



WHY HASN'T TORREFACTION TAKEN OFF?

**TAPPI—INTERNATIONAL BIOENERGY & BIOPRODUCTS
CONFERENCE**

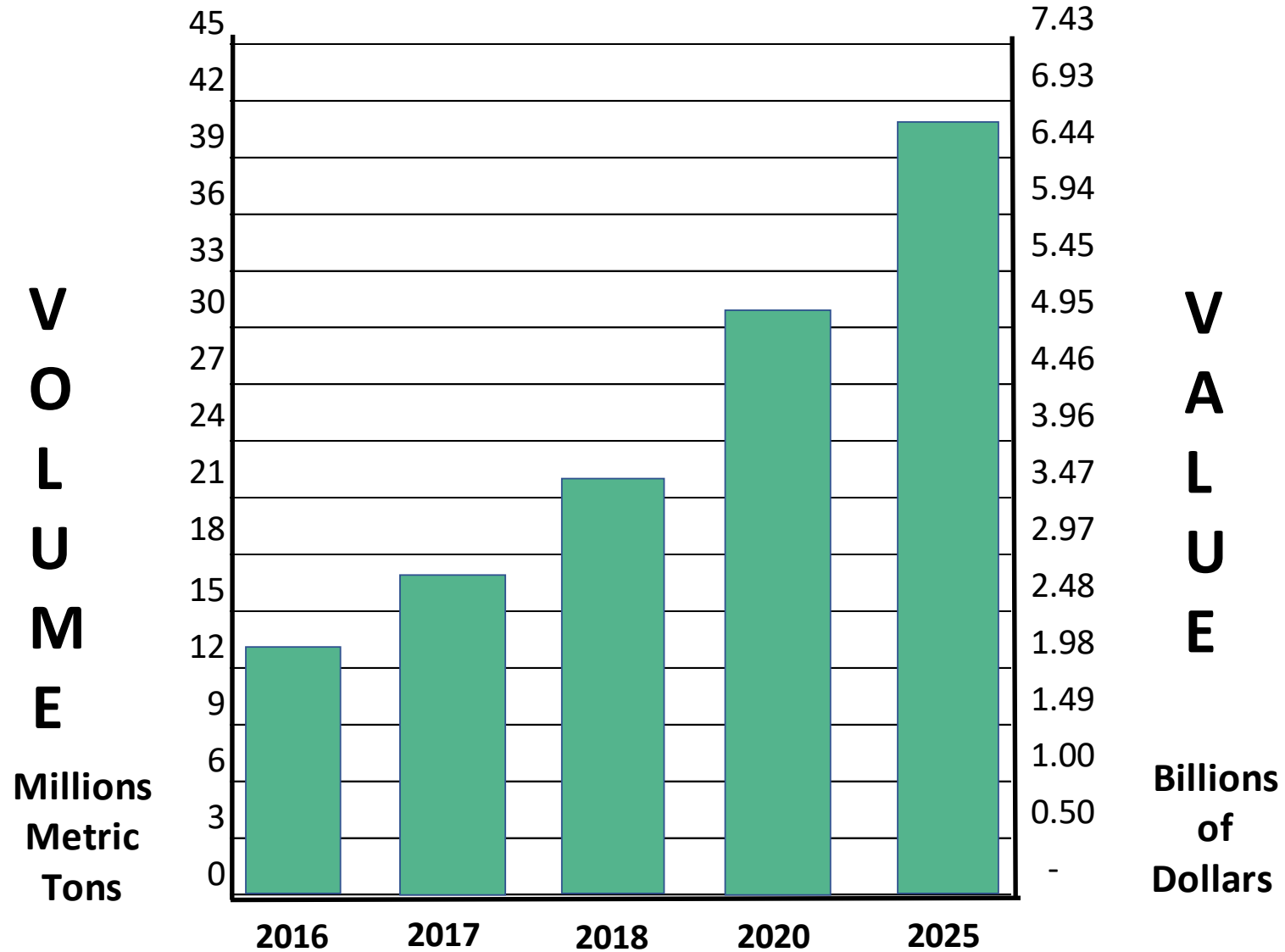
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**Dan Herren, President
Advanced Torrefaction Systems, LLC**

OVERVIEW

- Background
 - Industrial Wood Pellet Market
 - Current Technology: “White” Wood Pellets
 - White Wood Pellets Deficiencies
- Torrefied Pellets: “Next Generation” Biomass Energy Feedstock
- Torrefaction and Its Benefits
- Problems With Current Torrefaction Technology
- Solution: Inert Gas (Catalytic Oxidation)
- Co-Firing
- Catalytic Oxidation---The Missing Link

INDUSTRIAL WOOD PELLET MARKET



Source: FutureMetrics, LLC Actual and Projected Volumes
Value = \$165 per metric ton

CURRENT TECHNOLOGY

“White” wood pellets are the current “state-of-the-art” biomass energy feedstock.





WHITE WOOD PELLETS DEFICIENCIES

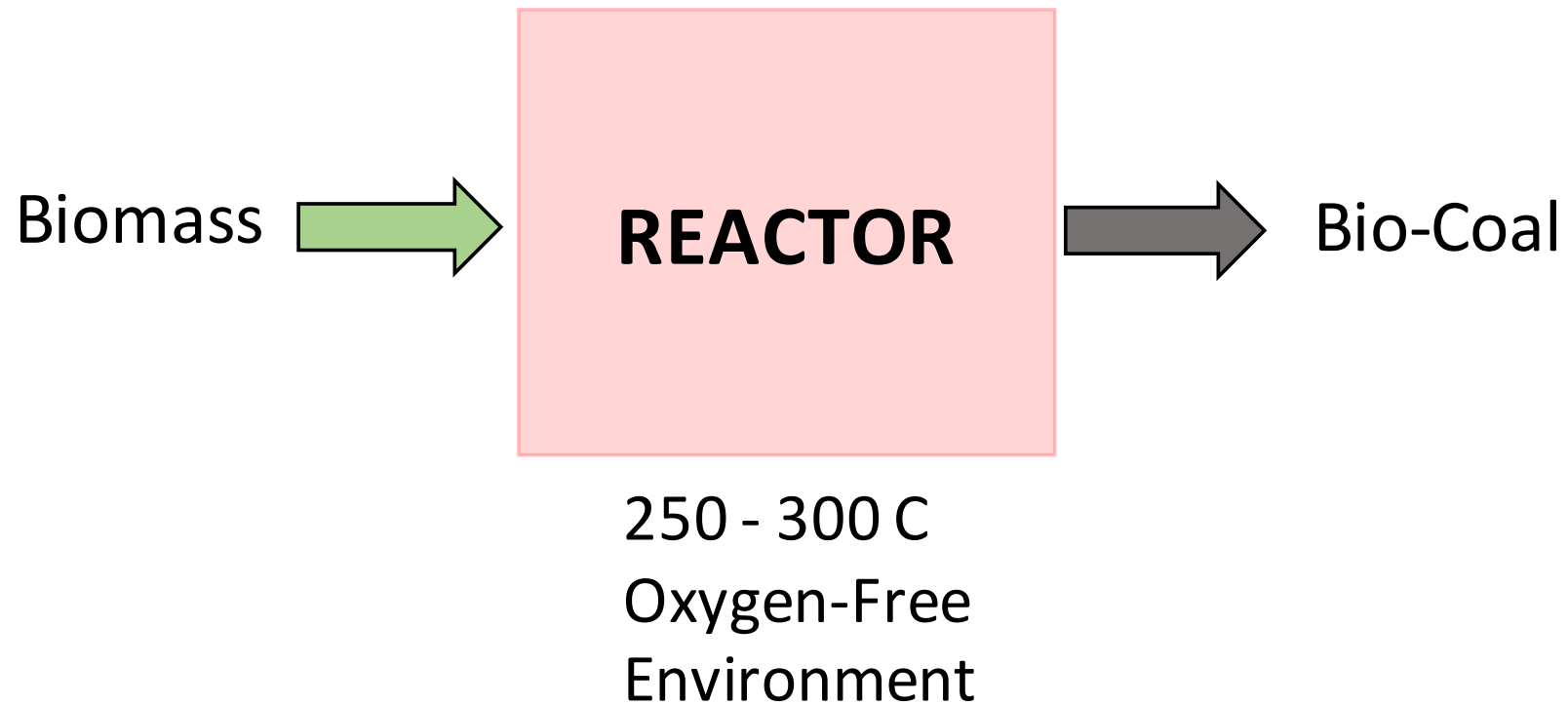
White wood pellets have characteristics that are very different from coal resulting in:

- Higher power plant infrastructure costs
- Higher plant operating costs
- Higher transportation costs
- Limited co-firing ratios

TORREFACTION: THE NEXT GENERATION

- Torrefaction is a process that turns biomass into **bio-coal**, the “next generation” form of biomass energy feedstock.
- Bio-coal has characteristics similar to coal which makes bio-coal an excellent coal replacement.

TORREFACTION



BIO-COAL VERSUS WHITE WOOD PELLETS

- Higher bulk density
- Higher energy density
- Improved grindability
- Hydrophobicity
- Can be stored outside
- Expanded feedstock options



BENEFITS OF TORREFACTION

- Can be produced at a cost on par with white wood pellets
- Reduce shipping costs by 35% compared to white wood pellets
- Provide financial and operational benefits at power plants
- Unlimited co-firing ratios (up to 100%)



WHAT'S THE PROBLEM?

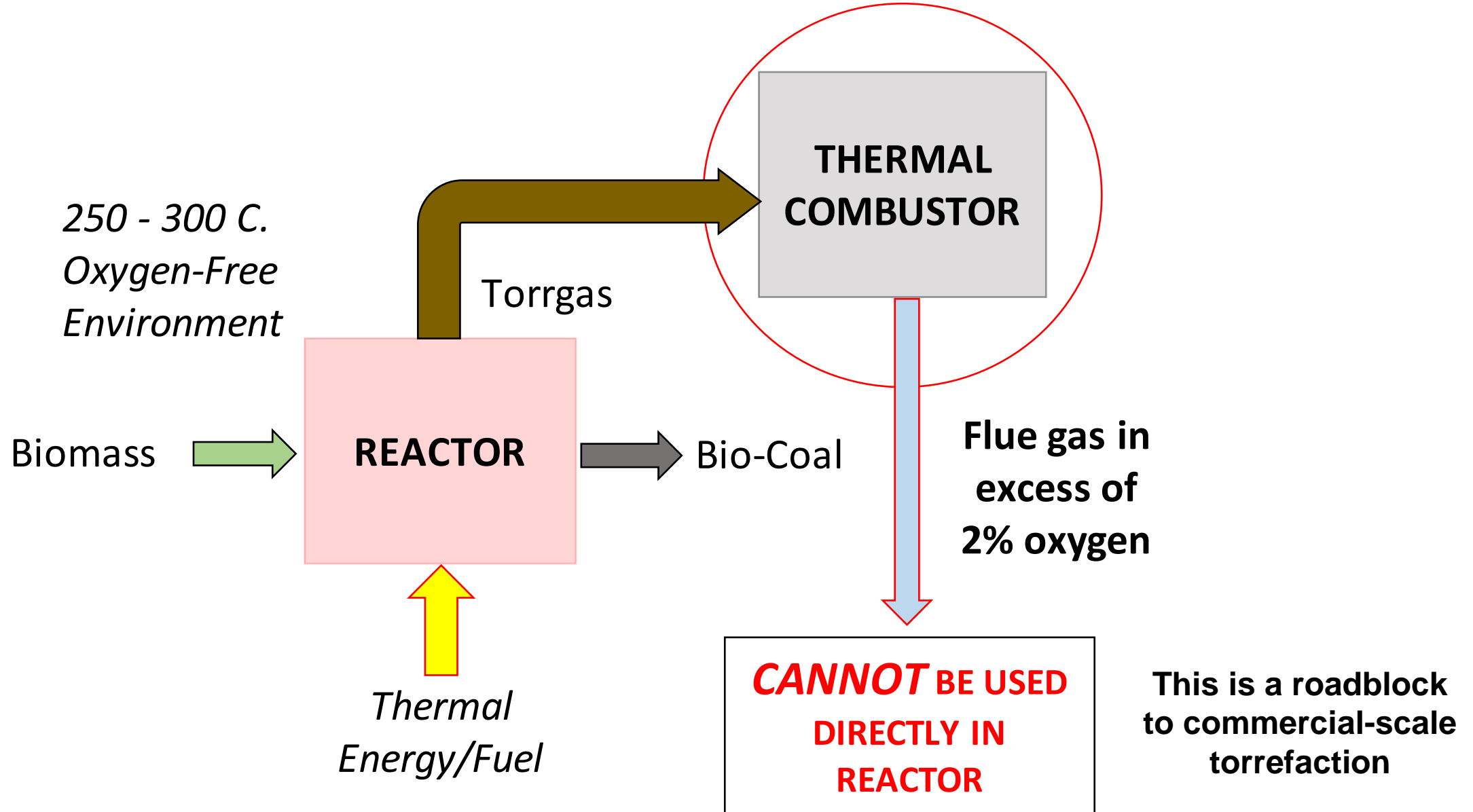
If bio-coal is a vastly superior biomass energy feedstock that costs less to use than white wood pellets, then

**WHY HASN'T
TORREFACTION
TAKEN OFF?**

CURRENT TORREFACTION TECHNOLOGY

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

CURRENT TORREFACTION TECHNOLOGY



CURRENT TORREFACTION TECHNOLOGY

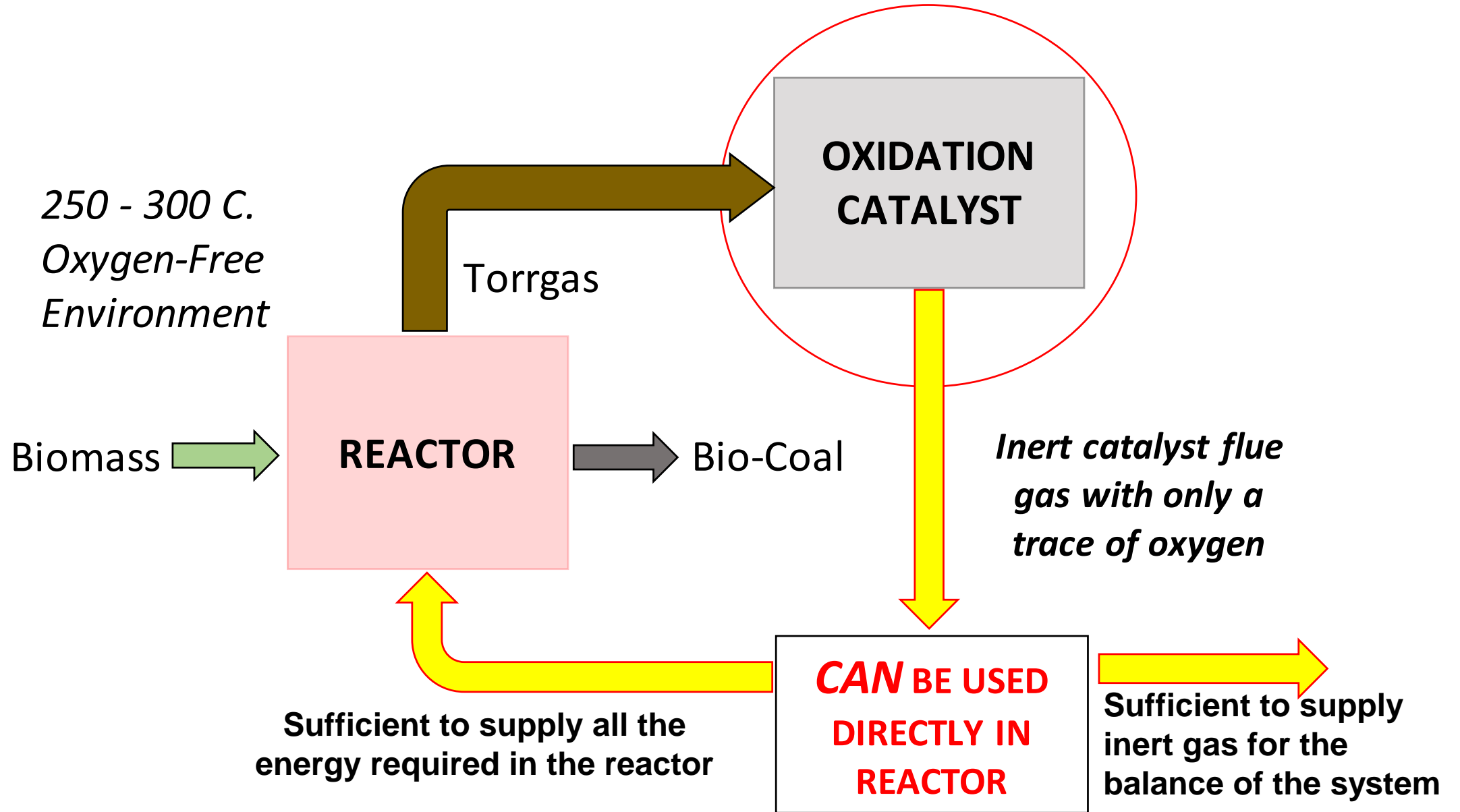
Inability to effectively handle the torrgas results in:

- Lack of operational reliability
- Increased risk of fires and explosions
- Employee health and safety concerns
- Less than optimal operational efficiency

SOLUTION?? IT'S A GAS!

- Safe, efficient and reliable torrefaction requires large volumes of **INERT GAS** for use throughout the process.
- Current technology cannot cost-effectively provide the inert gas required for commercial torrefaction.
- **SO WHERE DOES IT COME FROM?**

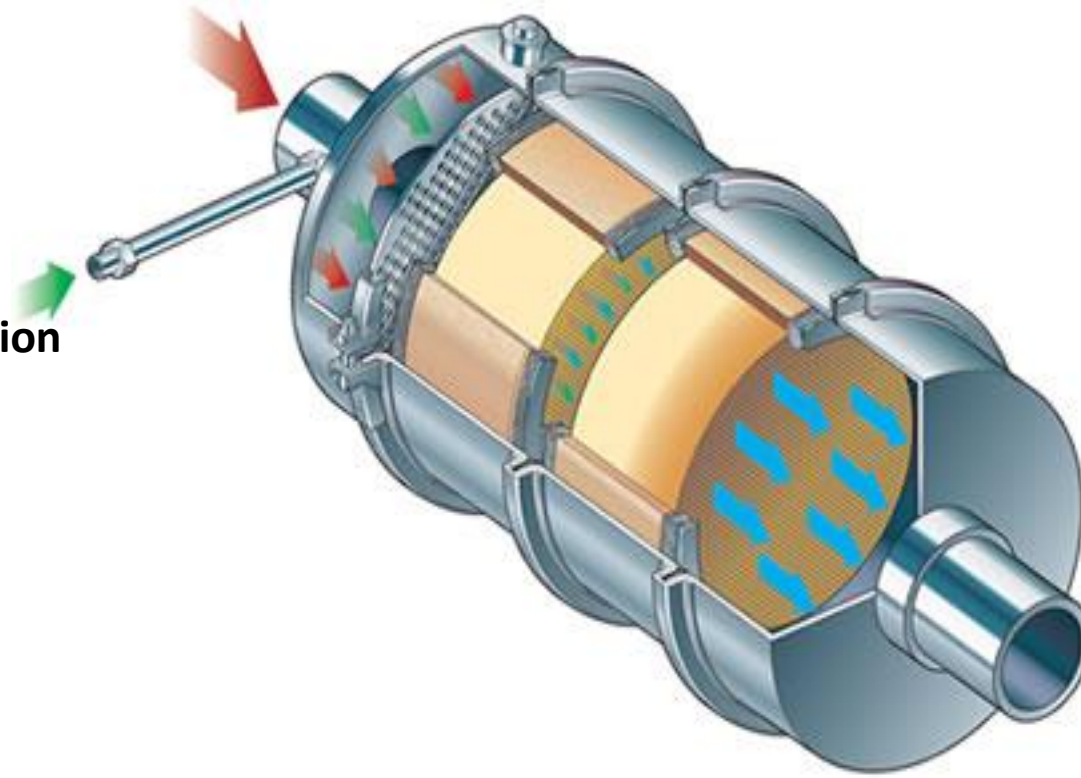
CATALYTIC OXIDATION TECHNOLOGY



OXIDATION CATALYST

Process off-gas in
(VOCs, CO and H₂O)

Combustion
air in



CO₂, N₂, H₂O and
heat out

From Johnson Matthey website

CO-FIRING POTENTIAL

Bio-coal can be co-fired with coal at ratios up to 100%:

- Bio-coal can be treated like coal
- Renewable, carbon-neutral energy feedstock
- Reduction of NO_x
- Reduction of SO_x
- Reduction of mercury
- Minimal plant modifications



CATALYTIC OXIDATION IS THE MISSING LINK

Torrefaction will not become commercially viable without catalytic oxidation technology.



THANK YOU!

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