



Advanced Torrefaction Systems, LLC

“Making BIOCOAL Commercially Viable”

Torrefaction 2.0

Submitted by: Dan Herren
Advanced Torrefaction Systems, LLC
dherren@atscat.com
314-650-1186

BIOCOAL

Torrefaction is a thermo-chemical process that transforms biomass into a high-quality solid fuel known as BIOCOAL.

- With properties similar to coal, BIOCOAL is an excellent carbon-neutral, renewable fuel for the production of electricity and industrial applications.
- BIOCOAL can be used as a “drop-in” substitute for coal at power plants.
- To meet carbon reduction goals, many governments are instituting mandates and/or offering incentives to eliminate the use of coal in their energy mix, and that is driving demand for BIOCOAL.

In Japan alone, it is estimated that meeting government mandates will require 6.2 million metric tons of BIOCOAL per year by 2030.

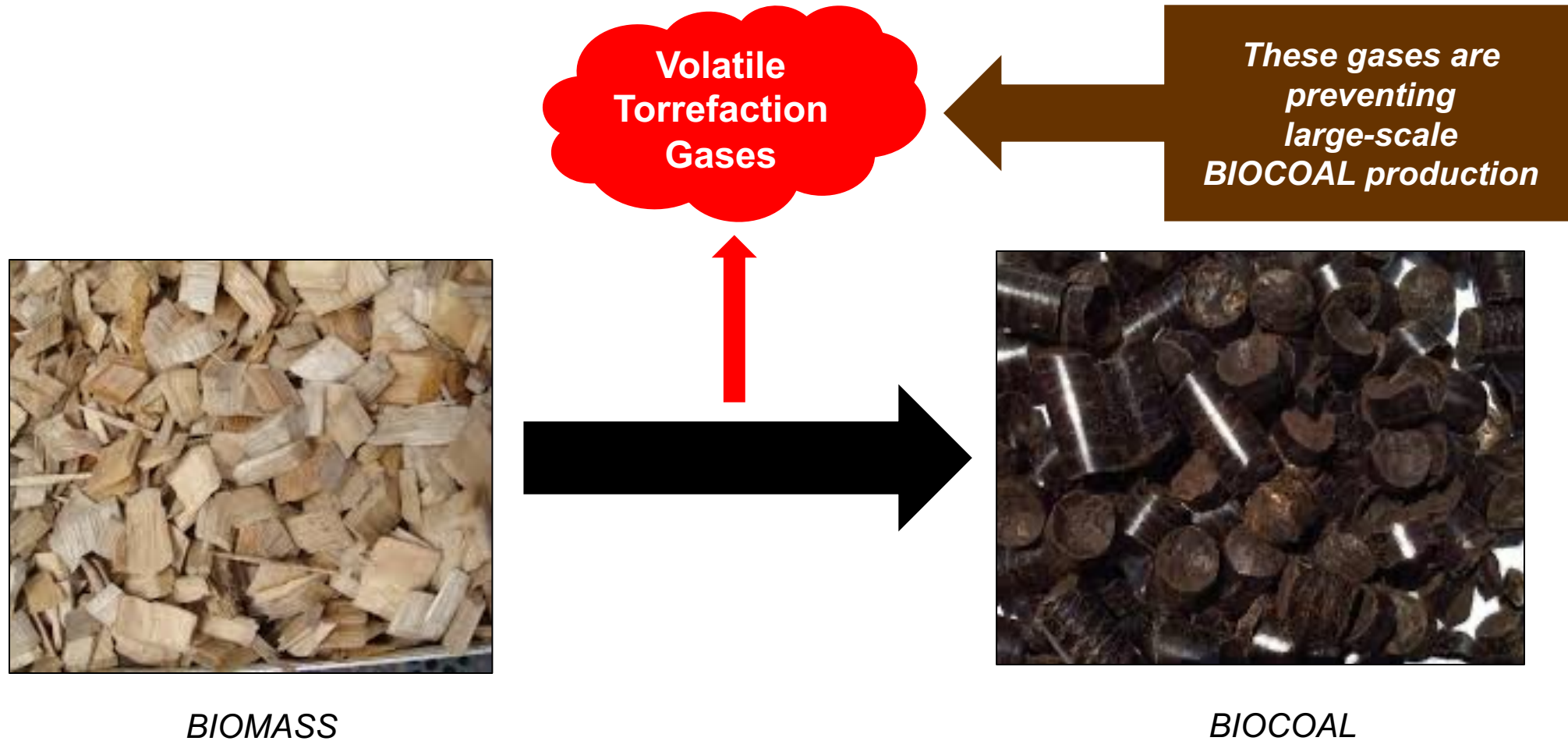
WHY HASN'T TORREFACTION TAKEN OFF?

- Given the tremendous potential of BIOCOAL, torrefaction has received worldwide attention over the last decade.
- Hundreds of millions of dollars have been spent on the development of torrefaction technology.
- Development over the last decade includes:
 - R & D: Universities, research institutes, governments, private sector
 - Pilot and demonstration plants
 - Attempts at building commercial-scale plants

Yet, BIOCOAL is still not available at commercial scale.

**WHAT IS PREVENTING COMMERCIAL-SCALE
PRODUCTION OF BIOCOAL?**

This is THE PROBLEM:



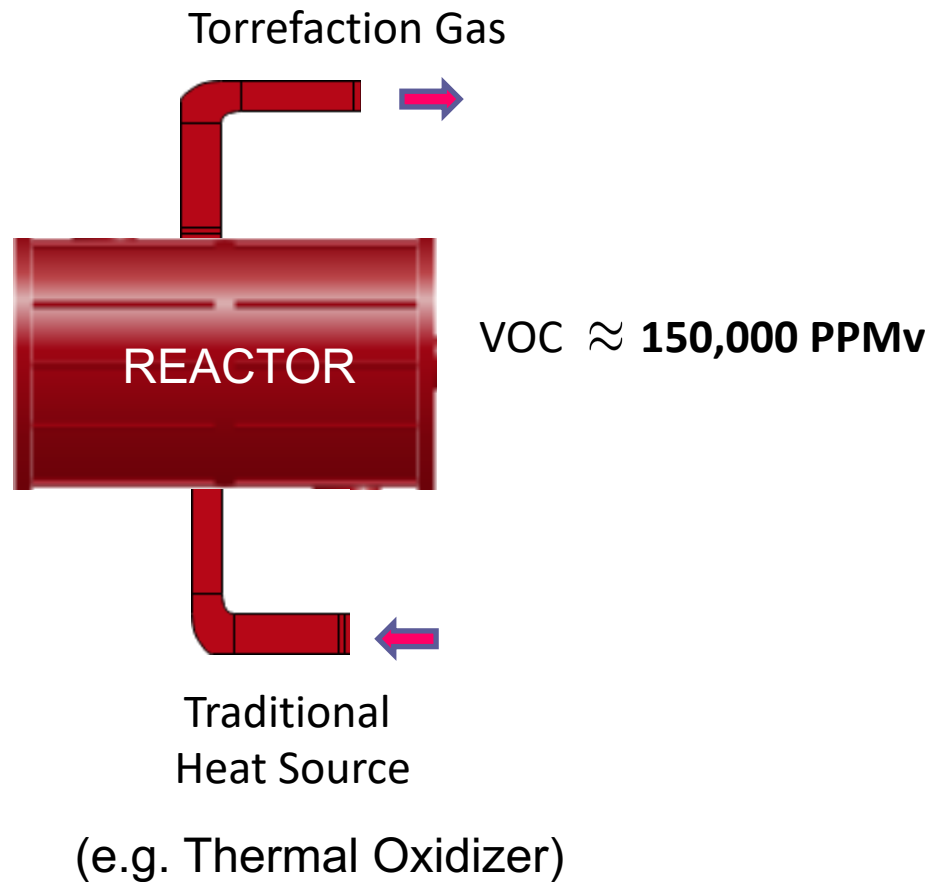


CURRENT TORREFACTION TECHNOLOGY

- **THE PROBLEM:** Current technology cannot effectively handle the volatile gases (VOCs) produced in the torrefaction process.
- **THE RESULT:** High concentration of VOCs throughout the whole system.

HIGH CONCENTRATION OF VOCs

CURRENT TECHNOLOGY





PROBLEMS CAUSED BY HIGH CONCENTRATION OF VOCs

- Condensation of gases on piping, equipment and controls, negatively impacting operational reliability
- Employee health and safety concerns such as increased risk of fires, explosions, and human respiratory hazards
- Environmental concerns such as air permit exceedances and equipment fugitive air emissions
- Product quality concerns: VOCs can condense onto the surface of the BIOCOAL causing high chemical oxygen demand (COD) levels in leachate and increasing the likelihood of self-heating in storage and transportation

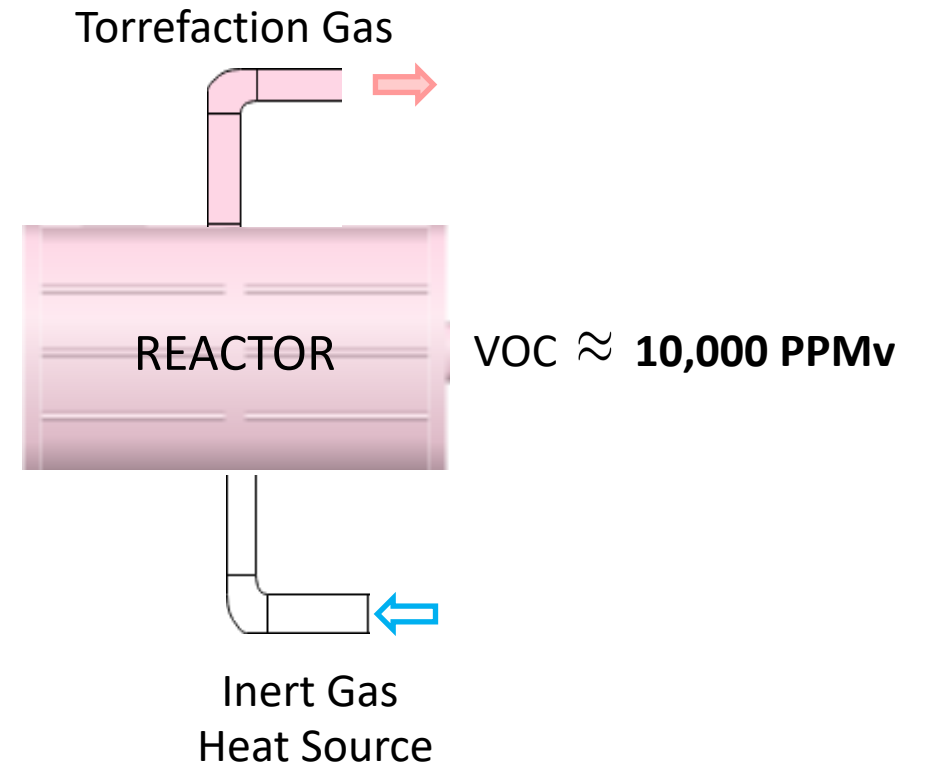
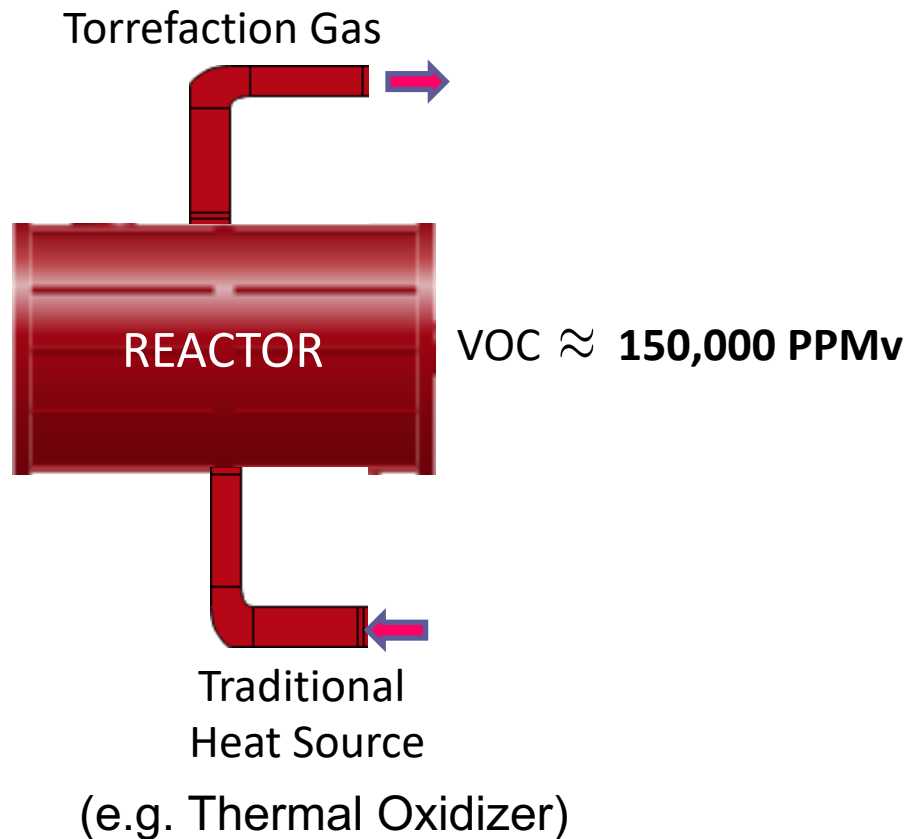


WHAT IS THE SOLUTION??

INERT GAS!

Safe, efficient and reliable torrefaction requires large volumes of inert gas for use throughout the process.

TRADITIONAL vs. INERT GAS HEAT SOURCE



Over 90% Reduction in VOCs

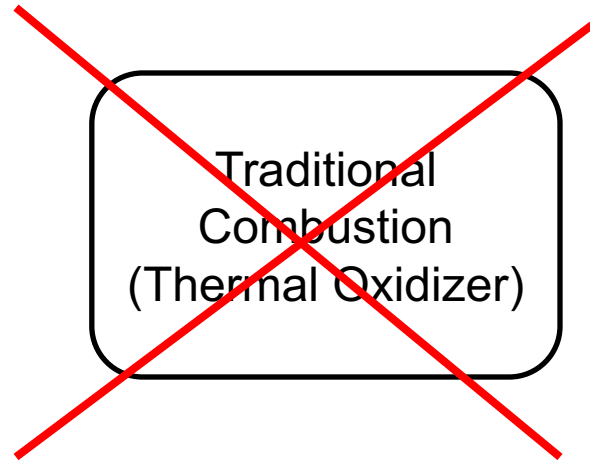
INERT GAS

- Current technology, which uses traditional combustion as the heat source for the reactor, cannot provide the inert gas required for commercial torrefaction.
- Purchasing or producing large volumes of inert gas (and heating it up) is cost-prohibitive.

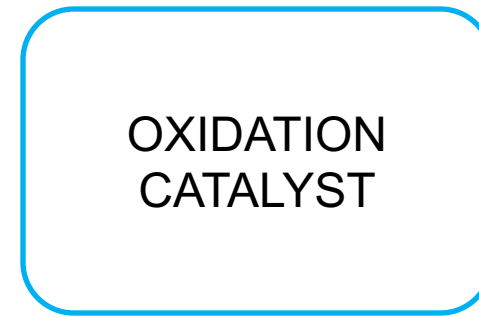
**SO WHERE DOES THE
REQUIRED INERT GAS COME
FROM?**

CATALYTIC OXIDATION

CURRENT TECHNOLOGY



CATALYTIC TECHNOLOGY



Both traditional combustion systems and catalytic oxidation systems have been used for decades in various industries worldwide. Selection criteria most often centers around the requirements of the specific application. Torrefaction requires very large amounts of essentially inert gas and therefore torrefaction applications require the use of a catalytic oxidation system.

CATALYTIC OXIDATION

- Combusts VOCs at up to a 99+% efficiency producing an essentially inert, hot flue gas stream----and it's **FREE!!** as a byproduct of the combustion
 - Heat source for torrefaction and drying
 - Purge gas for use throughout entire system
 - Inert medium for cooling
- Reduces concentration of VOCs in the reactor by over 90%



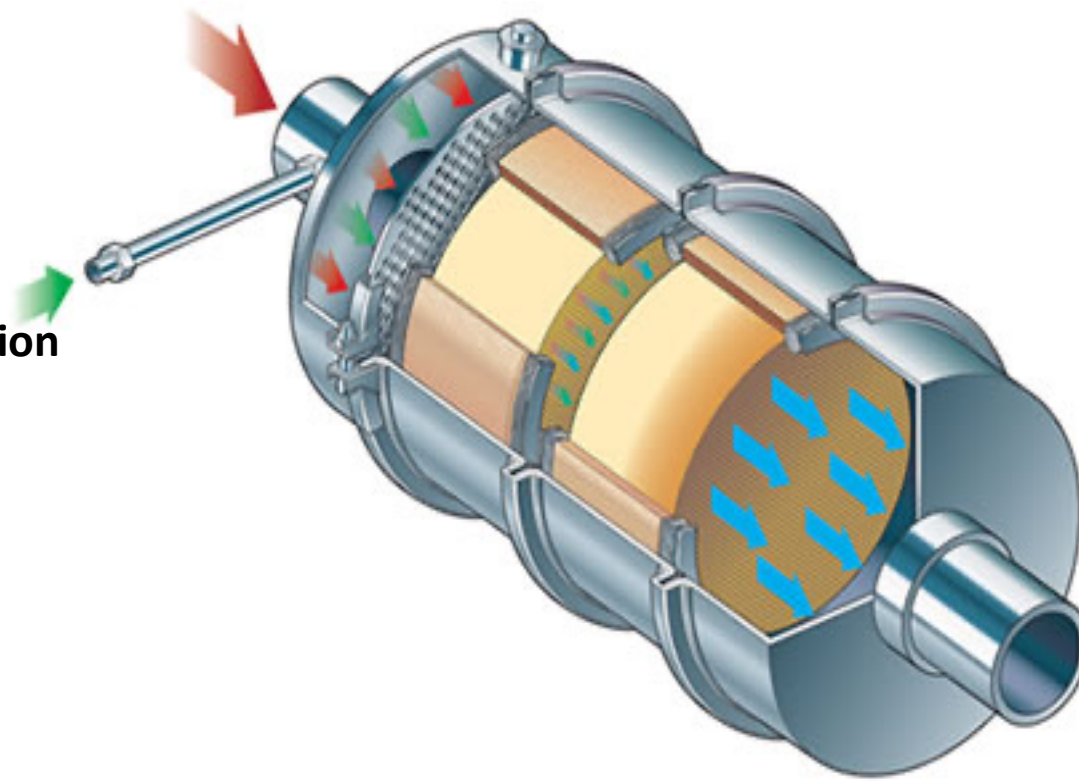
BENEFITS OF REDUCING HIGH CONCENTRATION OF VOCs WITH INERT GAS FROM AN OXIDATION CATALYST

- Essentially eliminates condensation of gases on piping, equipment and controls, allowing reliable operations
- Dramatically reduces risk of fires, explosions, and human respiratory hazards
- Dramatically reduces environmental concerns
- By continually stripping VOCs from the surface of the BIOCOAL with inert gas, condensation is prevented thereby addressing the issues of high COD levels in leachate and self-heating in storage and transportation

OXIDATION CATALYST

Process off-gas in
(VOCs, CO and H₂O)

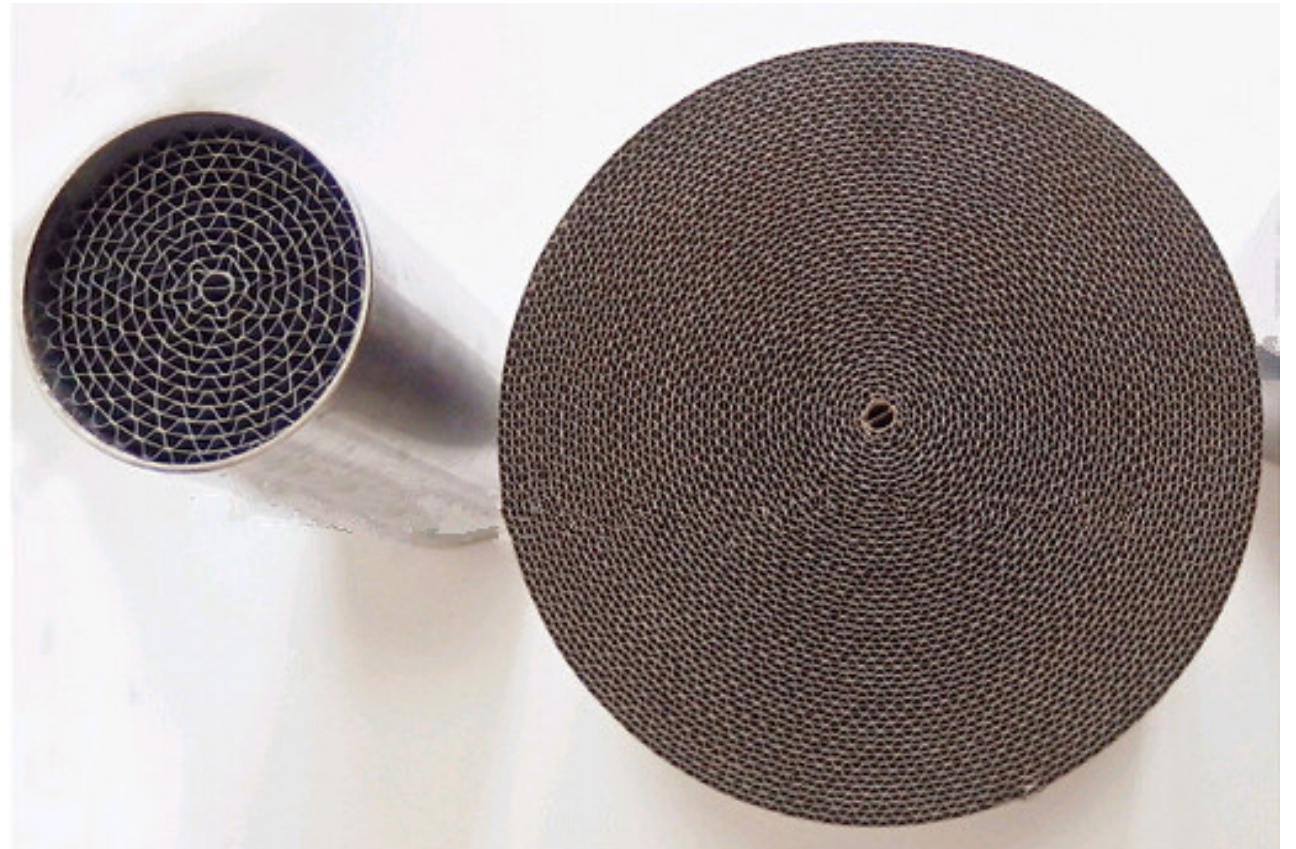
Combustion
air in



CO₂, N₂, H₂O and
heat out

From Johnson Matthey website

OXIDATION CATALYST BED



OXIDATION CATALYST


- Tried and true technology used throughout the world
- Combusts VOCs at a much lower temperature (under 1100° F) than traditional combustion
 - Creates essentially no NOx
 - Less ambient heat loss improves process efficiency

CATALYTIC OXIDATION TECHNOLOGY TESTED AT THE INL

Advanced Torrefaction Systems
ATS TorreCAT™ Catalytic Oxidation Technology
has been successfully tested at the
Idaho National Laboratory.

Quote from Idaho National Lab Scientist-in-Charge

“Torrefaction was never this easy without the catalyst because oxygen levels are much easier to control and there is no black gooey torrefaction oil.”




Why use traditional combustion that results in a very high concentration of VOCs and the problems that creates when the use of an oxidation catalyst can reduce that concentration by more than 90%?

Catalytic oxidation is the

MISSING LINK

in the torrefaction process that will finally make BIOCOAL commercially viable.



To learn more, please contact
DAN HERREN, PRESIDENT
ADVANCED TORREFACTION SYSTEMS, LLC
ST. LOUIS, MISSOURI
dherren@atscat.com
314-650-1186 (US)