



AICHE®

LEADING IN  
PRODUCTION  
EFFICIENCY



## A SINGLE SOURCE ADDRESSING MULTIPLE WAYS TO FIGHT POLLUTANTS WHILE IMPROVING ENERGY EFFICIENCY

December 6, 2022  
[www.DurrMegtec.com](http://www.DurrMegtec.com)

Nina B. Zerman - Senior Manager

# AGENDA



- 1- Company Overview & Dürr CTS Global Mission for Industries**
- 2- Air Pollution Abatement Technologies**
- 3- VOC Abatement Technologies**
- 4- Thermal Oxidizer Technologies**
- 5- Typical Emission Requirements**
- 6- Specific Thermal Oxidizer Technologies**
  - A- Direct Fired Thermal Oxidizer**
  - B- Recuperative Thermal Oxidizer**
  - C- Regenerative Thermal Oxidizer**
- 7- Q & A**

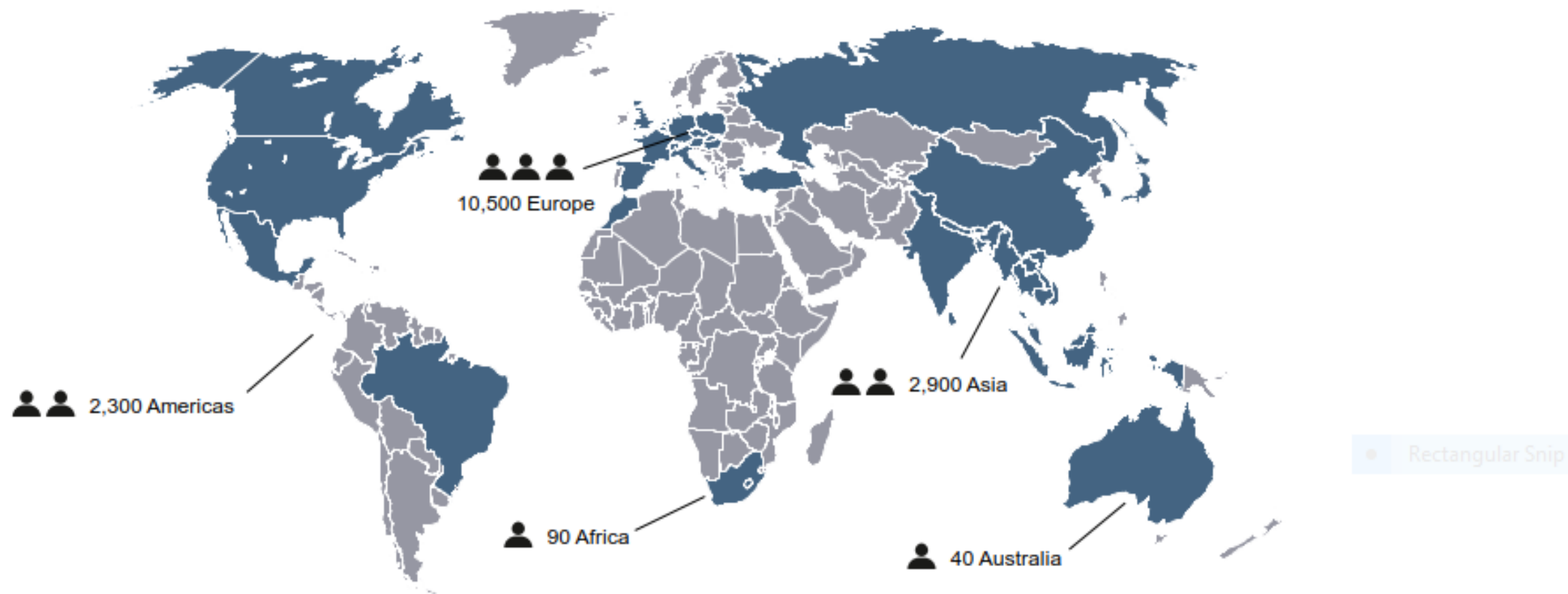


# 1

## Corporate Overview

# GLOBAL POSITIONING

Approx. 17,000 employees<sup>1</sup> at 120 locations in 35 countries



<sup>1</sup>incl. around 800 external employees

# CAPABILITIES & PURPOSES



- To help our customers prosper by staying in **compliance with environmental regulations** and public image.
- To provide our customers with **maintenance-free operations, minimized downtime**, and superb aftermarket services. Strong after-market support.
- To contribute to a clean environment and public health through delivering the most innovative and **energy-efficient** environmental solutions
- **We let you focus on your business while we handle the business of air pollution control.**



# CLEAN TECHNOLOGY SYSTEMS (CTS) LOCATIONS



## North America

### Southfield, Michigan



- Oxi.X RL\_ (Rotary RTO)
- Oxi.X DF\_ (Direct Thermal)
- Oxi.X TR\_ (Thermal Recup)
- Cat.X CF\_ (Concentrator)
- Cat.X CR\_ (SCR)

### De Pere, Wisconsin



- Oxi.X RC\_ (Rotary RTO)
- Oxi.X RM\_ (Poppet RTO)
- Oxi.X RV\_ (Flameless RTO)
- Cat.X PL\_ (Recuperative Catalytic)
- Cat.X HP\_ (Straight Catalytic)

### Waterloo, Canada



- Part.X PW\_ (WESP)
- Part.X PV\_ (Venturi Scrubber)
- Sorpt.X SW\_ (Acid Gas Scrubbers)
  - (Open Spray, Packed Towers, Atomized Scrubbers)
- Sorpt.X AC
  - (Evaporative Gas Cooling)
- Cat.X CR\_ (SNCR)

### Vero Beach, Florida Columbus, OH

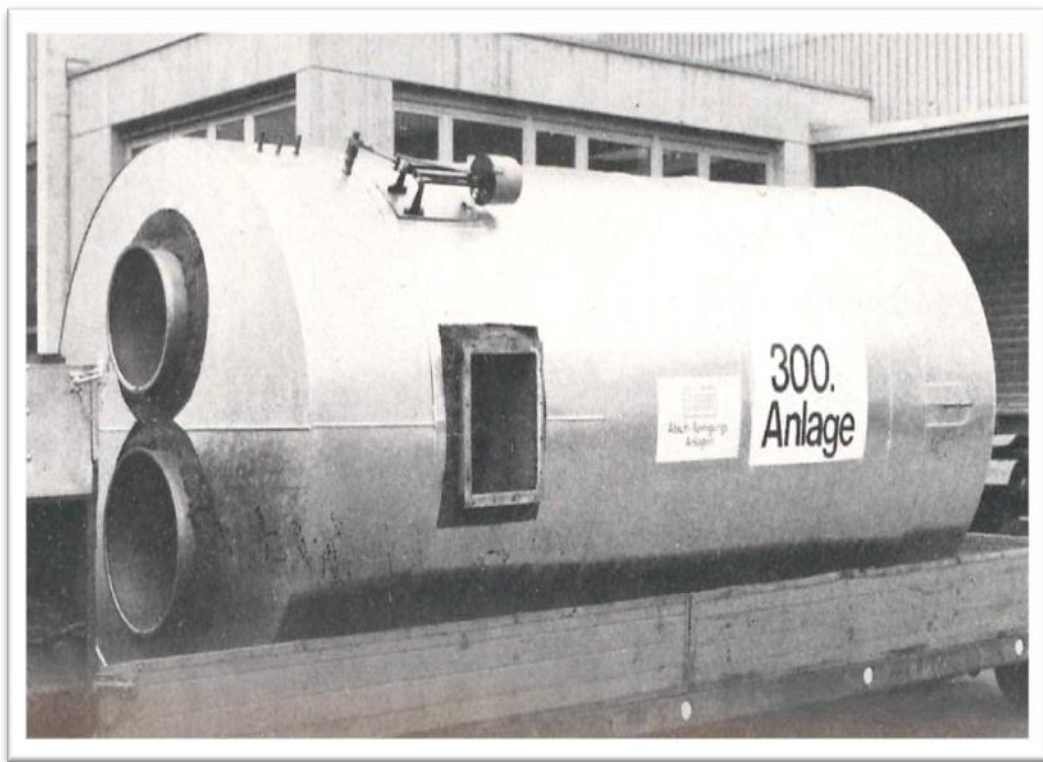


- Sorpt.X\_ CA (Carbon Adsorption)
- Sorpt.X\_ LD (Distillation)
- Sorpt.X\_ LC (Liquid Condenser)

# TREATING 700,000 SCFM PROCESS FLOW (1,120,000 NM<sup>3</sup>/HR)



# AIR POLLUTION CONTROL





# MARKET SEGMENTS



## CLEAN TECHNOLOGY SYSTEM



Chemical



Carbon fiber



Ceramics



Chemical Industry



Composites



Ethanol Industry



Food & Beverage



Metals & Mining



Glass Industry



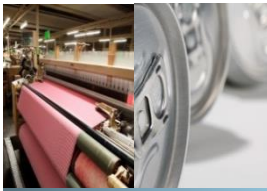
Painting & Surface Treatment



Petrochemical



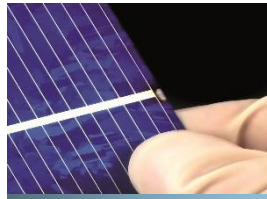
Pharmaceutical



Printing / Coating



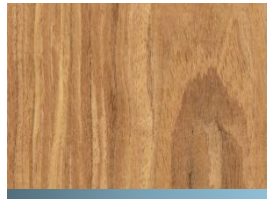
Rubber & Latex



Semiconductor



Waste Incineration



Wood

## SOLUTIONS



# 2

**Engineering and  
Operations**

# DURR AIR POLLUTION CONTROL FOR INDUSTRIES



## Environmental Solutions

EMISSION	TECHNOLOGY
<b>Particulate</b>	<ul style="list-style-type: none"><li>» Pulse jet fabric filter/baghouse</li><li>» Wet and dry ESPs</li><li>» Multiclone® dust collector</li><li>» Wet particulate scrubbers</li></ul>
<b>NOx</b>	<ul style="list-style-type: none"><li>» SCR</li><li>» SNCR</li></ul>
<b>SO<sub>2</sub>/acid gases</b>	<ul style="list-style-type: none"><li>» Wet scrubbers/acid gas absorbers</li><li>» Spray dry absorbers</li><li>» Dry sorbent injection</li></ul>
<b>Acid mists</b>	<ul style="list-style-type: none"><li>» Wet ESPs</li><li>» Dry sorbent injection</li></ul>
<b>VOCs, CO, HAPs</b>	<ul style="list-style-type: none"><li>» Regenerative thermal oxidizers (RTOs)</li><li>» Regenerative catalytic oxidizers (RCOs)</li><li>» Catalytic recuperative oxidizers</li></ul>
<b>Odor</b>	<ul style="list-style-type: none"><li>» Oxidizers</li><li>» Adsorption systems</li></ul>



# GENERAL POLLUTANT SOURCES

## Typical Emission Sources

### Process Point Source

- » Chemical Reactors
- » Distillation Columns
- » Cracking Units
- » Condenser
- » Strippers
- » Mixers
- » Ovens / Furnaces

### Process Fugitive Source

- » Storage Tank Vents
- » Feed openings
- » Discharge openings
- » Access Ports

### Area Fugitive Source

- » Waste Storage Areas
- » Raw Material Storage Areas

# SIDE PRODUCTS OF COMBUSTION



## COMPLETE COMBUSTION

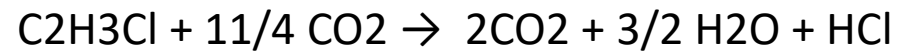
### ACRYLONITRILE



### METHYL MERCAPTAN

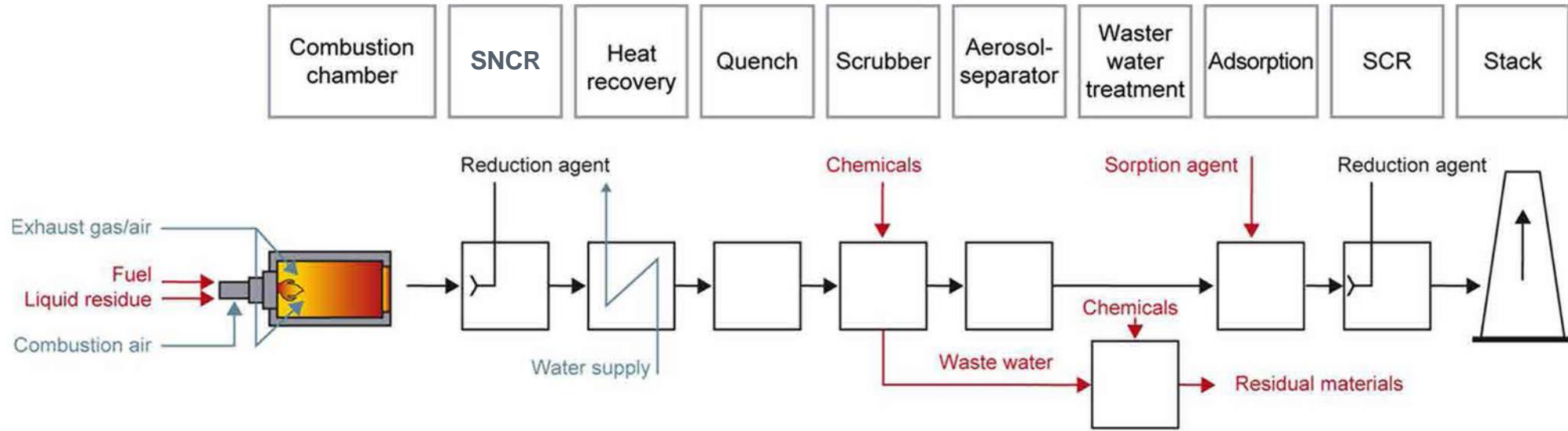


### VINYL CHLORIDE



# TECHNOLOGIES USES

Dürr solutions and products-pre & post oxidizer



Organic solvents CHO-bonds	x		x						
Halogenated compounds	x		x	x	x	x	x	x	x
Nitrogenous compounds	x	x	x				x		x
Sulphurous compounds	x		x	x	x	x	x	x	
Heavy metals and mercury	x		x	x	x	x	x	x	
Other liquids containing salts	x		x	x	x	x	x	x	
Particles (ash) in liquids	x		x	x	x	x	x	x	

# DERIVATIVES & TYPICAL APPLICATIONS

- **PTA**- Purified Terephthalic Acid -raw material for manufacturing PET (Polyethylene Terephthalic), PBT ( Polybutylene Terephthalic) and PTT ( Poly Trimethylene Terephthalic)
- **PET**- Polyethylene Terephthalate , plastic bottles
- **Polyethylene** - HDPE, LDPE, LLDEP
- **ABS**- Acrylonitrile Butadiene Styrene- pipes, for application that extrusion is required
- **EPDM**, Ethylene Propylene Diene Monomer – roofing
- **SSBR**, Solution styrene Butadiene Synthetic – synthetic rubber, car tires
  
- **NBR**, Nitrile Rubber, Copolymer of acrylonitrile and butadiene. For construction, seals, grommets
- **PBR**, Polybutadiene – synthetic rubber, for golf balls, tires, plastics
- **EVA**- Ethylene Vinyl Acetate- Co polymer of ethylene and vinyl acetate, used for elastic characteristic
- **POSM**- Propylene Oxide Styrene Monomer- similar to some styrene applications
- **EO/EG**- Ethylene Oxide and Ethylene Glycol- used in Polyester fiber, PET

# Engineering Corp Overview



## Design codes and guidelines:

### Controls and Electrical Design

- National Fire Protection Association (NFPA) 70 - National Electric Code
- NFPA 79 – Electrical Standards for Industrial Machinery
- NFPA 86 – Industrial Ovens and Furnaces
- UL508A – Industrial Control Panels
- Dürr Systems UL File E56711 Industrial Control Panels
- FM Global Loss Prevention Data Sheets
- 6-9 – Industrial Ovens and Dryers
- 6-11 – Fume Incinerators

### Mechanical Systems and Component Design

- Compressed Air Tanks – American Society of Mechanical Engineers (ASME) - Code for Pressure Vessels, Section VIII, Division 1, “U” Certificate of Authorization No. 16802
- Fixed Ladders – Occupational Health and Safety Administration (OSHA) Standard 29 CFR1910.23
- Walking and Working Surfaces – OSHA Standard 29 CFR1910 subpart D
- Mechanical Power Transmission Guards – OSHA Standard 29 CFR1910.219
- Ductwork – Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA) – Round or Rectangular Industrial Duct Construction Standards
- Centrifugal Fans – American National Standards Institute (ANSI)/Air Movement & Control Association (AMCA) Standard 210-99 – “Laboratory Methods of Testing Fans”





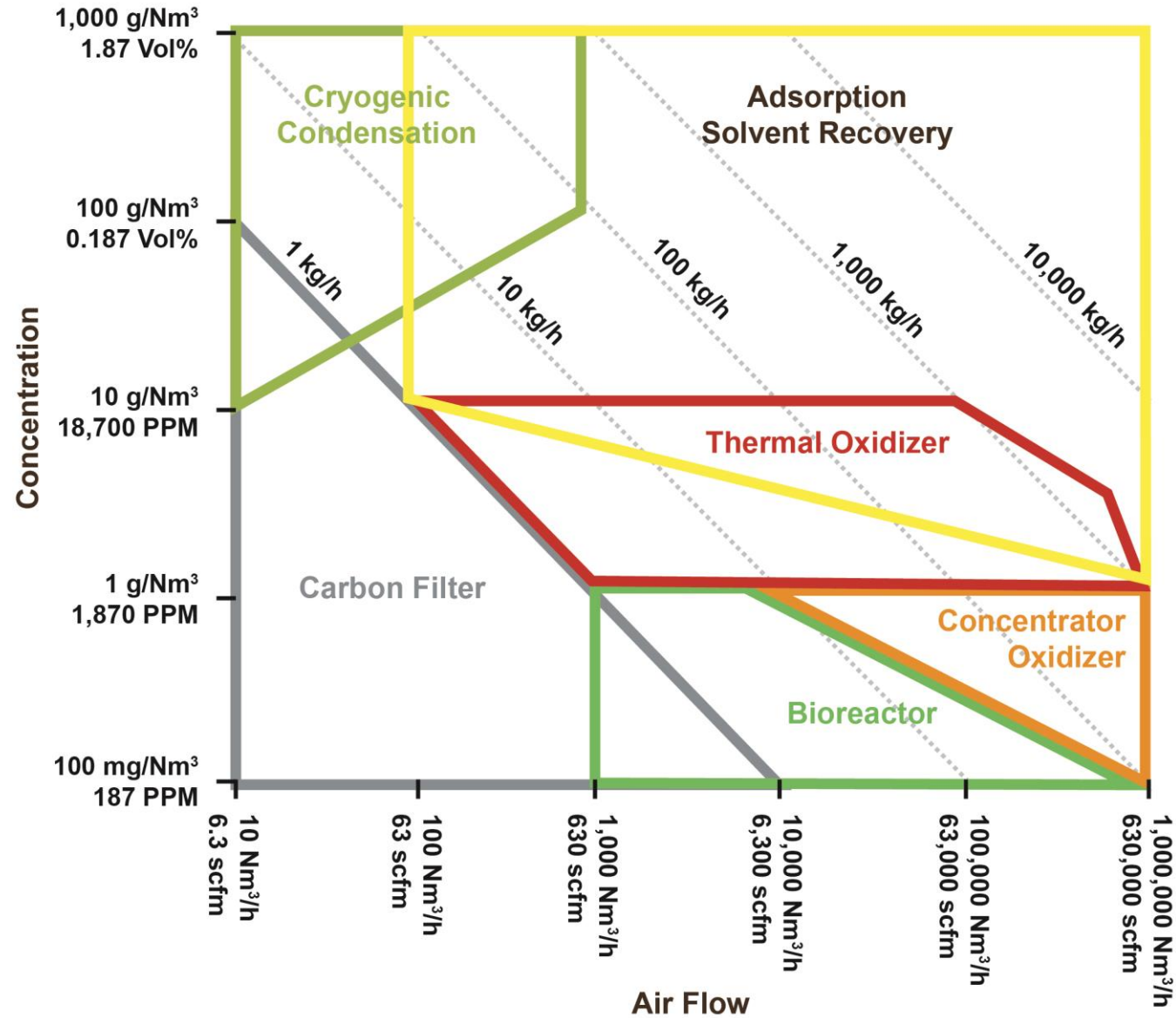
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VOC TREATMENT

# TECHNOLOGY MAP

\*EMISSIONS \*TECHNOLOGY \* PRODUCT \* INDUSTRY \* PROCESS



# TYPICAL EMISSION & SPECS REQUIREMENTS IN USA



- **VOC DRE: 90-99.9%**
- **NOx: 0.072-0.036 lbs/MMBtu**
- **SOx: Not typically required with TO technology**
- **CO: 50 ppmv at outlet**
- **Residence Time: 0.3-2.0 seconds**
- **Operating Temperature: 1450-1800 °F**
- **Particulate: 0.1 gr/dscf**

Component	Durr Standard	Optional
Gas Train - Design	NFPA 86	
Gas Train - Approval	GE Global Assest Protection Services (GAPS), replaced Industrial Risk Insurers (IRI) Factory Mutual (FM)	
Gas Train - Fabrication	General good practices	ASME B31.3
Ductwork – Design & Construction	SMACNA	
FAN	AWS D14.6 AMCA 210	API 560 API 673 AMCA 203
RTO & Skid	AWS D1.1	NDE ASME VIII DIV 1
DFTO Combustion Chamber	AWS D1.1	ASME VIII DIV 1 API 560
DFTO (vertical)	ASME STS-1	
Exhaust Stack	ASME STS-1	

# OVERVIEW: OXIDIZERS FOR VOC CONTROL



	<b>Direct Fired Thermal Oxidizer (VAR)</b>	<b>Thermal Recuperative Oxidizer (TAR)</b>	<b>Recuperative Catalytic Oxidizer (RCO)</b>	<b>Regenerative Thermal Oxidizer (RTO)</b>
<b>VOC DRE</b>	99+%	99+%	98-99%	98-99.3%
<b>Typ. Operating Temperature</b>	1550-1800°F	1400-1450°F	600-850°F	1550-1600°F
<b>Thermal Efficiency</b>	0%	55-65%	55-65%	93-97%
<b>LEL Range</b>	45% +	5-25%	0-10%	0-25%
<b>Capitol Cost</b>	- -	-	+	++
<b>Operating Cost</b>	++	+	-	--
<b>Condensable</b>	Good	Good	Ok	Ok
<b>Particulate</b>	Best	Better	Poor	Good
<b>Moisture</b>	Best	Better	Ok	Good
<b>Corrosive</b>	Ok	Ok	Ok	Ok

# DÜRR SINGLE SOURCE APC SYSTEMS



Pharma	
Location:	Grimsby (United Kingdom)
Process:	Halogenated HC, Nitrogen compounds
Air flow rate:	5,000 Nm <sup>3</sup> /h & 10,000 Nm <sup>3</sup> /h
Pollutants:	Dichlormethane, chloroform, acetone, MEK, acetonitrile
Concentration	200 g/Nm <sup>3</sup>
Dürr Solution:	<b>2 Oxi.X DFTO, Scrubber, SCR</b>
Commissioning:	2007



# DÜRR SINGLE SOURCE APC SYSTEM



Chemical	
Location:	Mumbai (India)
Process:	Nitrogen bound HC
Air flow rate:	5,000 Nm <sup>3</sup> /h
Pollutants:	Acetonitrile, Acetone, Butanol, Styrene
Concentration:	750 g/Nm <sup>3</sup>
Dürr Solution:	<b>Oxi.X DF, Scrubber, SCR</b>
Commissioning	2014





## Air pollution control for PTA production





# DÜRR VAR- DIRECT FIRED THERMAL OXIDIZER



# DIRECT FIRED THERMAL OXIDIZER



Standard VOC Destruction Rate	99.9+%
Thermal Efficiency	0%
Flue Gas Capacity/One Unit	500 to 80,000 SCFM
Optional Heat Recovery Available	Hot Air, Steam, Glycol, Oil

- » Applications are **high concentrated** streams (sized on BTU concentrations)
- » Ideal for high BTU concentrated streams 45% + LEL
- » High heat recovery potential

# OXI.X DF – DIRECT FIRED THERMAL OXIDIZER



Horizontal oxidizer with air quench – packaged for containerized shipping





# RECUPERATIVE THERMAL OXIDIZER

Standard VOC Destruction Rate	99+%
Thermal Efficiency	55-65%
Internal Heat Exchanger	Pre-Heats the Inlet Air
Simplicity	Burner and Internal Tubes
Flow Capacity	Up to 2,000-20,000 SCFM
Optional Heat Recovery Available	Hot Air, Steam, Glycol, Oil

- » Applications are (LVHC-HVHC) low-high volume, **higher concentrated** streams
- » **Ideal for medium-high BTU 5-25% + LEL**
- » High heat recovery potential

# RECUPERATIVE THERMAL OXIDIZER – OXI.X TR



Typically pre-assembled and compact oxidizer

Consists of:

- » Combustion chamber
- » Burner
- » Shell and tube heat exchanger
- » > 99% destruction efficiency
- » Variable heat exchanger designs available from 55% to 65%
- » Low pressure drops
- » Simple to operate and maintain
- » Standard raw gas burner offers lower operating costs than similar units installed with combustion blowers





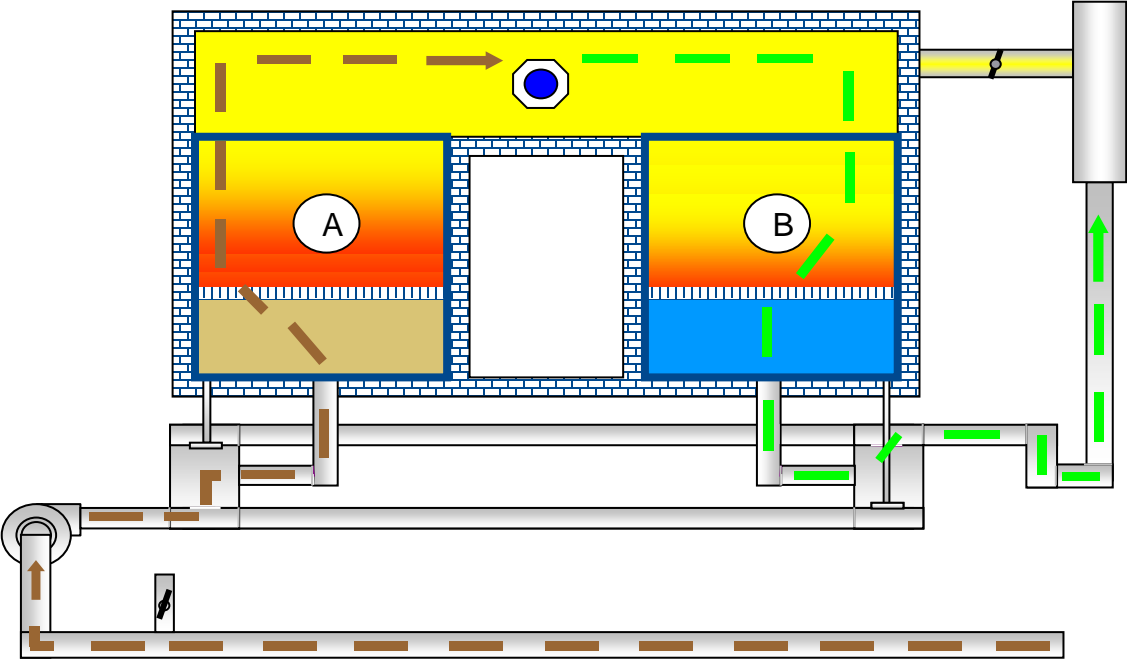
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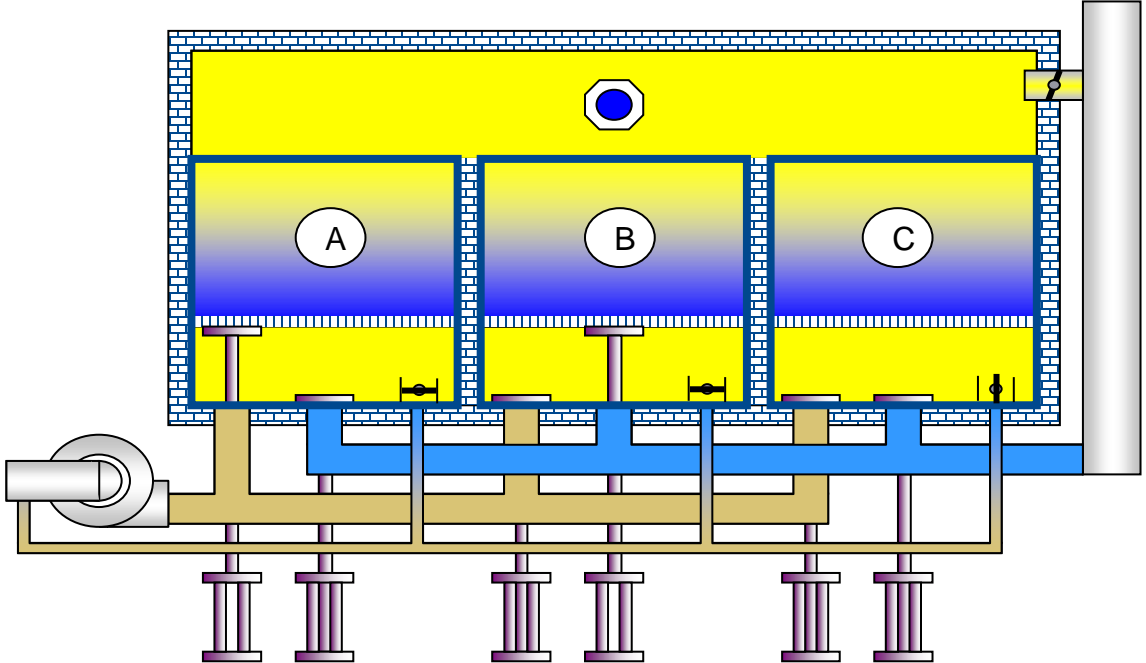
ENERGY CONSERVATION AND  
SUSTAINABILITY

# REGENERATIVE THERMAL OXIDIZER

# DUAL & MULTIPLE CHAMBER RTO



Oxi.X RM  
MILLENNIUM® RTO



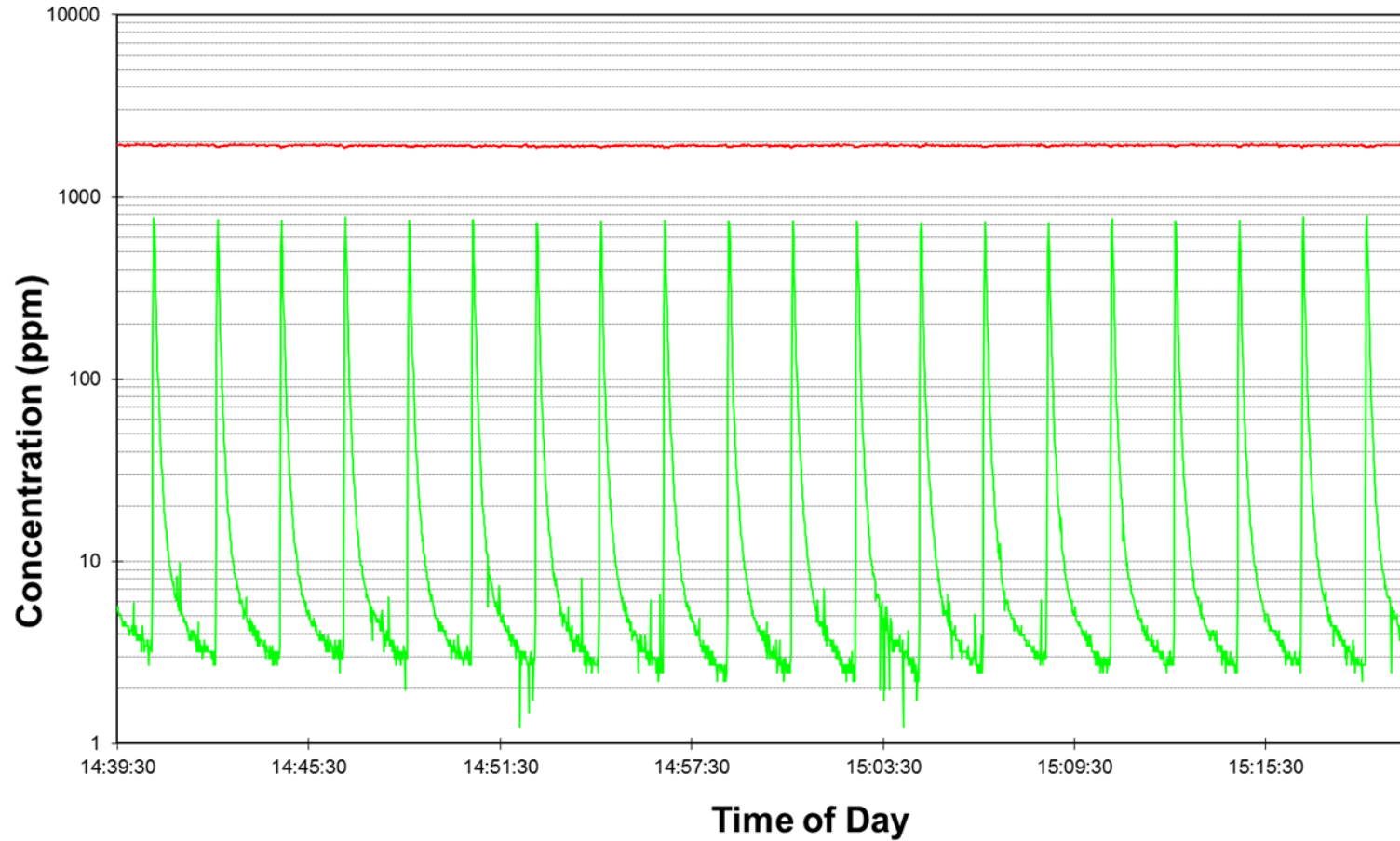
Oxi.X RE  
Epsilon® RTO



# 2-TOWER RTO VOC (THC) EMISSION TESTING RESULTS



VOC DRE – 95~98%



— THC Inlet Concentration = 1909.5 ppm    — THC Exhaust Concentration = 38 ppm    — RTO DRE = 98 %

# DÜRR 2 TOWER RTO SYSTEM

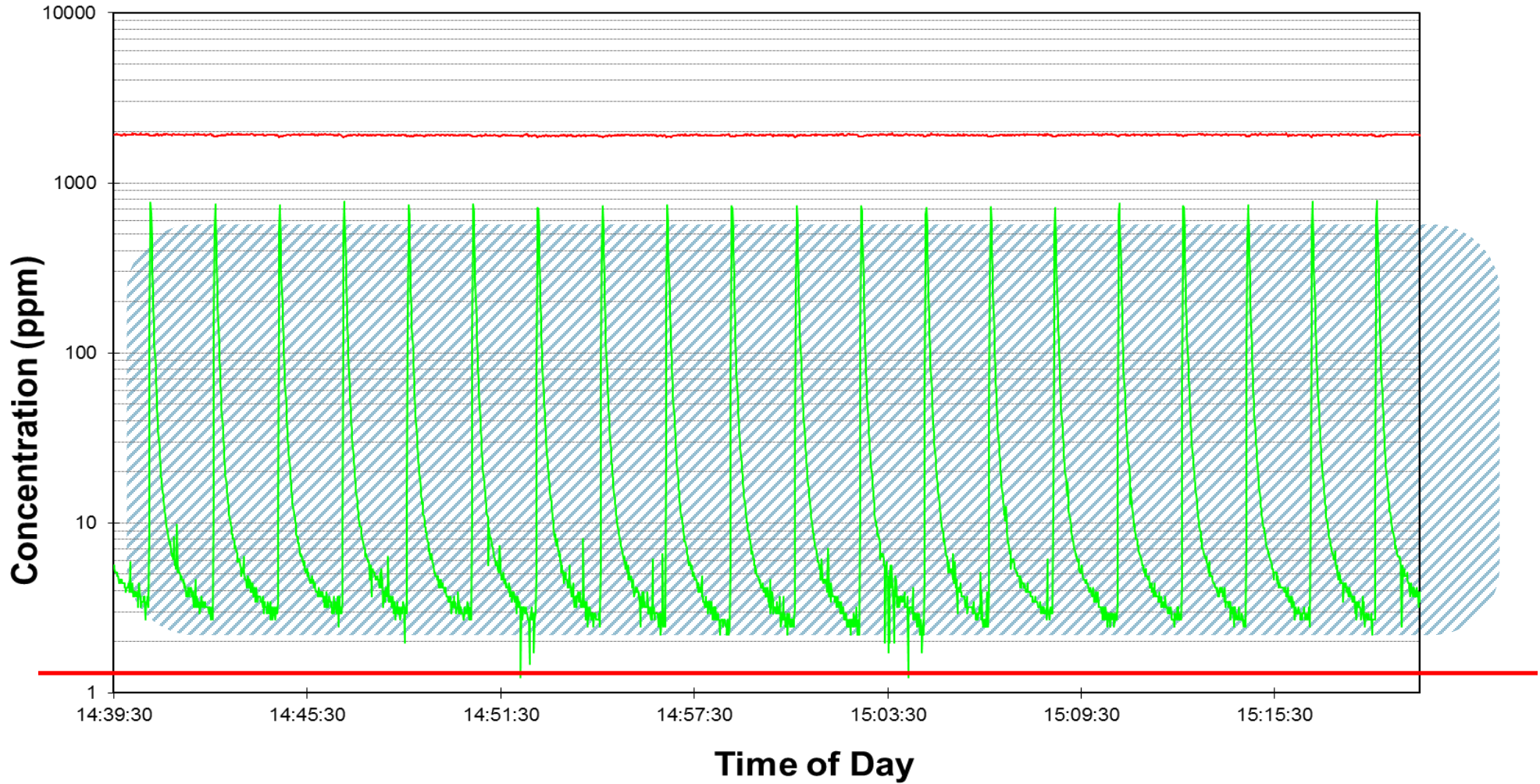


# OXI.X RM - DÜRR 2 TOWER RTO SYSTEM



# 2-Tower RTO VOC (THC) Emission Testing Results

VOC DRE - 95~98%



— THC Inlet Concentration = 1909.5 ppm    — THC Exhaust Concentration = 38 ppm    — RTO DRE = 98 %

# DÜRR 3 TOWER RTO SYSTEM



# OXI.X RA 3 TOWER RTO SYSTEM



# RESPONDING TO CUSTOMER WANTS

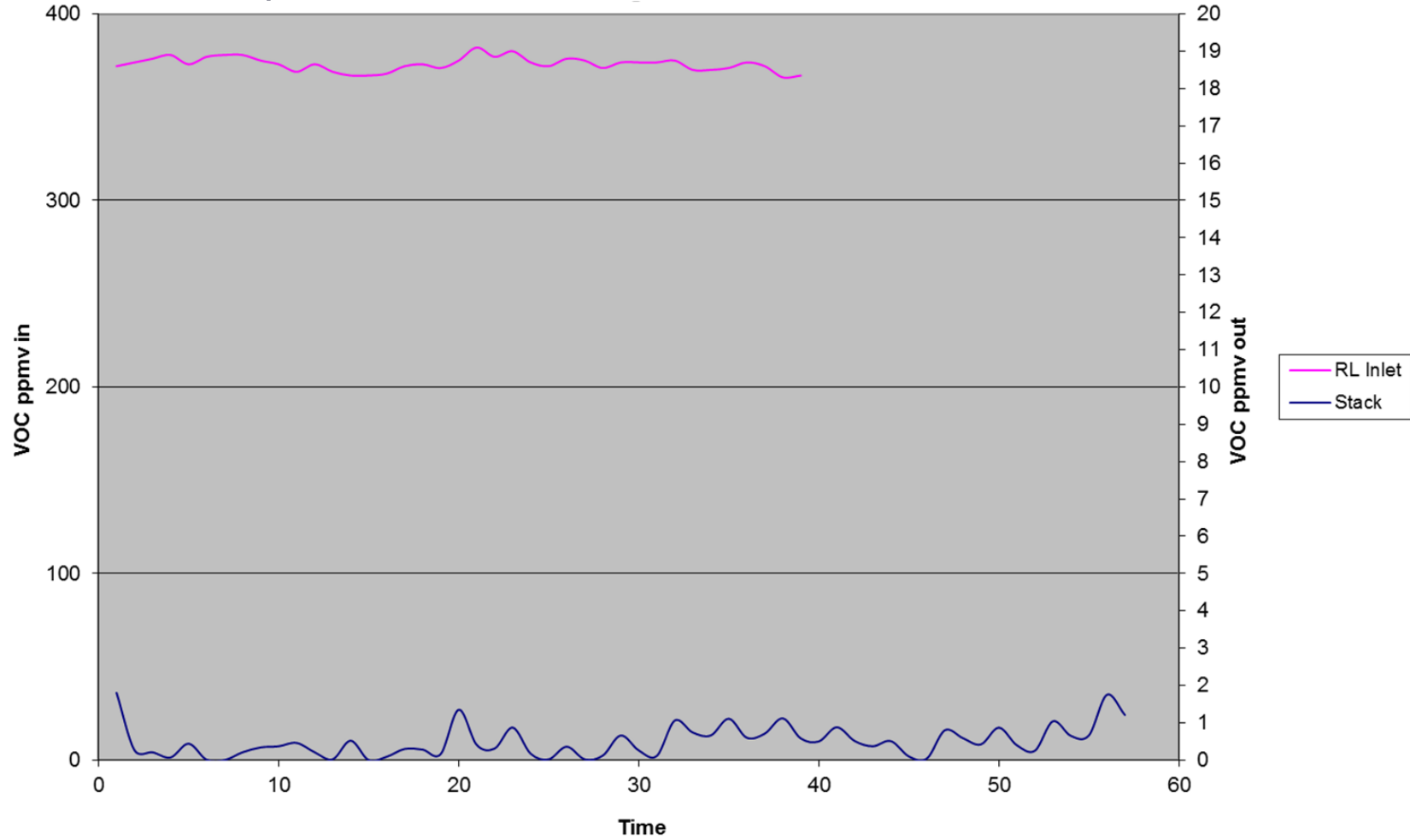


- **Smaller size**
- **Less moving parts**
- **Lower purchase price**
- **Higher performance**
- **Cheaper to operate**
- **Easier to operate/maintain**
- **Quicker installation**
- **One Medica Chamber**
- **One Moving part**
- **Preassembled**
- **Skid-mounted**

# DÜRR OXI.X RL ROTARY VALVE RTO SYSTEM VOC CONCENTRATION MEASUREMENT

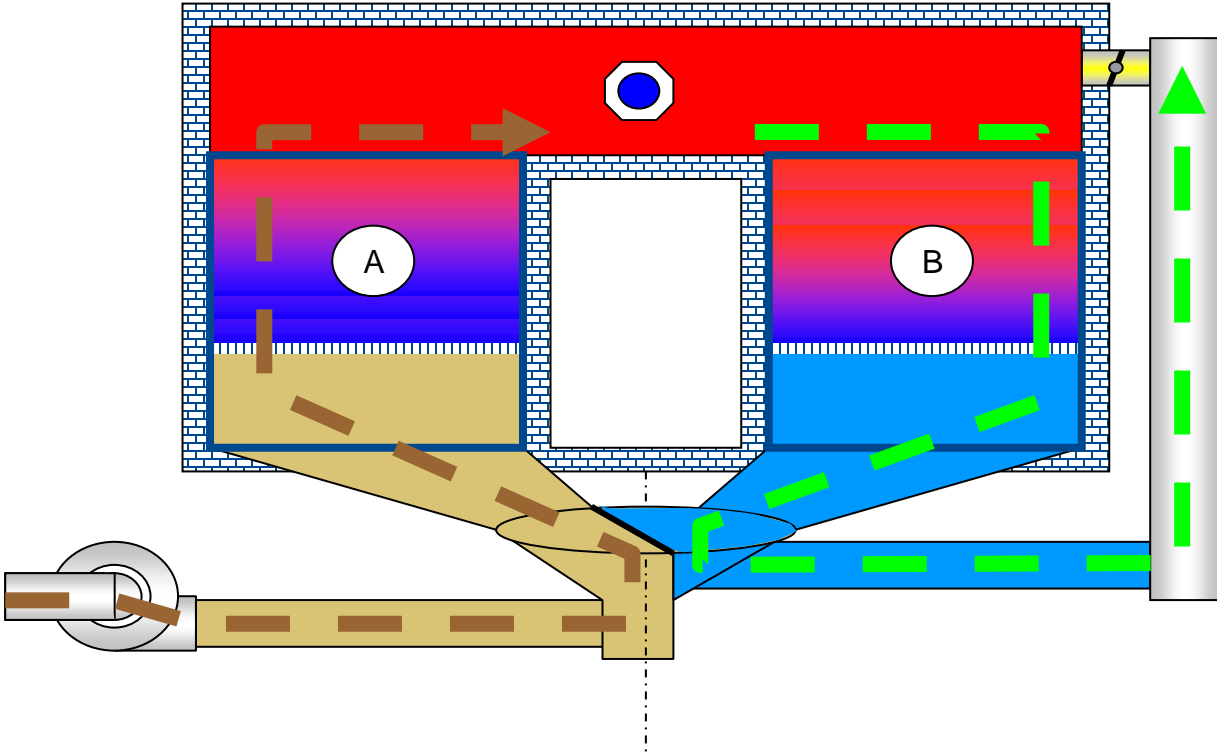


Manufacturing Plant – DRE = 99.7%

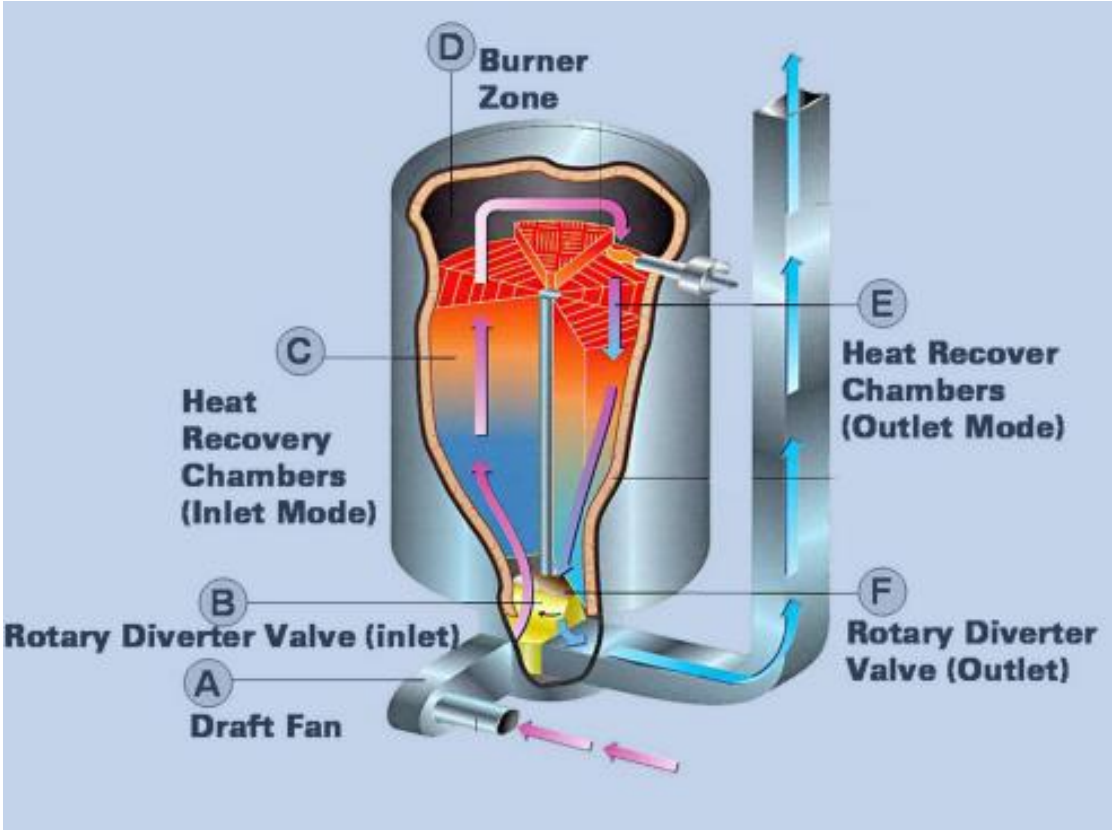




# DUAL & SINGLE CHAMBER ROTARY RTO



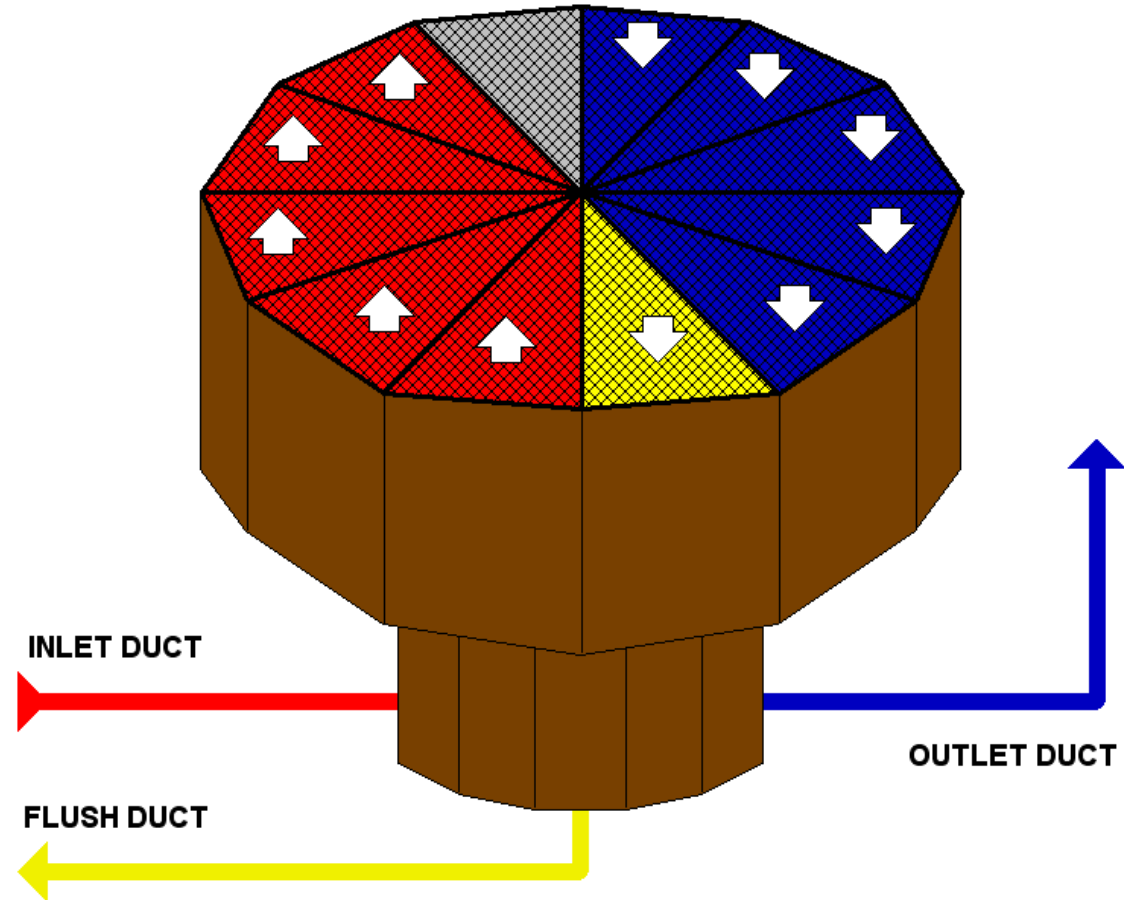
CleanSwitch® RTO



ECOPURE RL® RTO

# ROTARY VALVE AND FLOW THROUGH THE BEDS

- The purpose of the rotary valve is to direct air in the appropriate direction through the ceramic media beds.
- There are 12 beds. At any give time:
  - (5) beds are in Outlet Mode
  - (5) beds are in Inlet Mode
  - (1) bed is in Flush Mode
  - (1) bed is in Blocked/Dead Mode
- For any bed the sequence is: Inlet-flush-outlet-blocked
- The typical index rate is 15 seconds (15 seconds \* 12 beds = 180 seconds for complete a rotation).
- Note that a bed is in inlet or outlet mode for five indexes. Therefore, a bed is each of those modes for 75 seconds.



# OXI.X RL ROTARY VALVE RTO SYSTEM

## DESTRUCTION EFFICIENCY TEST REPORT

Table 1  
 Prime Coat Oven RTO Performance Testing  
 Total and Non-Methane Hydrocarbons

██████████  
 Chicago, Illinois  
 Clayton Project No. 13-03095.00  
 October 16, 2002

Parameter	Run 1	Run 2	Run 3	Average
Sampling Time	7:23 - 8:23	9:22 - 10:22	10:32 - 11:02	
Inlet Gas Stream Volumetric Flowrate (scfm)	15,528	15,780	16,404	15,904
Outlet Gas Stream Volumetric Flowrate (scfm)	20,606	19,256	18,130	19,331
Inlet THC Concentration (ppmv C <sub>3</sub> H <sub>8</sub> )	143	152	144	146
Inlet THC Mass Flowrate (lb/hr C <sub>3</sub> H <sub>8</sub> )	15.9	17.1	16.9	16.6
Outlet THC Concentration (ppmv C <sub>3</sub> H <sub>8</sub> )	0.5	0.5	0.5	0.5
Outlet Methane Concentration (ppmv CH <sub>4</sub> )	0.2	0.2	0.3	0.2
Outlet Methane Concentration (ppmv C <sub>3</sub> H <sub>8</sub> )	0.1	0.1	0.1	0.1
Outlet NMHC Concentration (ppmv C <sub>3</sub> H <sub>8</sub> )	0.4	0.4	0.4	0.4
Outlet NMHC Mass Flowrate (lb/hr C <sub>3</sub> H <sub>8</sub> )	0.06	0.06	0.05	0.06
<b>Destruction Efficiency (%)</b>	<b>99.6</b>	<b>99.7</b>	<b>99.7</b>	<b>99.7</b>

**OXI.X RL**

**3 x 60,000 SCFM Oxi.X RL Unit**





**High-efficiency  
RTO with rotary  
valve  
Oxi.X RL**



# Regenerative Thermal Oxidizer Oxi.X RA

# OXI.X CS CLEANSWITCH™ ROTARY VALVE RTO SYSTEM



## Installation

- » Rotary style valve
- » Twin media beds
- » Modular construction
- » Simple and economical installation.



# OXI.X RL ROTARY VALVE VS. MULTI-TOWER



1988  
20,000 SCFM  
VF

1998  
60,000 SCFM  
Rotary RTO



# HOT GAS BYPASS SYSTEM

- Variable Energy Recovery
- Allows RL to handle a wide range of VOC loading
- Utilizes a high burner chamber temperature control loop
- Allows hot gas to bypass exhaust bed
- Temporarily reduces the thermal efficiency, thereby allowing higher solvent concentrations to be processed



# Operating Cost Comparison Example:

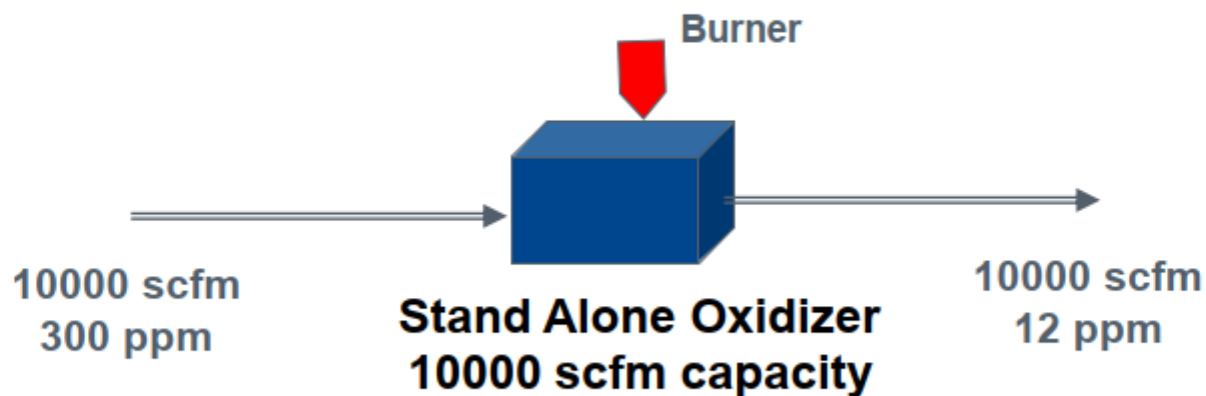
<b>Process Exhaust Volume</b>	<b>: 50,000 scfm (1416 cmm)</b>
<b>Process Exhaust Temperature</b>	<b>: 75°F (24°C)</b>
<b>VOC Concentration</b>	<b>: 200 ppm = (140 lb./hr = 63.5 kg/hr)</b>
<b>Avg. Molecular Weight</b>	<b>: 90 kg/kg mole</b>
<b>Solvent (VOC) Heating Value</b>	<b>: 33,000 Btu/kg</b>
<b>Annual Operating Hours</b>	<b>: 8,760</b>
<b>Fuel Cost</b>	<b>: \$5.00/MMBtu (\$0.18/m<sup>3</sup>) Natural Gas</b>
<b>Electricity Cost</b>	<b>: 0.06/kWh</b>

# Operating Cost Comparison

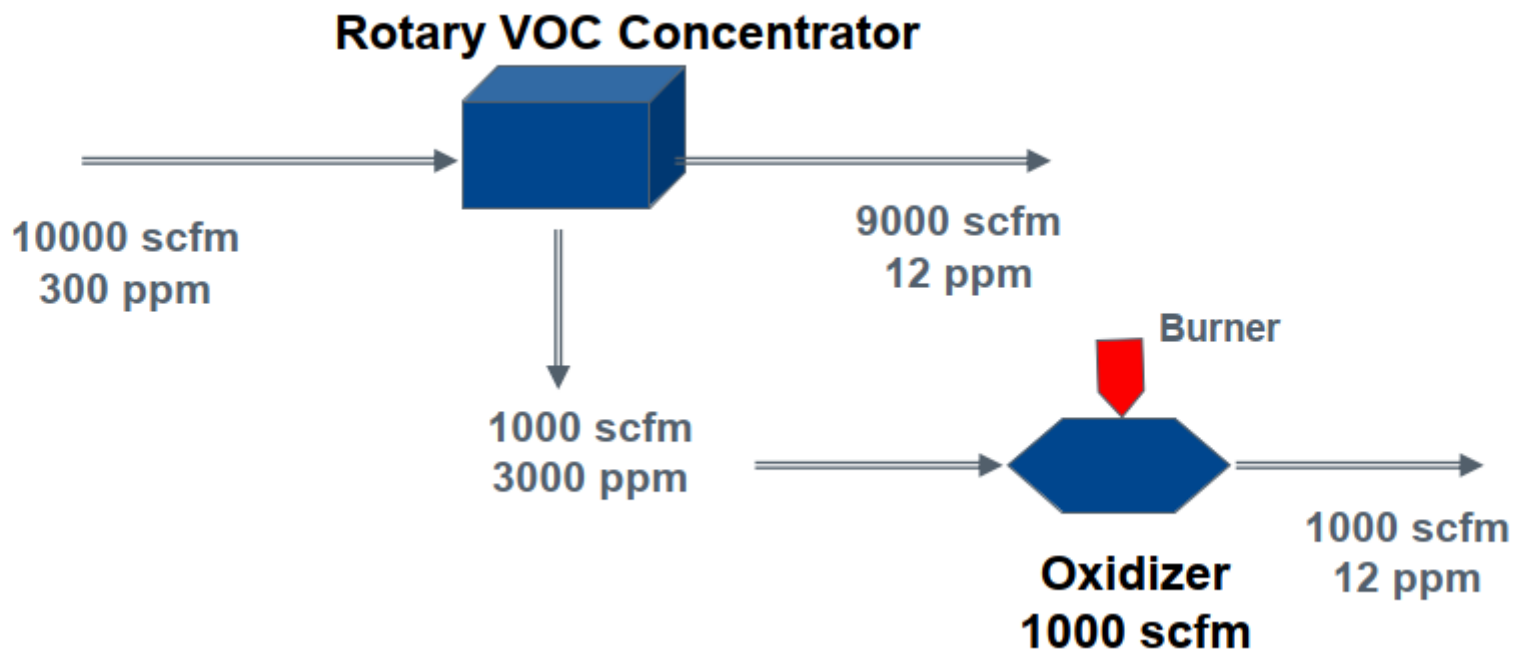
VOC Control System	Electricity			Fuel			Total	
	kW	\$/hr	\$/yr.	m <sup>3</sup> /hr	\$/hr	\$/yr.	\$/hr	\$/yr
Recuperative Thermal Oxidizer	125	7.5	65,700	564	101.5	889,315	109	954,840
Recuperative Catalytic Oxidizer	125	7.5	65,700	369	66.42	581,840	73.92	647,539
Regenerative Thermal Oxidizer	125	7.5	65,700	96	17.28	151,372	24.78	217,073
Regenerative Catalytic Oxidizer	109	6.54	57,290	34	6.12	53,611	12.66	110,902
VOC Concentrator System	34	2.04	17,870	0.0	0.0	0.0	2.04	17,870

# How concentrator help in savings?

Without  
concentrator



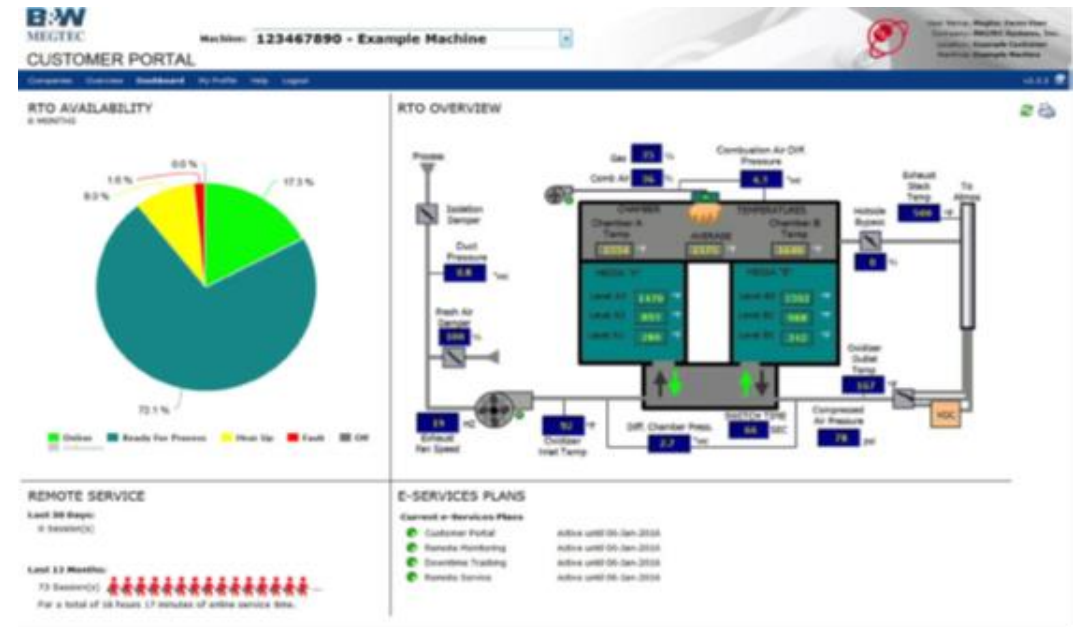
With  
concentrator



# CUSTOMER CARE CENTER



- VPN connection for trending, monitoring and remote diagnostics
- 24/7 Parts, Technical & Service Support
- Parts dispatching
- Spare Parts Inventory:
- Preventive Maintenance Services
- Customer Care Programs
- In-House Operational & Maintenance Workshops



# RL INSTALLATION (CHAMBER LOWER SECTION)

Combustion Chamber –lower Section



# OVERVIEW OF WHAT WE DISCUSSED



- 1- Company Overview & Dürr CTS Global Mission for Industries**
- 2- Air Pollution Abatement Technologies**
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AICHE®



## **Nina Zerman – Senior Manager – Key Account Manager**

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# THANK YOU !