“HOT TOPIC HOUR” PRESENTATION

CO-FIRING BIOMASS IN STOKER BOILERS

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JANSEN
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Presentation Outline

- JANSEN Background and Projects
- Biomass Combustion and Goals
- Biomass Combustion Problems and Challenges
- Phased Approach
- Modifying/Retrofitting Combustion Systems
- Benefits Synopsis

Jansen Background

Experience

- 36 Years of Boiler Experience (“Difficult Fuels”)
- Forest Products, W-t-E, IPP’s
- Tested/Evaluated > 300 Boilers, Worldwide
- >100 Advanced Combustion Systems, Many Coal Co-Fired
- Superheater (Re-)Design/Replacement
- New Economizers for Increased Efficiency

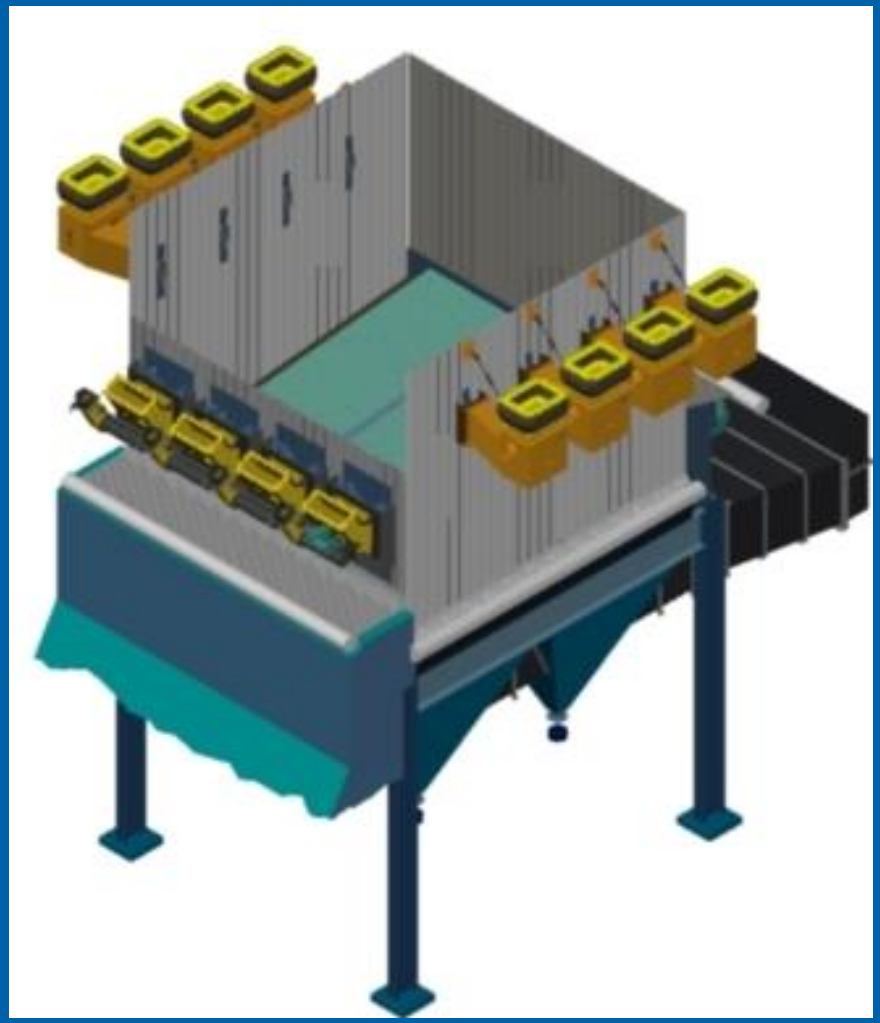
Types of Projects

- Combustion System Upgrades
  - Bark/Wood/Biomass/Sludge/TDF Boilers
  - Chemical Recovery Boilers
  - RDF/MSW Boilers
  - Boilers often Co-Fired with Coal
- Boiler MACT Compliance
- Boiler Fuel Conversions
- New/Replacement Superheaters and Economizers
- Complete Boiler Upgrades

Introduction – What is Biomass?

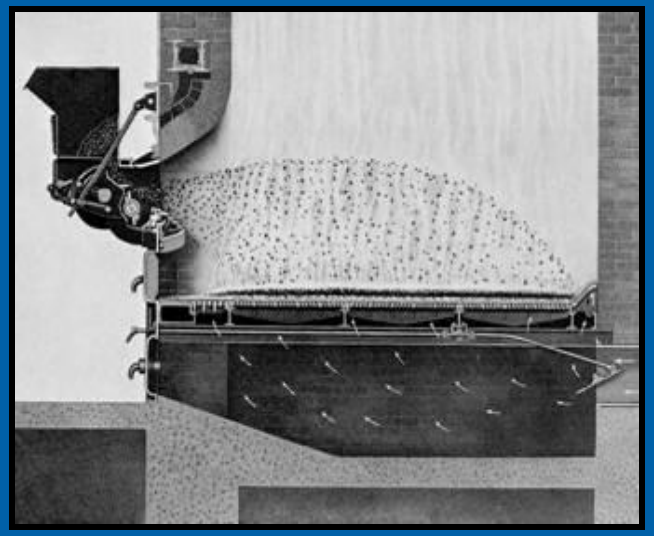
- Various Types of Solid Waste Wood:
  - Bark, Hogged Fuel, Sawdust, Clippings, Chips, Pellets
  - Construction and Demolition (C&D) Material
  - Ground Pallets and Old Furniture
  - Agricultural Wastes from Harvesting/Processing
- Refuse Derived Fuel (RDF)
- Tire Derived Fuel (TDF)
- Waste Sludge from Water Treatment Plant
- Some say: “Any fuel that is not fossil fuel”

Introduction – Fuel & Air Supply

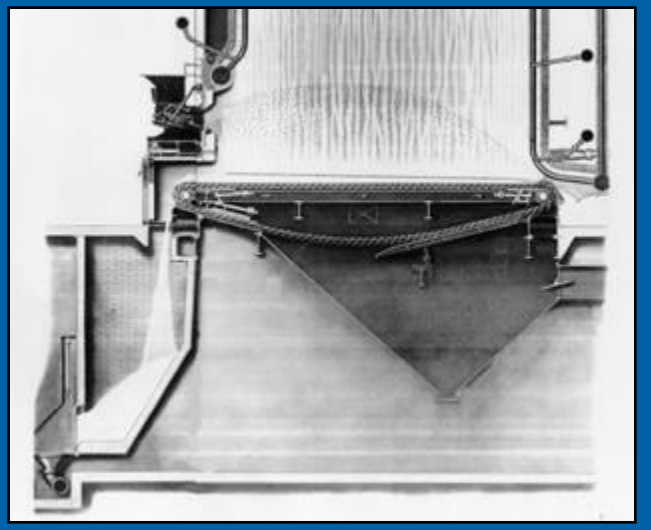


Introduction - Stoker Grates

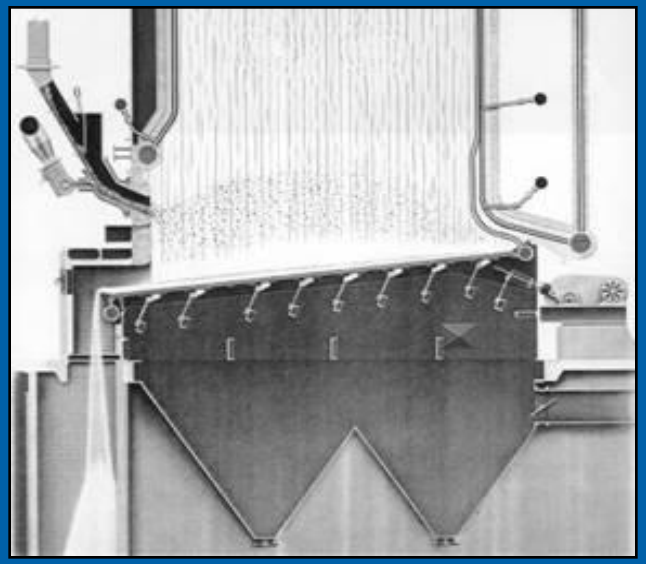
Pinhole



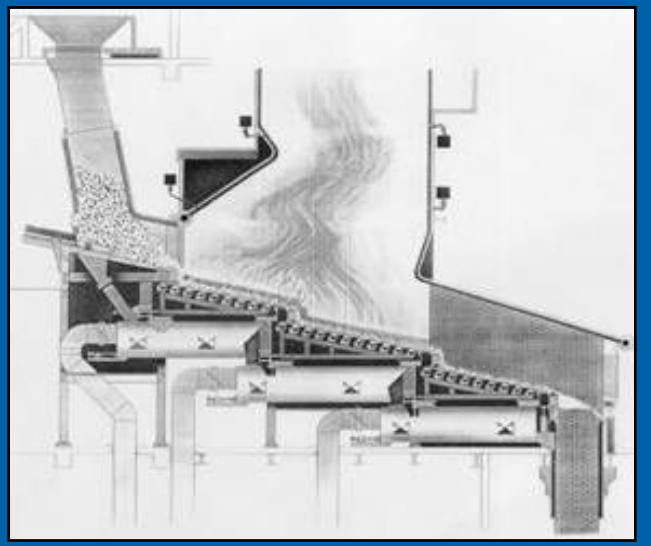
Traveling



Vibrating

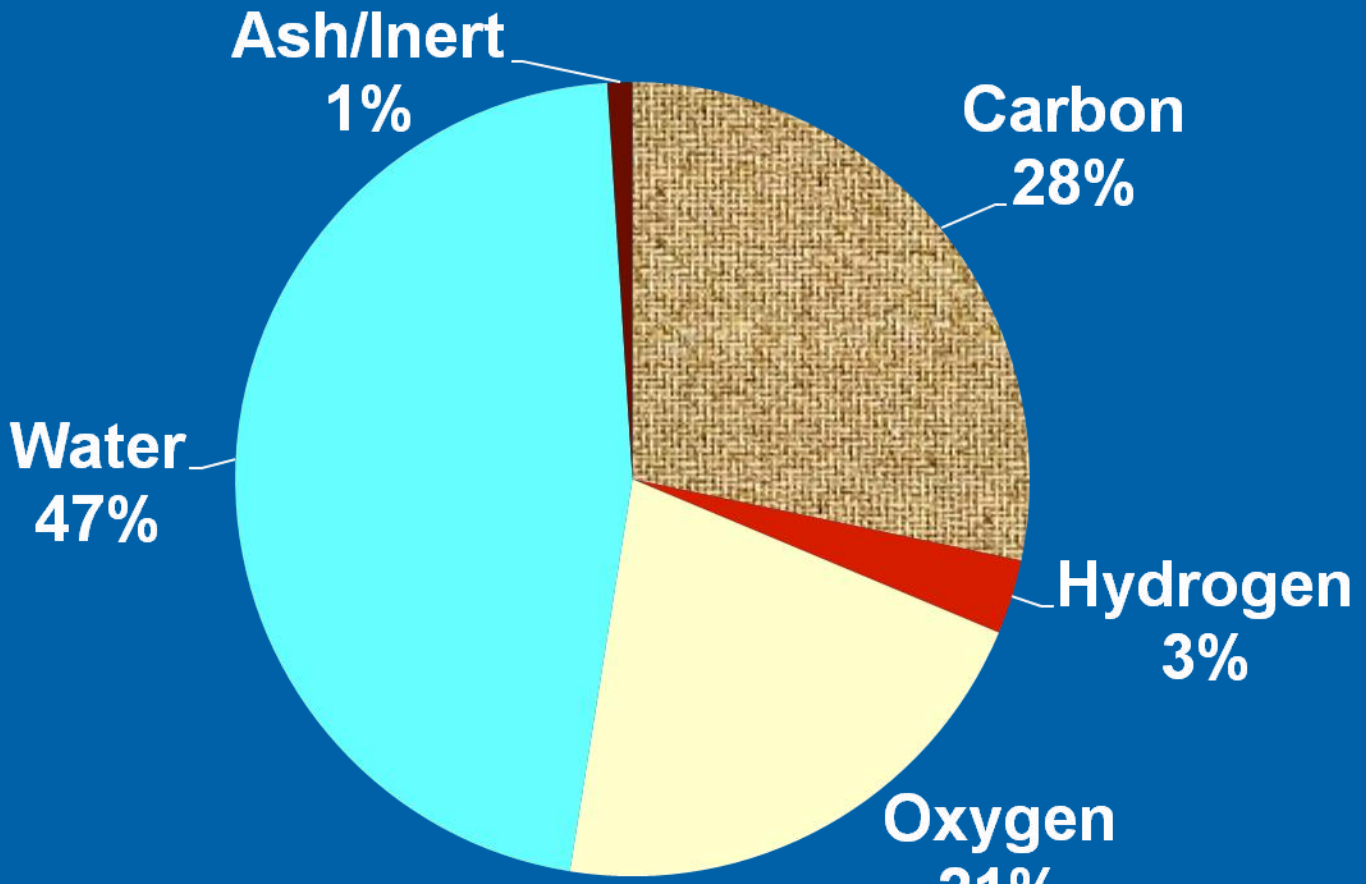


Reciprocating



Courtesy of Detroit Stoker Company

Biomass Composition



By mass

Combustion Goals

To Achieve Continuous and Reliable Operation, *Economically*

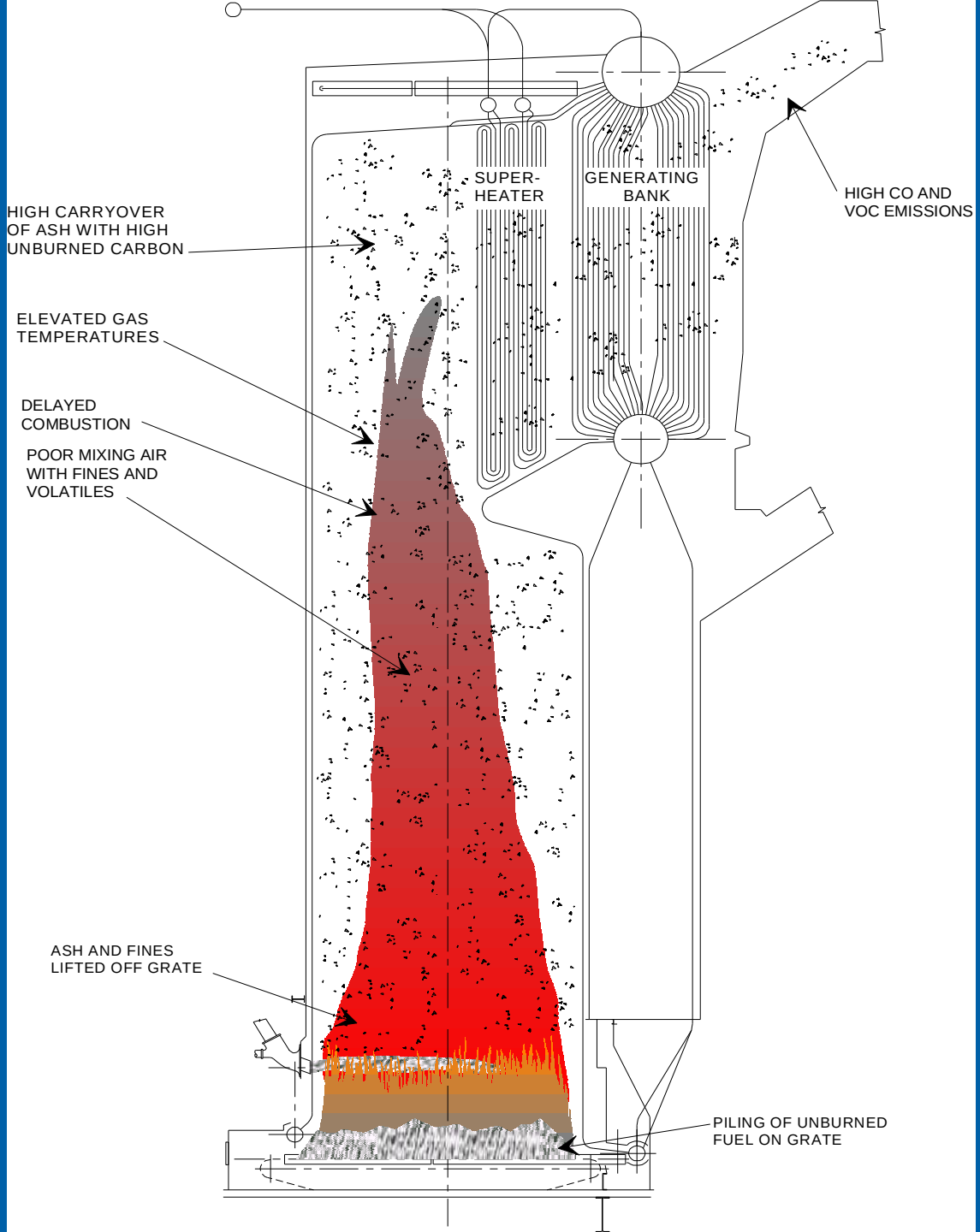
- Uninterrupted, Stable Operation
- Meet Regulatory Emissions Limits
- Optimize Fuel Economy
- Optimize Steam Conditions for Power Generation
- Minimize Erosion/Corrosion Factors

More Difficult to Achieve with Biomass

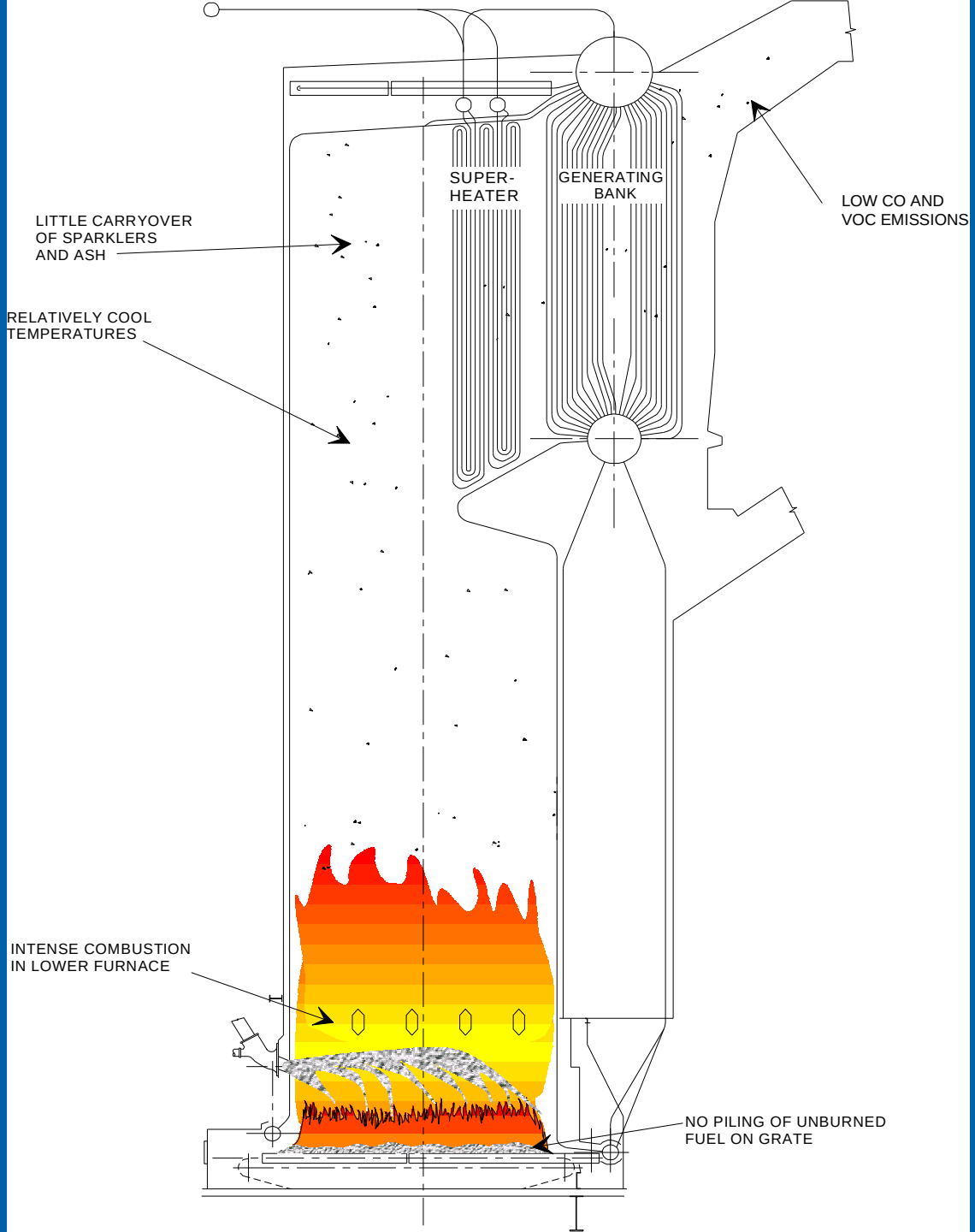
Combustion Problems

Symptoms Frequently Seen with Biomass Combustion

- High Carryover of Fly Ash; High Unburned Carbon
- Delayed Combustion, Flames “Licking” Superheater
- High Excess Air/Low Efficiency
- Puffing, Uncontrolled Combustion
- High CO and VOC Emissions
- Limited Waste Fuel Burning Rates
- Need for Fossil Fuel Co-firing (oil/gas/coal)
- Clinkering and Slagging



Poor Combustion Conditions



Good Combustion Conditions

Causes of Poor Combustion

- **Poor Mixing of Combustion Air with Fuel**
  - Time, Temperature, Turbulence
  - Volatiles, Fines Over Grate
- **High Undergrate Air (UGA) Flows**
  - Increases Airborne Material/Carryover
  - Higher Excess Air - Lower Efficiencies

Typical Project

Phased Approach

- Initial Feasibility Study
- Process Engineering Evaluation
- Definition of Conceptual Modifications
- Project Implementation

Engineering Evaluation

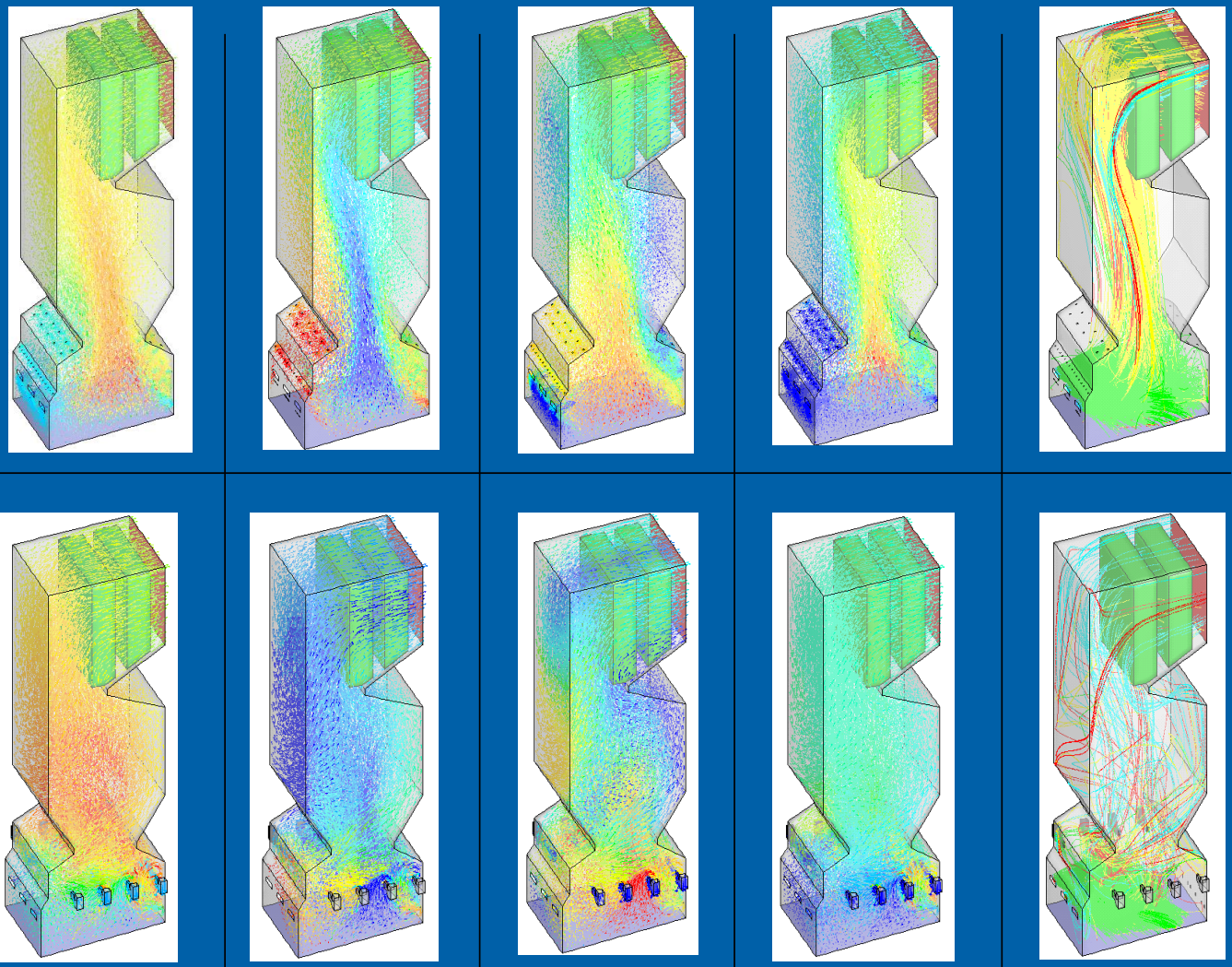
Key Design Factors for Biomass:

- Grate Size, Furnace Volume
- Fuel and Air Distribution
- Material and Heat Flows, Thermal Efficiency, and Fuel Economy
- Conduct CFD Modeling - Simulate Combustion
  - Analytical Tool to Characterize Performance
  - Evaluate Potential Modification Designs
- If Needed, Analyze Steam/Water-side Circulation

CFD Modeling Output

Original OFA System

Upgraded OFA System



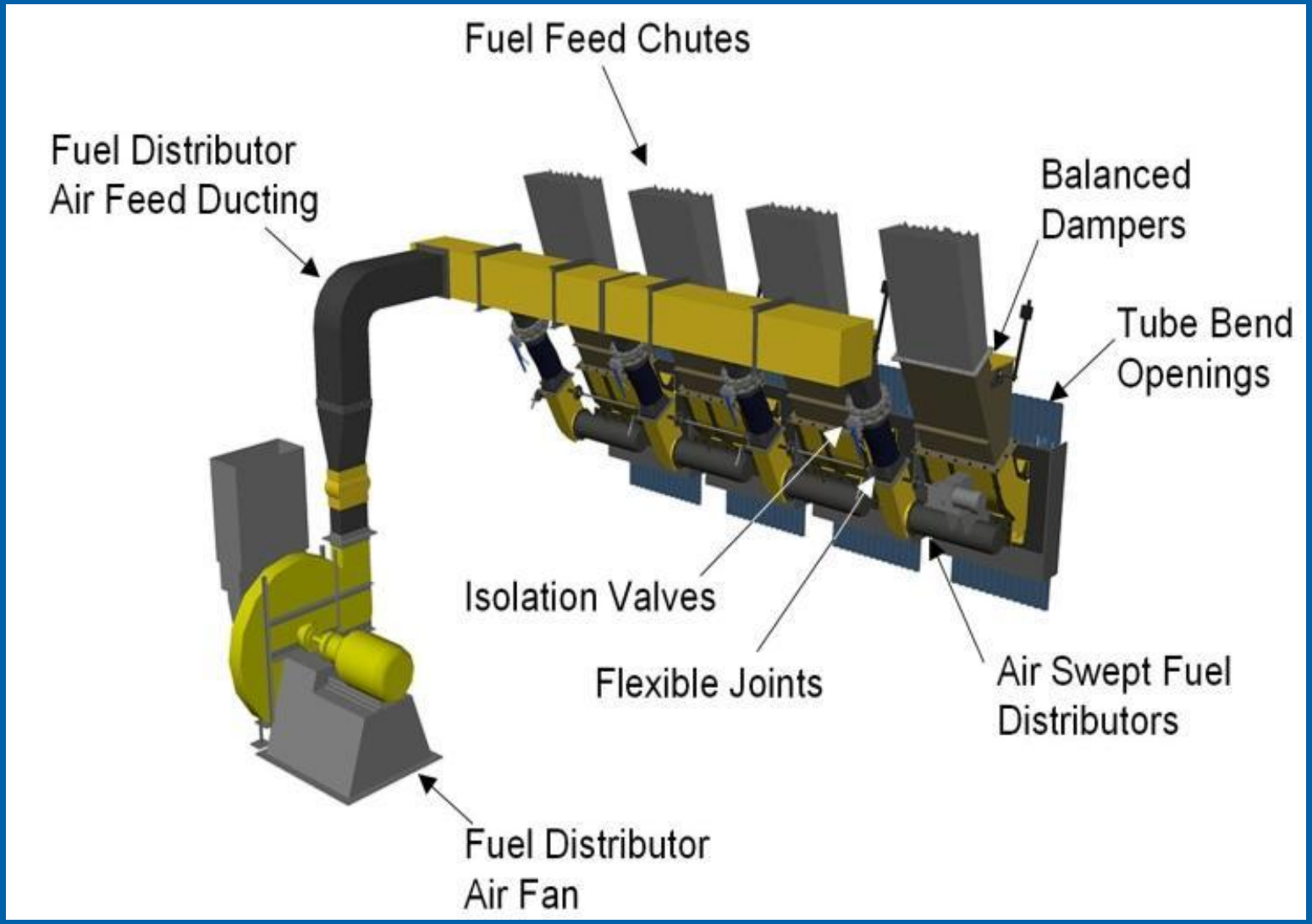
Temperature | O_2 | CO | NO | Particulate

Modifying Combustion Systems

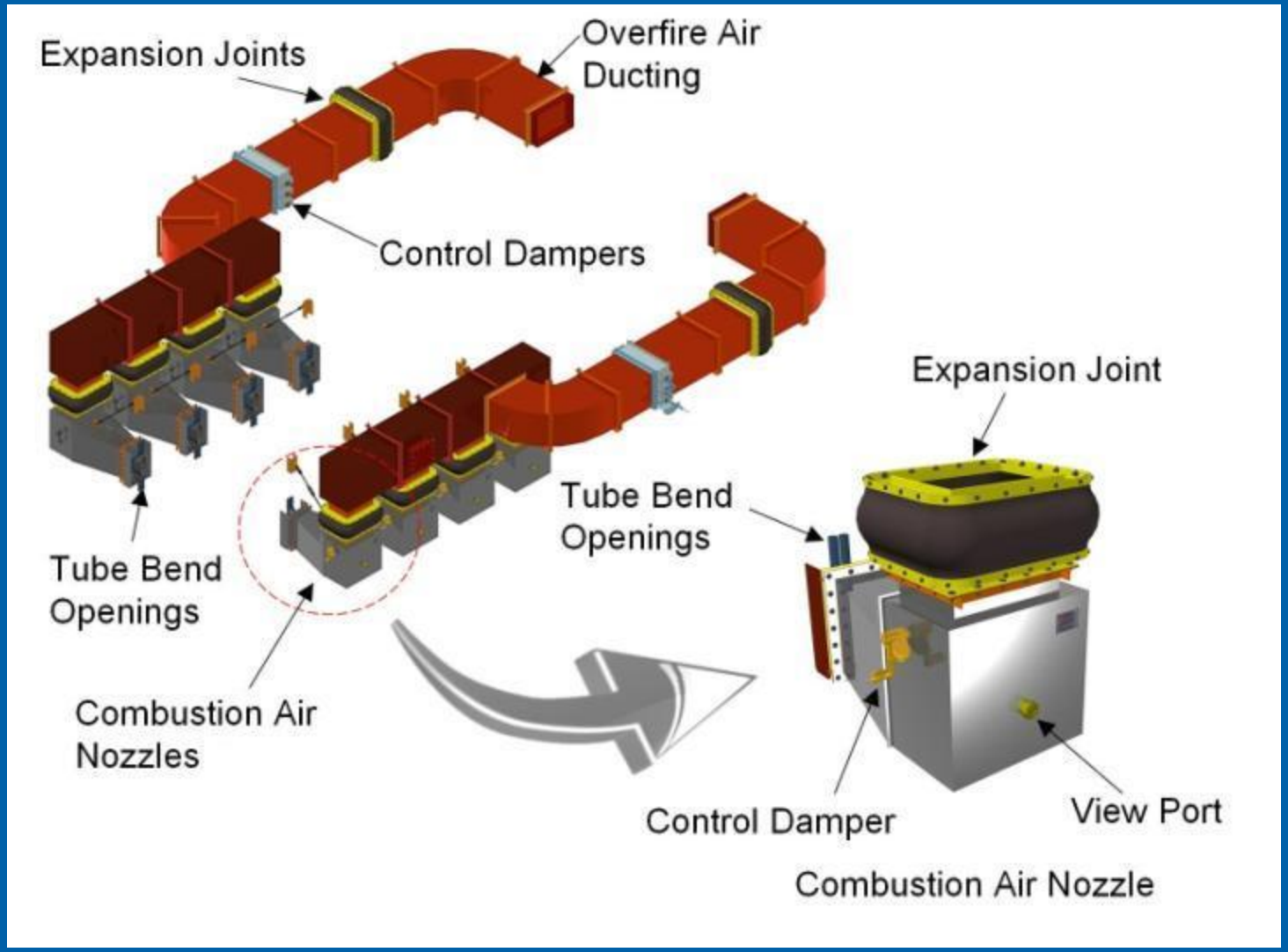
Modification/Upgrade Concepts:

- More Uniform Fuel Distribution with Flexibility to Control Fuel Trajectory
- Limited UGA Quantities to Minimize Lift-off of Fine Fuel Particles Off the Grate
- Preheated Combustion Air, Particularly for High Moisture Content Fuel
- Effective OFA Delivery to Promote Mixing of Air with Volatiles and Fines Coming Off the Grate

Modifying Combustion Systems - Fuel Feeders



Modifying Combustion Systems - OFA Supply



Modifying Combustion Systems - Benefits

Benefits Experienced:

- Increase Biomass Capacity Significantly (5% - 40%)
- Reduce/Eliminate Fossil Fuel Usage
- Improve Emissions (CO, NO_x, PM)
- Reduce Carryover, Erosion
- Reduce Unburned Carbon Losses (LOI)
- Increase Thermal Efficiency

Today's Opportunities and Challenges - Fuel Based

New Types of Biomass Fuels

- C&D Wood, Sludge, TDF, OCC, Railroad Ties, Pallets, Sometimes RDF/MSW
- Deviations in Fuel Analysis (water, HHV, elemental)
- Trace Contaminants (chlorides, minerals, silica)
- May Affect Deposit Chemistry, Clinker Formation, Slagging, Accelerated Erosion/Corrosion

Questions?

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