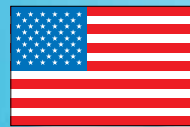


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Representatives are located in major US Cities, Canada, Asia, and selected countries, visit www.pcc-group.com to find your local agent.



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PCC QuickSwitch REGENERATIVE THERMAL OXIDIZER (RTO)

Guaranteed emission destruction performance while reducing or eliminating fuel cost

RTO Product Brochure
Version 24.04



PROCESS COMBUSTION CORPORATION

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PCC's QuickSwitch RTO offers guaranteed emission destruction performance of Volatile Organic Compounds (VOCs), Hazardous Air Pollutants (HAPs) and other airborne contaminants. Our performance guarantee ensures regulatory compliance and a safe and clean environment.

PCC's RTOs are designed to achieve the highest thermal efficiency possible. Highly efficient direct heat transfer media minimizes or eliminates auxiliary fuel costs ensuring the lowest lifetime equipment ownership costs.

PCC RTO systems are designed for safety, extremely high uptime, and reliability. The QuickSwitch indexing valve uses an air seal, solving the wear and tear problem of mechanical seals. PCC's 50+ years of experience in the Air Pollution Control industry ensures our systems stand the test of time.

Simple Design and Operation	page 1
QuickSwitch Air-Sealed Indexing Valve	page 5
Supplemental Natural Gas Injection (SNGI)	page 6
High Efficiency Heat Exchange Media	page 7
"Plug and Play" Easy Installation	page 9
Complete Project Integration	page 10
PCC's 50+ years of Combustion Experience	page 11
Wide Market and Application Expertise	page 12

TECHNICAL CAPABILITIES

Guaranteed Destruction and Removal Efficiency (DRE) of 98% and 99% if Puff Capture option is selected.

Thermal Energy Recovery (TER) from 65-97%

Standard sizes from 1,200 scfm to 80,000 scfm.

Use PCC's online RTO sizing and process tools:

[RTO Calculator](#)



[Heat Release Calculator](#)



[LEL Calculator](#)



8,000 scfm



20,000 scfm



140,000 scfm

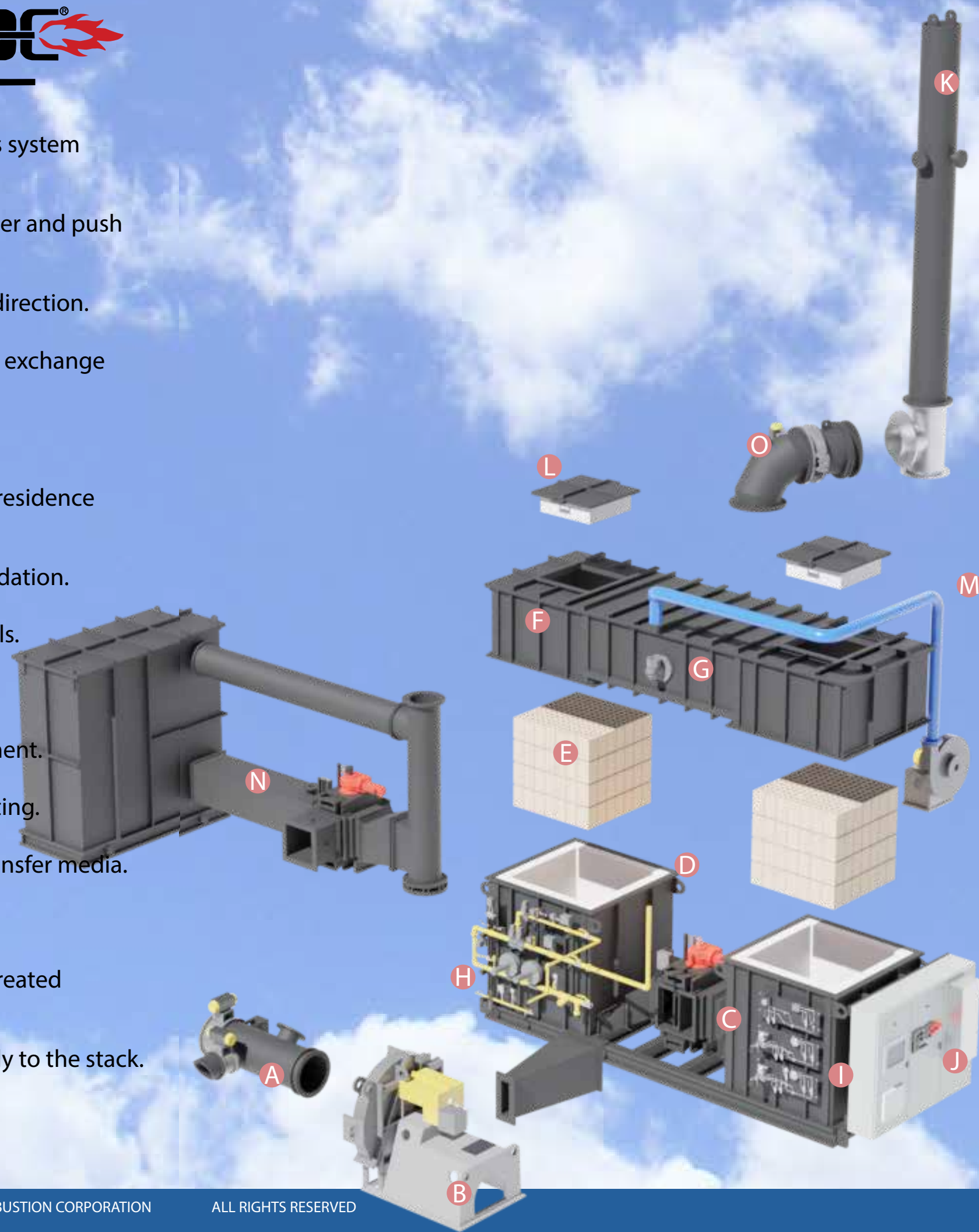
View PCC's RTO Operation video [here](#)



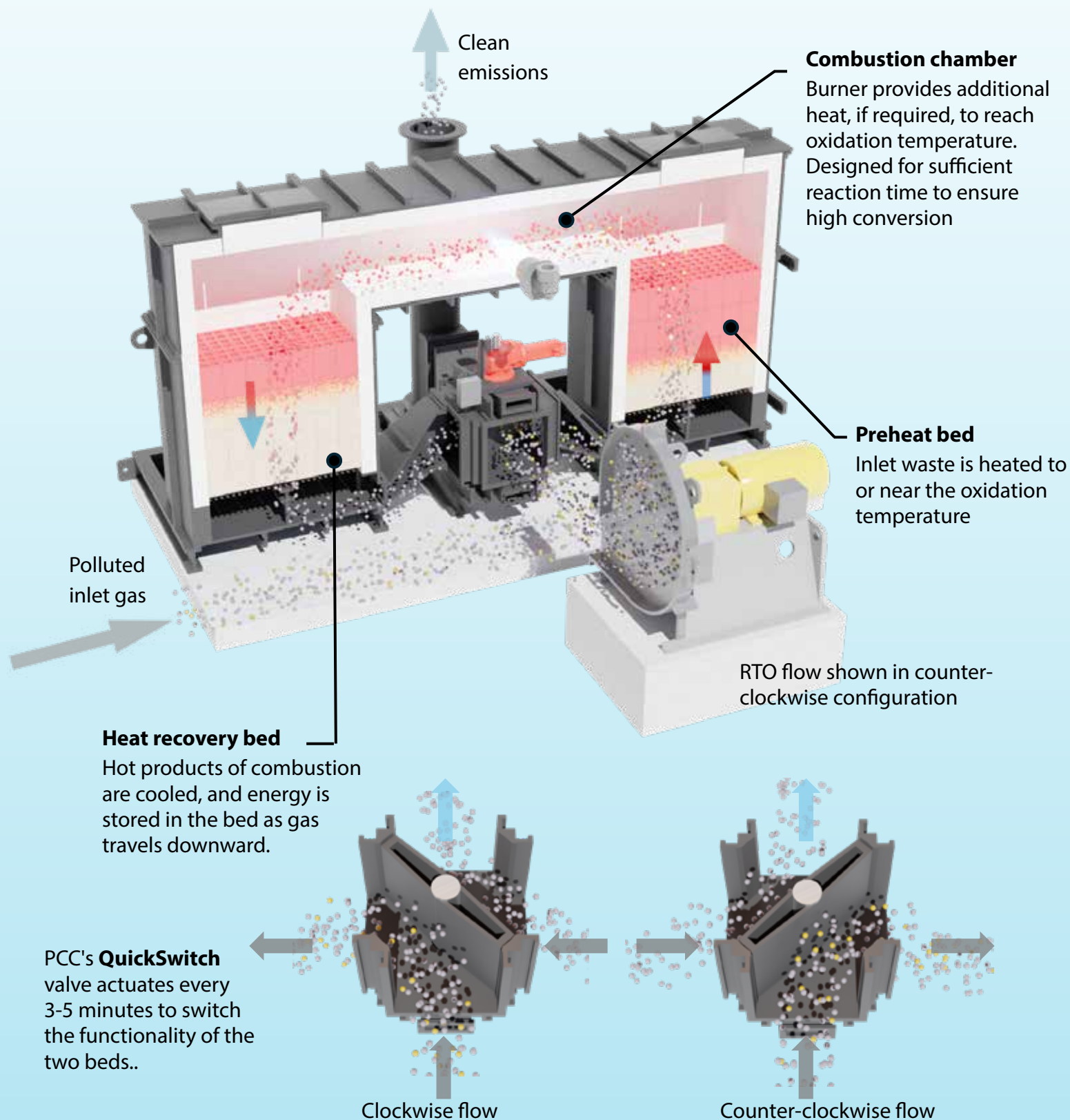
SYSTEM DESIGN OVERVIEW



- A Process gas and make up air control dampers**
Isolates RTO from upstream process in interlock scenarios, purges system before ignition, and allows idle mode operation with ambient air.
- B Process gas blower**
Supplies motive force to draw waste gas from the customer header and push through RTO and stack.
- C QuickSwitch valve**
Low maintenance indexing, air-sealed valve to reverse RTO flow direction.
- D Heat recovery chambers**
Supports media and ensures excellent flow distribution into heat exchange beds.
- E Heat transfer media**
High efficiency direct heat transfer ceramic packing.
- F Combustion chamber**
Insulating ceramic fiber lined chamber designed for destruction residence time.
- G Burner**
Heats media beds for start-up, and provides heat required for oxidation.
- H Gas train**
NFPA86 and FM Global designed burner and gas injection controls.
- I Instrumentation manifolds**
Localized, easy to read, and accessible.
- J Skid mounted HMI and PLC panel**
Large 15" HMI screen; panel is prewired and tested prior to shipment.
- K Stack**
Disperses clean emissions with EPA test ports for compliance testing.
- L Access hatches**
Allows for quick and easy inspection and replacement of heat transfer media.
- M Burner air blower and duct**
Supplies adequate air to burner for oxidation.
- N Puff capture system (optional)**
For increased DRE performance, puff capture system collects untreated emissions during valve transition and recycles it to the RTO inlet.
- O Hot gas bypass (optional)**
Extends high VOC capabilities by diverting hot treated gas directly to the stack.

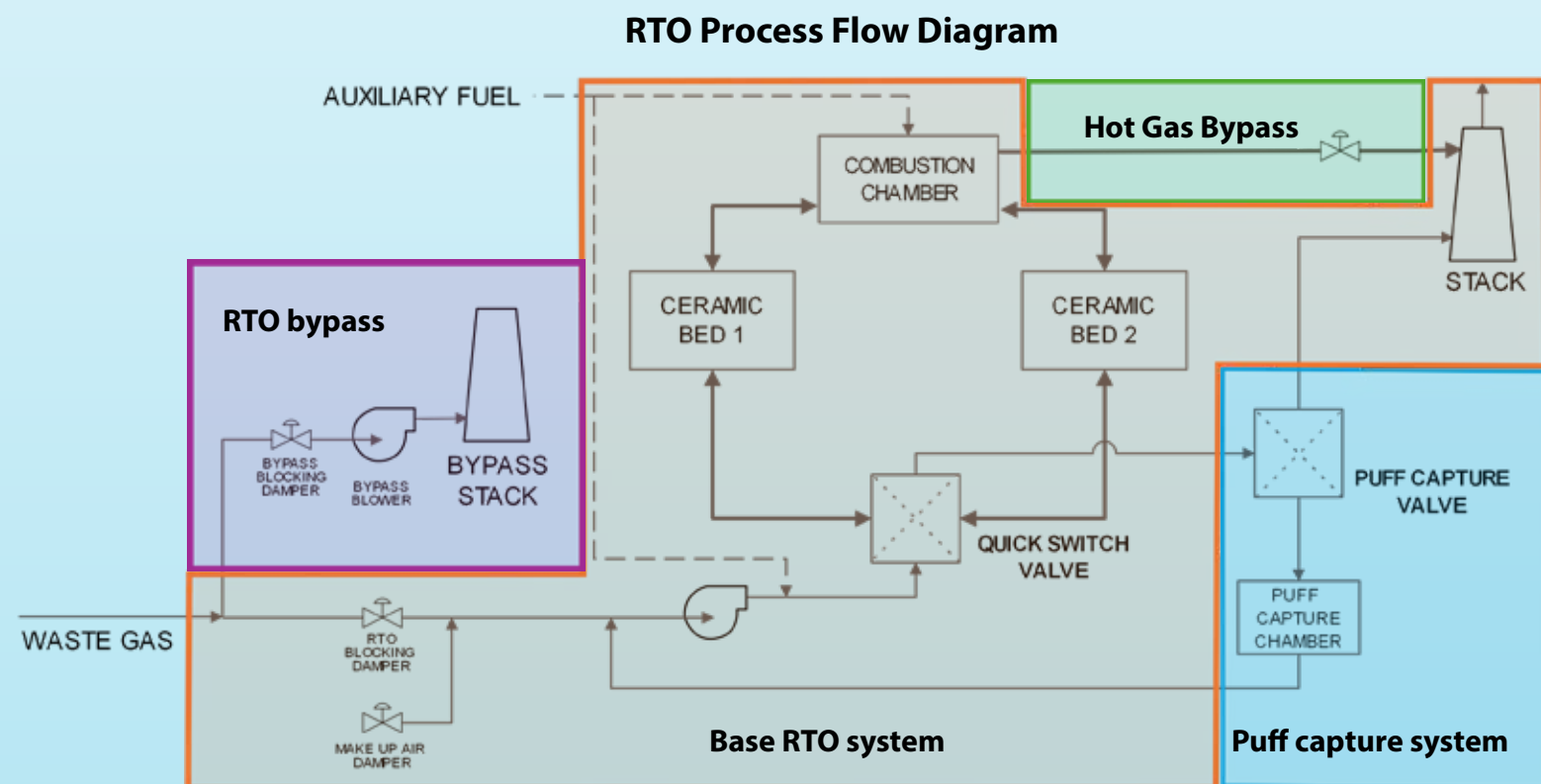


PCC's QuickSwitch RTO regenerates thermal energy needed for contaminant oxidation by reversing the flow direction through two direct heat transfer beds.



The base RTO can be enhanced with several add-ons to extend the capabilities of the system.

- Base RTO**
 The base RTO system provides all necessary equipment, instrumentation and controls to achieve 98% DRE with up to 97% TER. The base system includes everything from the inlet control dampers through to the exhaust stack.
- RTO bypass system**
 The RTO bypass system allows upstream processes to continue running while the RTO is isolated.
- Hot gas bypass system**
 The hot gas bypass system safely controls the combustion chamber temperature during times of high VOC heat loading by diverting hot combustion chamber gas directly to the stack and bypassing the heat exchange beds.
- Puff capture system**
 The puff capture system increases the destruction performance from 98-99+% by capturing and recycling the small puff of untreated waste gas that occurs when the RTO QuickSwitch valve transitions. The system consists of a second QuickSwitch valve, residence chamber, and interconnecting ductwork.



PCC's air-sealed, indexing QuickSwitch (QS) valve is designed for high sealing performance with low maintenance.

High performance air seal

Air is used to create an extremely low leakage seal between the flow diverter and valve housing.

Eliminates high-wear, mechanical seal

Only a high temperature gasket is used to reduce the gap between the flow diverter and valve housing. Sealing is performed by the air blade, greatly reducing mechanical seal wear.

Extremely fast switch

Contaminated air "puff" is reduced by having a total actuation time of just half a second.

Soft close control

Proprietary gearmotor software accelerates and decelerates the diverter in a smooth and fluid manner. This eliminates jerky movement and extends equipment life.

Simplified design, reduced footprint

The QS valve offers a compact size with reduced components. The QS valve can be located between the media beds. Poppet valves require 2 pneumatic cylinders and large transition ducts and manifolds.

Freeze-proof electrical actuation

Unlike pneumatic actuators, the electrical actuator is freeze-proof. Operation is not limited by humidity of compressed air.

Increased valve diagnostics

Electrical motor control allows for high levels of diagnostic signals and feedback such as valve switch time, angular velocity, torque and amperage



2' QS Valve



3' QS Valve

Injecting natural gas into the inlet process gas for auxiliary heat, eliminating burner firing.

Advantages of SNGI

Zero NOx

By operating without a flame, NGI virtually eliminates thermal NOx emissions.

Fuel heating value is released in the preheat bed as the temperature reaches the fuel gas autoignition temperature.

SNGI outperforms low NOx burners, which typically achieve 30 ppmv NOx emissions.

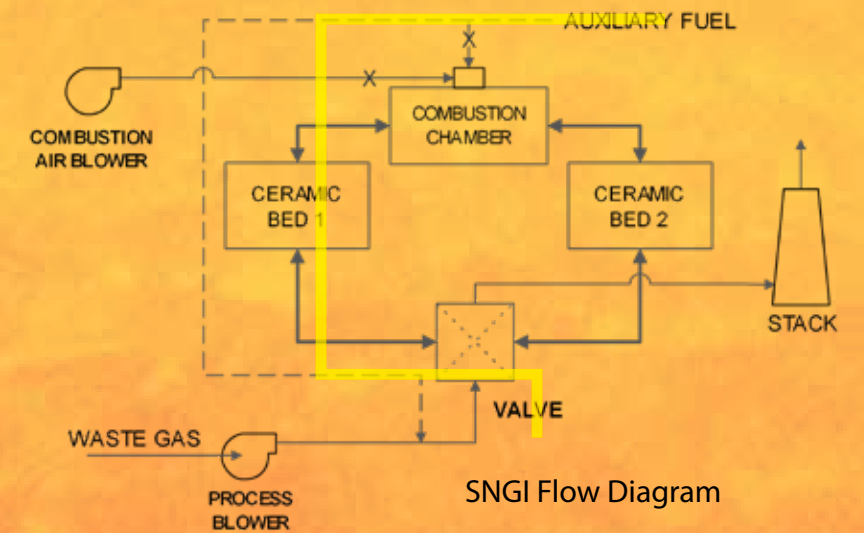
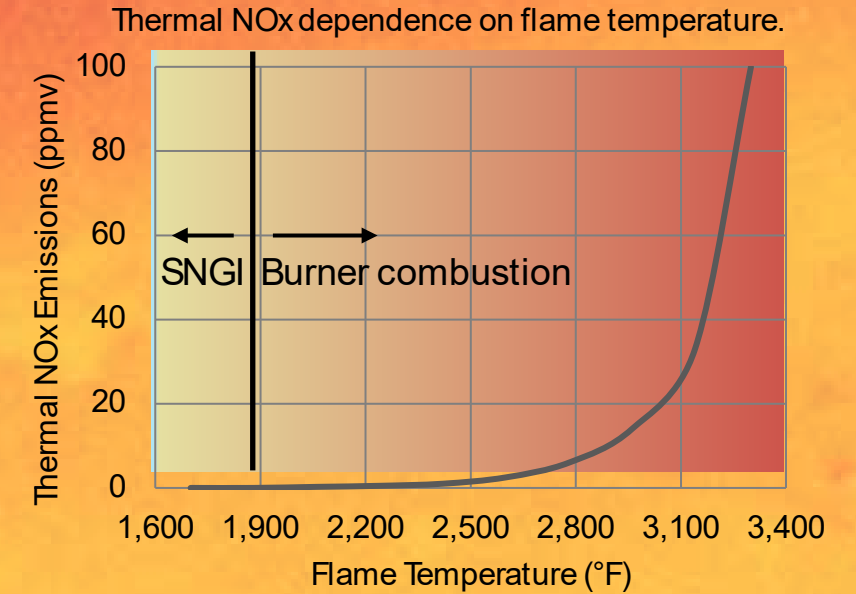
Fuel Savings

SNGI operation requires 20-30% less fuel compared to burner operation.

Fuel savings are realized by turning off burner air and fuel gas. Since the burner is mounted on the combustion chamber, burner fuel and air do not gain any heat recovery from the preheat bed.

Safety

NFPA86 and FM Global designed gas train ensures injected natural gas is safely controlled below the LEL in the inlet.

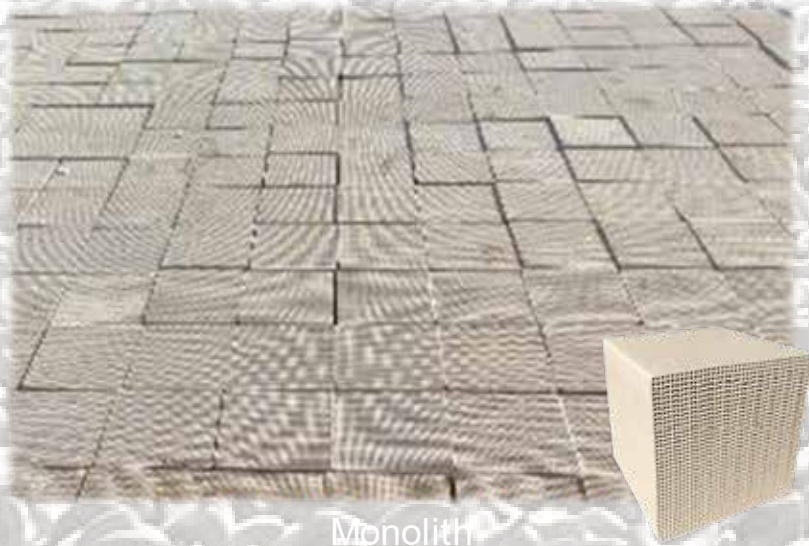




PCC customizes each RTO with the appropriate media type(s) and quantity to optimize fuel economy, ensure chemical compatibility, and minimize maintenance concerns.

MEDIA DESIGN CONSIDERATIONS - VELOCITY AND PRESSURE DROP

Characteristic	Structured Monolith	Random (Saddle)
Pressure Drop	Lower (designed for higher bed velocities)	Higher (designed for lower bed velocities)
Thermal Efficiency (Heat Transfer)	Higher at same bed velocity	Lower at same bed velocity
Sizes	Various porosities to optimize thermal efficiency for a given bed depth One Block: 6"(L) x 6"(W) x 6" or 12"(H) 25-50 x 25-50 cells	Various nominal sizes to optimize thermal efficiency for a given bed depth One Saddle: 1/2" or 1"
Ease of Install/Removal	More intensive install and removal	Dump in/vacuum truck removal
Chemical Resistance	Custom solutions available	Custom solutions available

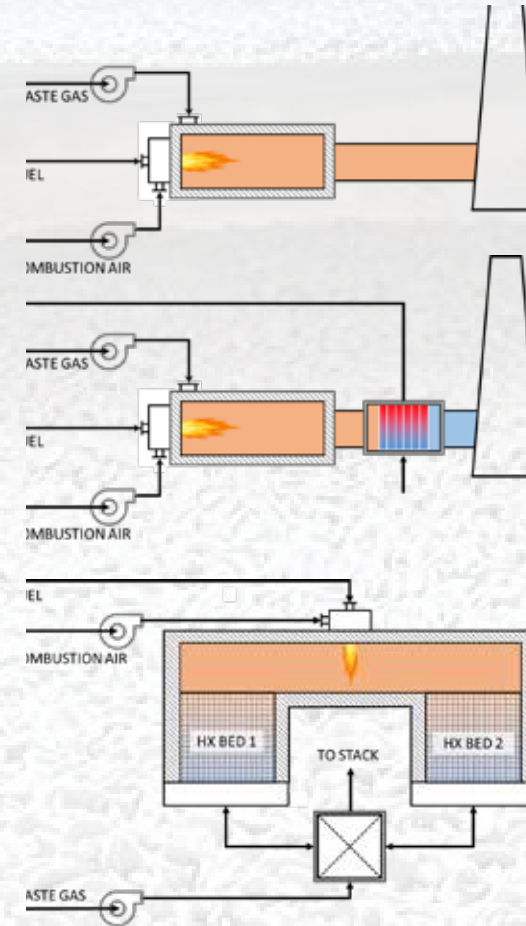


Monolith



Ceramic saddles

97% Thermal Energy Recovery means RTO operation costs are a fraction of other technologies.



Traditional Thermal Oxidizer
–0% energy recovery

Recuperative Thermal Oxidizer
–65% energy recovery
–indirect recovery with waste or air preheat

Regenerative Thermal Oxidizer
–97% energy recovery
–direct heat exchange with high efficiency media

Case Study - Operating Cost Comparison

Compares the operating cost for the three above technologies, assuming a 10,000 SCFM flow rate of waste gas with 750 ppmv of Ethanol as the VOC.

Case	TE = 0% TE	TE = 65%	TE = 97%
Gas Consumption	17.5 MMBTU/HR	5.66 MMBTU/HR	0.045 MMBTU/HR
Estimated Gas Cost ²	\$78.65/HR	\$25.45/HR	\$0.20/HR
Gas Phase ΔP	5" WC	11" WC	19" WC
Electrical Consumption ³	7.73 kW	17.0 kW	29.4 kW
Electrical Cost	\$0.46/HR	\$1.02/HR	\$1.76/HR
Total Operating Cost	\$79.11/HR	\$26.47/HR	\$1.96/HR

¹Contaminant LHV assumed to be 11,525 Btu/lb, Contaminant molar mass assumed to be 46.

²Gas cost assumed to be \$4.50/MMBtu

³Electrical cost assumed to be \$0.06/kWhr

PCC QuickSwitch RTOs are designed for quick and easy installation to reduce cost and downtime for our customers.



Each RTO is designed to ship in the fewest pieces with single piece shipping for units up to 10,000 scfm. Large RTOs are segmented into pre-wired and insulated pieces for field assembly.



All systems are shop insulated and assembled to ensure excellent fit in the field.



Instrumentation is pre-piped and pre-wired with quick connections to reduce field tubing and wiring.



Small units can be installed and started in 1-3 days.

PCC routinely packages additional equipment to offer a fully integrated pollution control train. This provides a single point of contact and simplified project management for our customers.

Air pollution control trains may include the following additional equipment:

- Wet electrostatic precipitators (WESPs)
- Collection duct headers
- Rotary concentrators
- Particulate cyclones
- Waste heat boilers
- Redundant RTOs
- Water strippers
- Gas scrubbers
- Baghouses

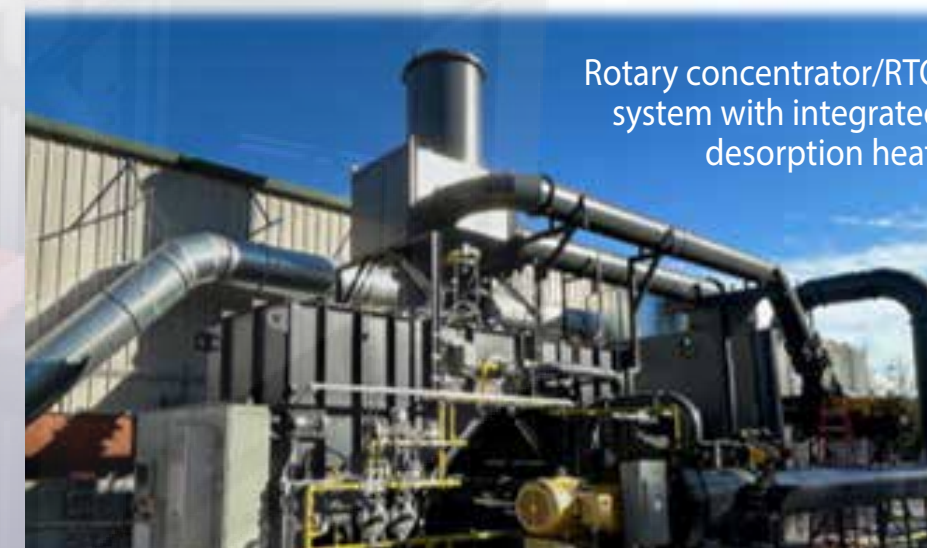
Our air pollution control trains offer integrated controls, so ancillary equipment is controlled by one clean HMI screen package.

In addition to equipment integration, PCC can provide additional services as a total solution offering, including:

- International project management
- Pre-RFQ engineering studies
- Gas flow measurement
- Equipment installation
- Equipment audits



Hundreds of feet of collection ductwork feeding the RTO



Rotary concentrator/RTO system with integrated desorption heat.



Two parallel RTOs with high efficiency prefilters

PCC is an ISO 9001 certified company that has specialized in oxidation systems since our founding in 1969. We are a dedicated and skilled group of engineers, designers, and project managers that specify and execute complex environmental equipment projects.

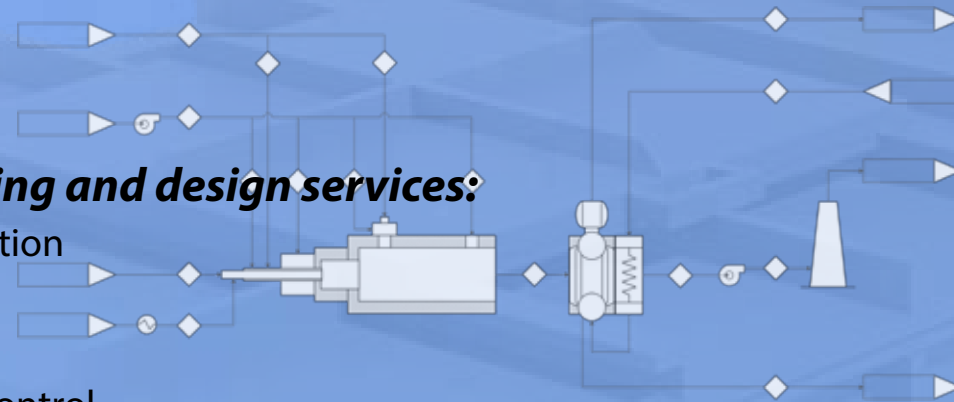
PCC specializes in the following technologies:

- Direct thermal oxidation
- Recuperative thermal oxidation
- Regenerative thermal oxidation
- Flameless thermal oxidation
- Electrical thermal oxidation
- Air heaters
- Gas scrubbers
- Biological oxidation



Comprehensive engineering and design services:

- AspenPlus process simulation
- 3D modeling
- Project management
- System automation and control



PCC successfully executes large, complex air pollution control trains.

PCC has RTO experience in a large variety of markets and applications. RTOs are especially advantageous for applications with **large flow, dilute waste** gas streams where thermal efficiency is critical to reduce fuel cost.

Standard equipment sizing up to 80,000 scfm. Larger flows can be custom engineered or employ multiple packaged systems in parallel.

Recuperative thermal oxidizers or direct fired thermal oxidizers are better suited for concentrated gas streams where the contaminant concentration is > 30% LEL.

Common application include:

- Battery recycling and production
- Coating operations
- Manufacturing room evacuation
- Printing
- Food and beverage
- Rotary wood dryers
- Tank vent from loading operation
- Paint manufacturing
- Ethanol production

