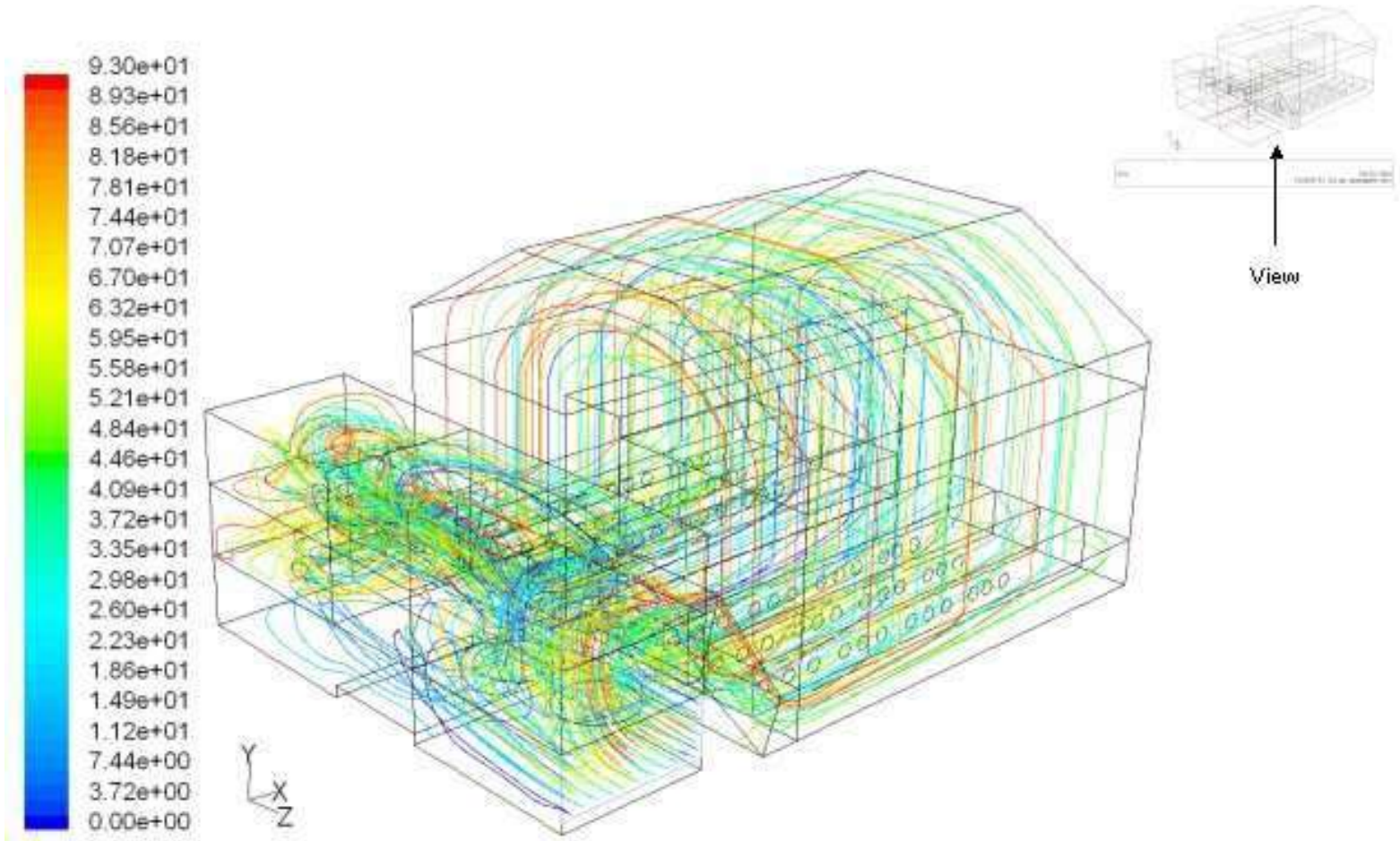
INDUSTRY FOCUS

- OIL AND GAS
- COMPOSITES
- PAINTING
- CHEMICAL
- EXPANDED POLYSTYRENE
- PHARMACEUTICAL
- COATING
- METAL DECORATING
- WOOD FINISHING
- PRINTING



RTO Mode of Operation

RTO Design Considerations



CRITICAL FACTORS

Airflow

Even Flow

Even flow distribution requires even pressure distribution

Heat Distribution

Even Pressure and Flow Distribution
= Even Heat Distribution
= High HCN Destruction at Lower Burner Temps AND Low NOx Outlets

Diverter Valve Options

TYPES OF VALVES

- Poppet Valves (Horizontal and Vertical)
- Butterfly Valves
- Rotating (Single) Valves

MODES OF OPERATION

- Pneumatic
- Hydraulic

WHY VERTICAL POPPET VALVES?

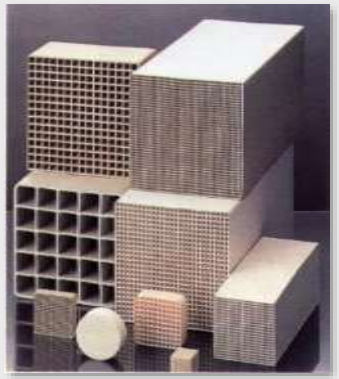
- Maintenance
- Design
- Cost

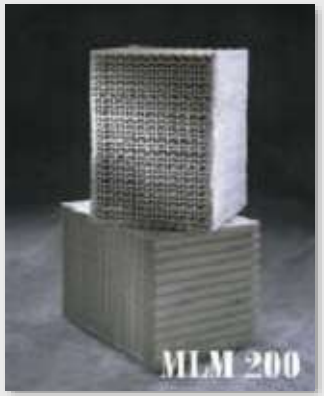
Typical Insulation

- 8” ceramic block, 8lb density
- Rated for 2,300°F
- Staggered seams, stainless steel reinforcements and multiple mounting pins
- Protective blanket

Types of RTO Heat Recovery Media

Advances in Ceramic Media Now Allow for 97% Thermal Energy Recovery!





RANDOM PACKING

- Typically 1” or 1½”
- ½” – 3” Available

EXTRUDED HONEYCOMB MONOLITH

- Variety of cell sizes and wall widths
- Typical block size: 150 x 150 x 300

MULTI-LAYERED MEDIA

- Style and Size Options

Media Comparison

	Saddles	Honeycomb Monolith	Multi-layered
Capital Cost	Low	High	Medium
Installation Cost	Lowest, significant advantage for large systems	Slightly higher	Slightly higher
Bed Size (Steel Cost)	Large cross section, tall bed	Smaller cross section, short bed	Smaller cross section, medium bed

Media Comparison

	Saddles	Honeycomb Monolith	Multi-layered
Condensable Compounds	Excellent	OK	Excellent
Dirty Applications	Excellent	Not Suited	Good
Clean Applications	Excellent	Excellent	Excellent

Option: Forced Draft vs. Induced Draft

- For acid gas systems induced draft is preferred
- With induced, system is under negative pressure, at any leak point fresh air would be drawn into system; acids (if present) would not leak out
- Any odor or safety concerns, induced draft is preferred

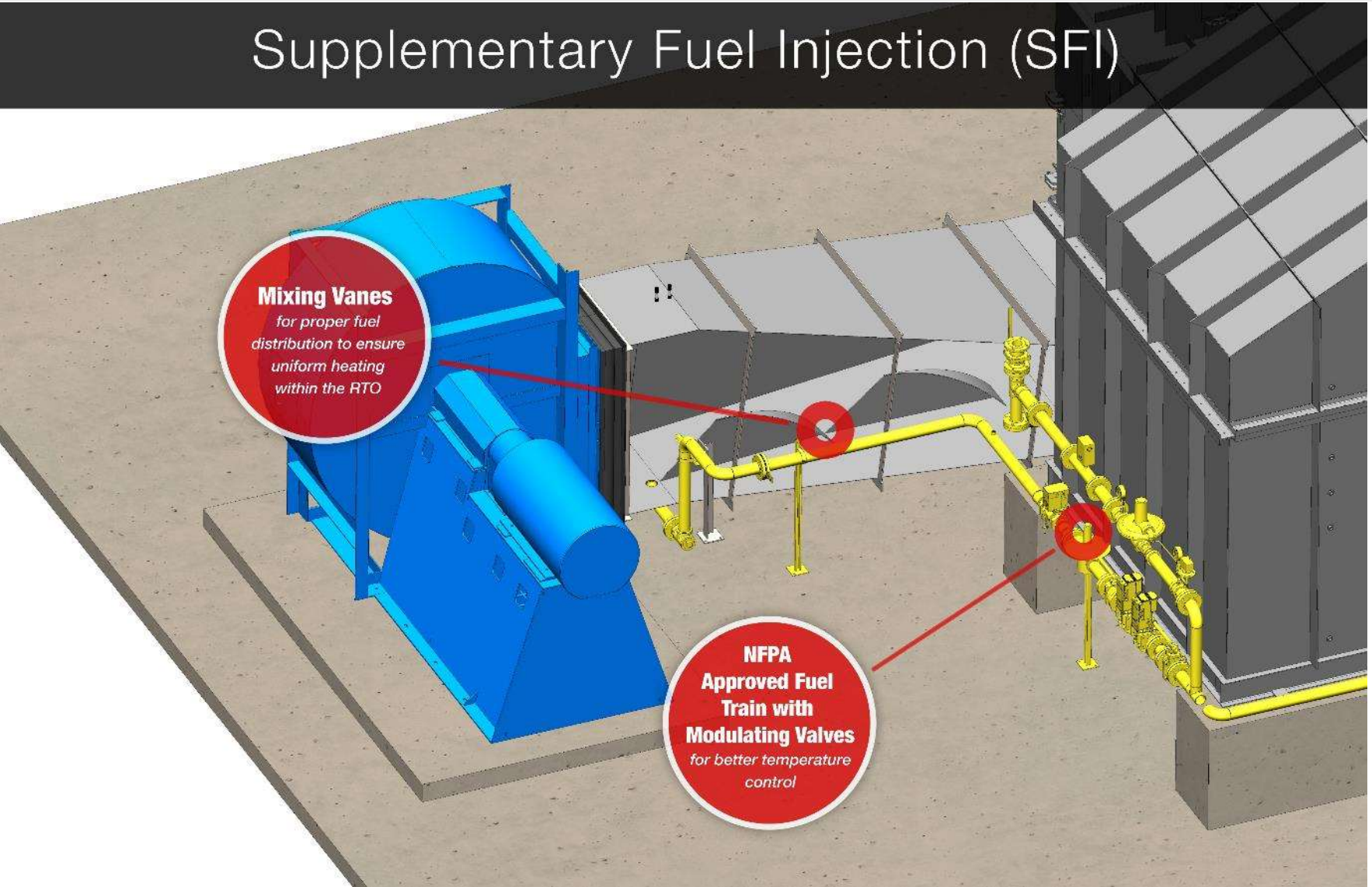
Option: Hot Side Bypass

- Allows unit to handle high VOC loads
- Damper position controlled by PLC and driven with pneumatic actuator with positioner
- Some stainless-steel components
- Damper position controlled by PLC and driven with pneumatic actuator with positioner
- Internally lined bypass duct

Duct and plenum are internally insulated

Option: Supplemental Fuel Injection (SFI)

- Reduces combustion air-flow, lowering operating costs
- Provides uniform temperature in the RTO
- Ultralow NOx emissions with flameless operation



Design Features & Benefits:

- Redundant and optional fuel delivery system
- Modulating valves for more precise control
- Multiple levels of safety features
- Mixing vanes ensure proper flow distribution

Option: Bake-out Feature

- Recommended for process streams with high boilers or condensables
- Runs on reduced airflow until cold face reaches 600-900°F then airflow redirected
- Organics will volatilize
- Inorganic ash will remain
- Valves and duct need to be insulated or guarded for personnel protection

Typical Control Panel Options

- NEMA 12 control panel inside facility
- NEMA 3R heated and air conditioned panel at the oxidizer skid
- Control room at the oxidizer to house Control Panel

Option: 3 Chamber RTO Design for 99.5%+ DRE

- Six controlled butterfly valves
- Third can is purged following valve change to direct untreated VOCs into purification chamber
- 90 second cycle time per bed
- Shorter cycle time leads to higher thermal efficiency
- Higher destruction efficiencies than 2 chamber design
- Higher capital cost than 2 chamber

Operating Cost Reduction Strategies

1. Know your estimated and actual oxidizer operating costs for gas usage and electrical consumption.
2. Pay attention to percentages.
    - A 1% drop in thermal efficiency for a standard RTO equates to a 20% increase in natural gas consumption.
3. Monitor your emission loading. Have process conditions changed since your oxidizer was installed?
4. Determine what type of oxidizer System would be specified today. Technologies and components have advanced.
    - Did you know RTOs can now reach 97% thermal efficiencies?

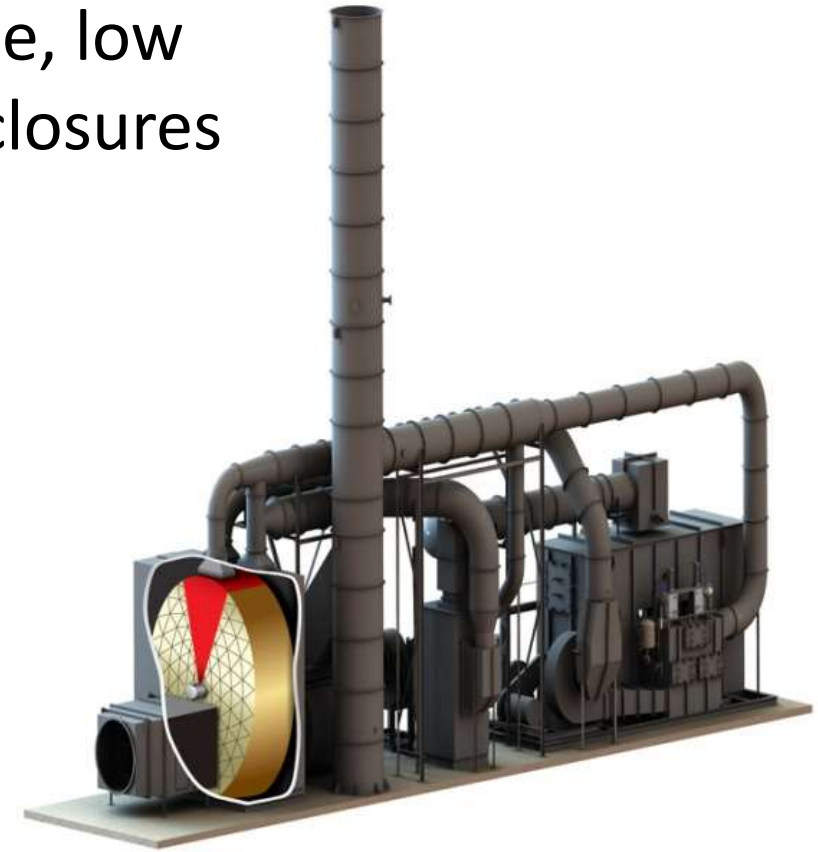
Operating Cost Reduction Strategies

5. Know what state and federal grant money is available to you.
    - Database of State Incentives for Renewables & Efficiency: **www.dsireusa.org**

6. Consider an emission concentrator for high volume, low concentration process streams; Permanent Total Enclosures (PTE), floor sweeps, washers, spray machines

Concentrator Applicability

- Airflows > 5,000 SCFM. Lower flow rates generally make this technology uneconomical.
- Inlet Temperature < 100ºF (40ºC)
- VOC Concentrations < 500 ppm. Higher concentrations reduce concentration factor making this technology uneconomical.
- DREs < 99%
- Relative Humidity < 90%



Operating Cost Reduction Strategies

7. Focus on Combustion Air
   - Using ambient air for oxidizer burners is like burning money.

Consider supplying combustion blowers with tempered air from a secondary heat exchanger.

Also ideal for process heating needs!

Operating Cost Reduction Strategies

8. Improve Primary Heat Recovery

Catalytic & Recuperative:
Metal Heat Exchangers
60-80% Efficient

Regenerative Thermal:
Ceramic Heat Recovery Media
95-97% Efficient

Operating Cost Reduction Strategies

9. Consider Secondary Heat Recovery

- Recover exhaust stack heat for use in industrial ovens and dryers
- Recover exhaust stack heat for other plant and/or process heating applications
- Upgrade Heat Efficiency of existing VOC control equipment

Heat Recovery Coil in the Oxidizer Stack

Operating Cost Reduction Strategies

10. Properly Maintain Existing Systems

Thank You!

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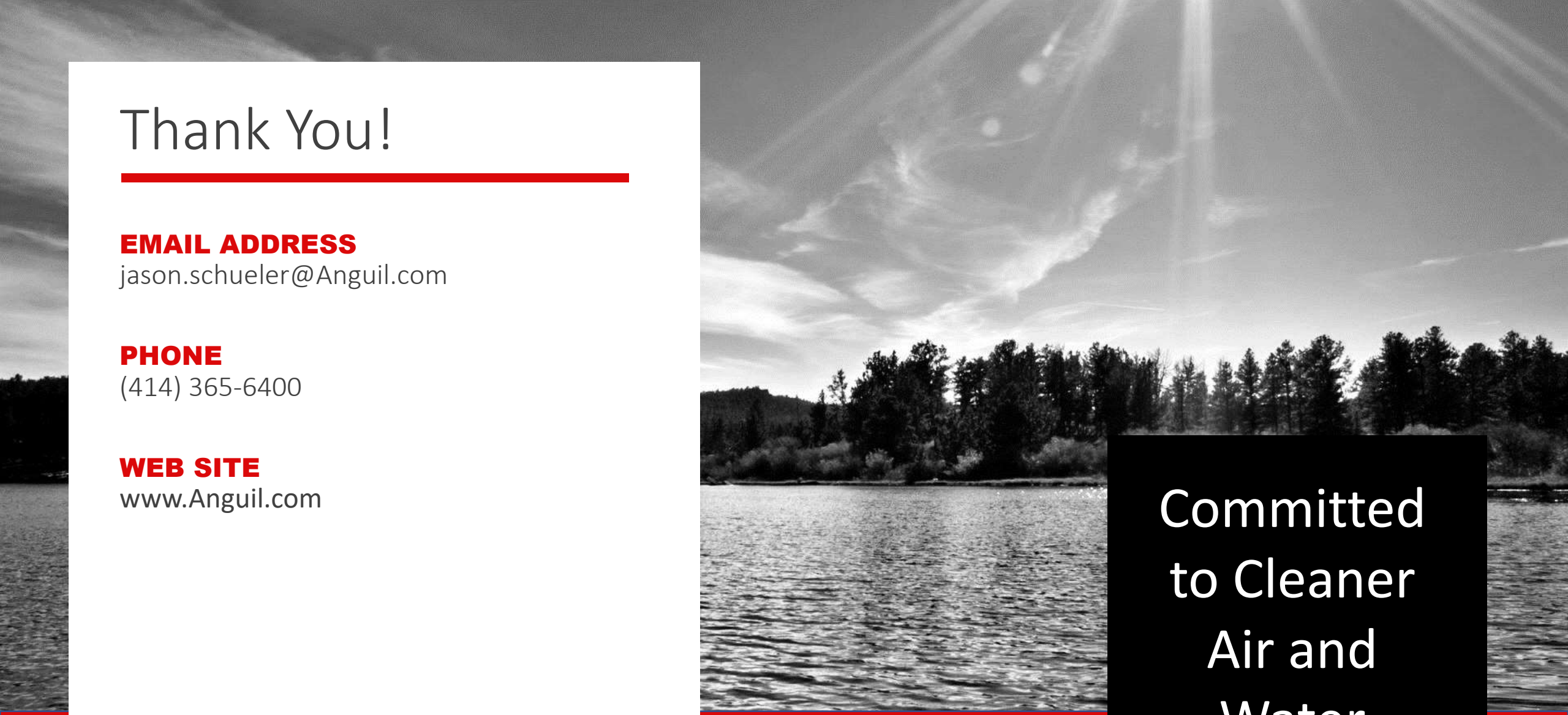

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