

Creating Power From Biomass: Torrefaction - A Key Facilitating Technology

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Torrefaction: A Technology to Enhance Biomass

- **Untreated biomass may be 50% water, it's bulky and it's not the most efficient or useable fuel or bio-feedstock. Torrefaction:**
 - Drives off most of the water
 - Reduces the bulk
 - Makes a better co-fire fuel to burn with coal
 - Makes superior briquettes and pellets
- **Torrefaction, applied at or near the point of harvest:**
 - Reduces transportation costs of biomass, per BTU
 - Produces a more valuable biomass shipment



Torrefaction: Adding Value and Reducing Transportation Costs/BTU

- **Untreated Biomass:**
 - Bulky
 - Moist
 - Fibrous
 - Perishable
 - Waste
 - Expensive to transport
- **Torrefied Biomass:**
 - Dense, If Pelletized, Etc.
 - Dry & Water Resistant
 - Easily Crushed
 - Does Not Rot
 - Valuable Fuel
 - Energy Dense

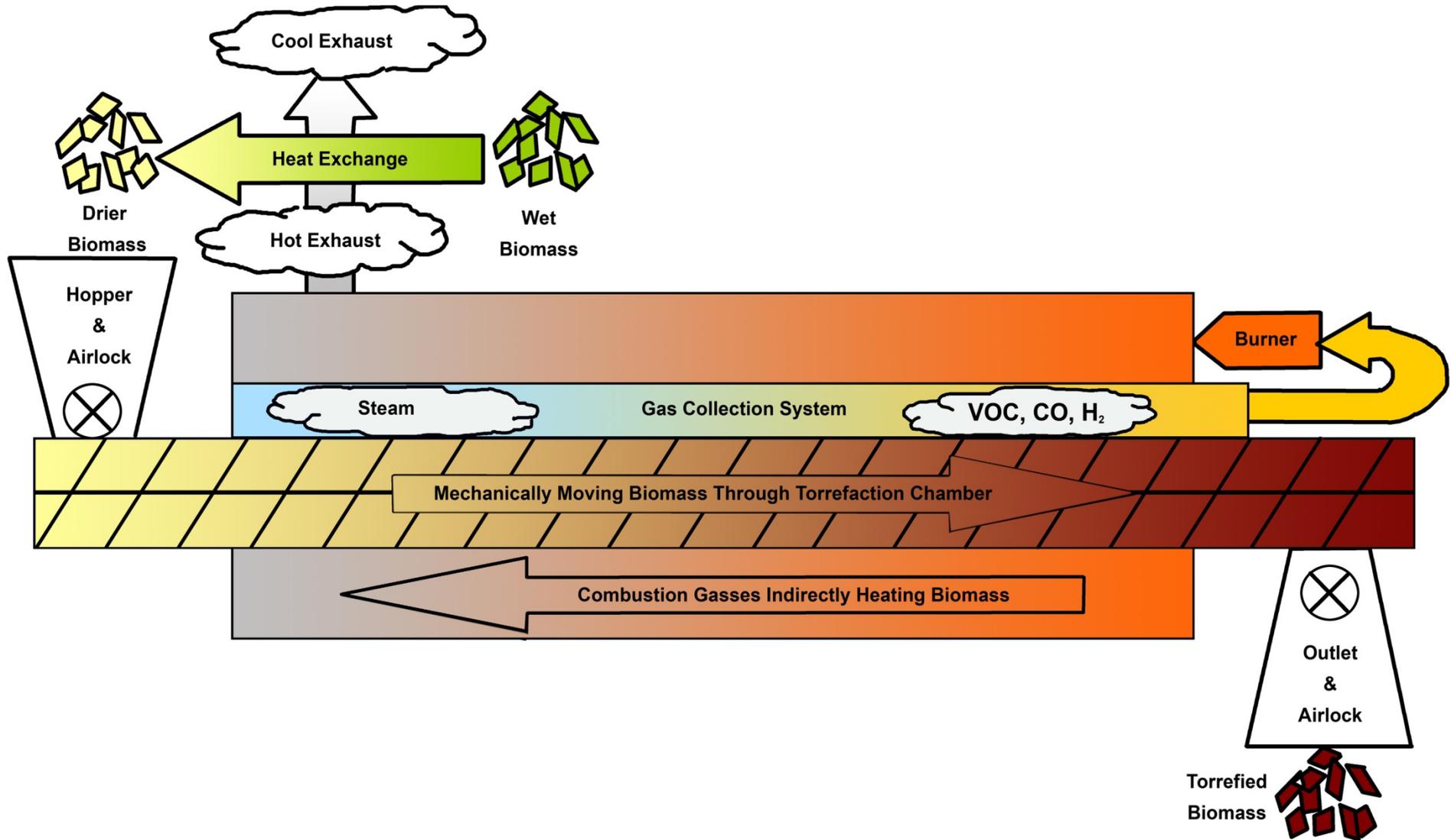


The Process of Torrefaction

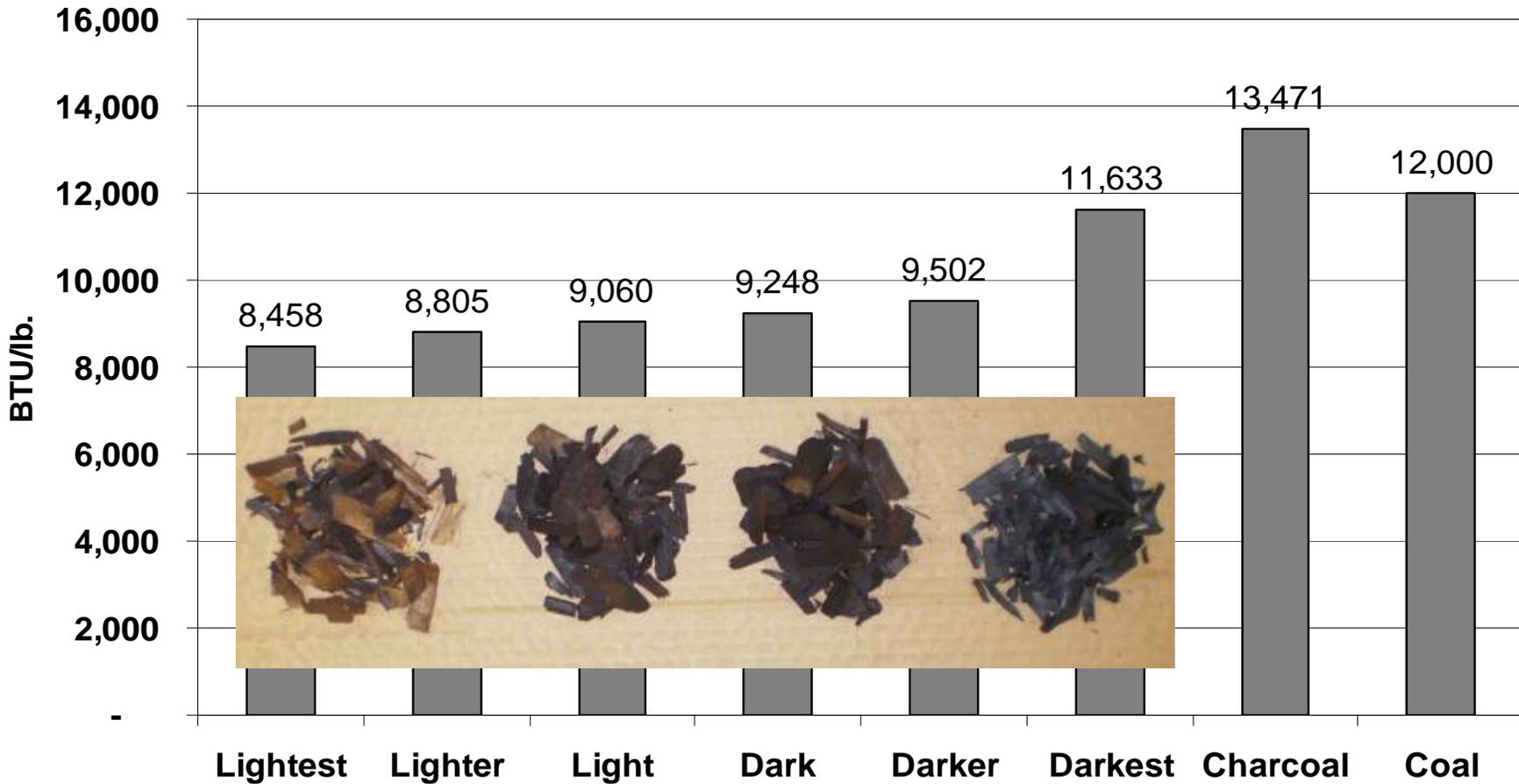
- Heating (200-300° C) wood, in a low-oxygen environment, liberates water, volatile organic compounds (VOC's), and hemicellulose (HC) from the cellulose and lignin.
- The VOC's and HC are combusted to generate 80% of the torrefaction process heat.
- The remaining and warm lignin acts as a binder when the torrefied wood is pelletized.
- Torrefied wood can easily replace coal in combustion or be a feedstock for further pyrolysis or gasification for combined heat and power or Fischer-Tropsch liquids.



Schematic of Torrefaction Machine



Higher Heating Value of Torrefied Wood, Charcoal and Coal: Color Approximately Indicates Heating Value



Chemistry of Torrefaction

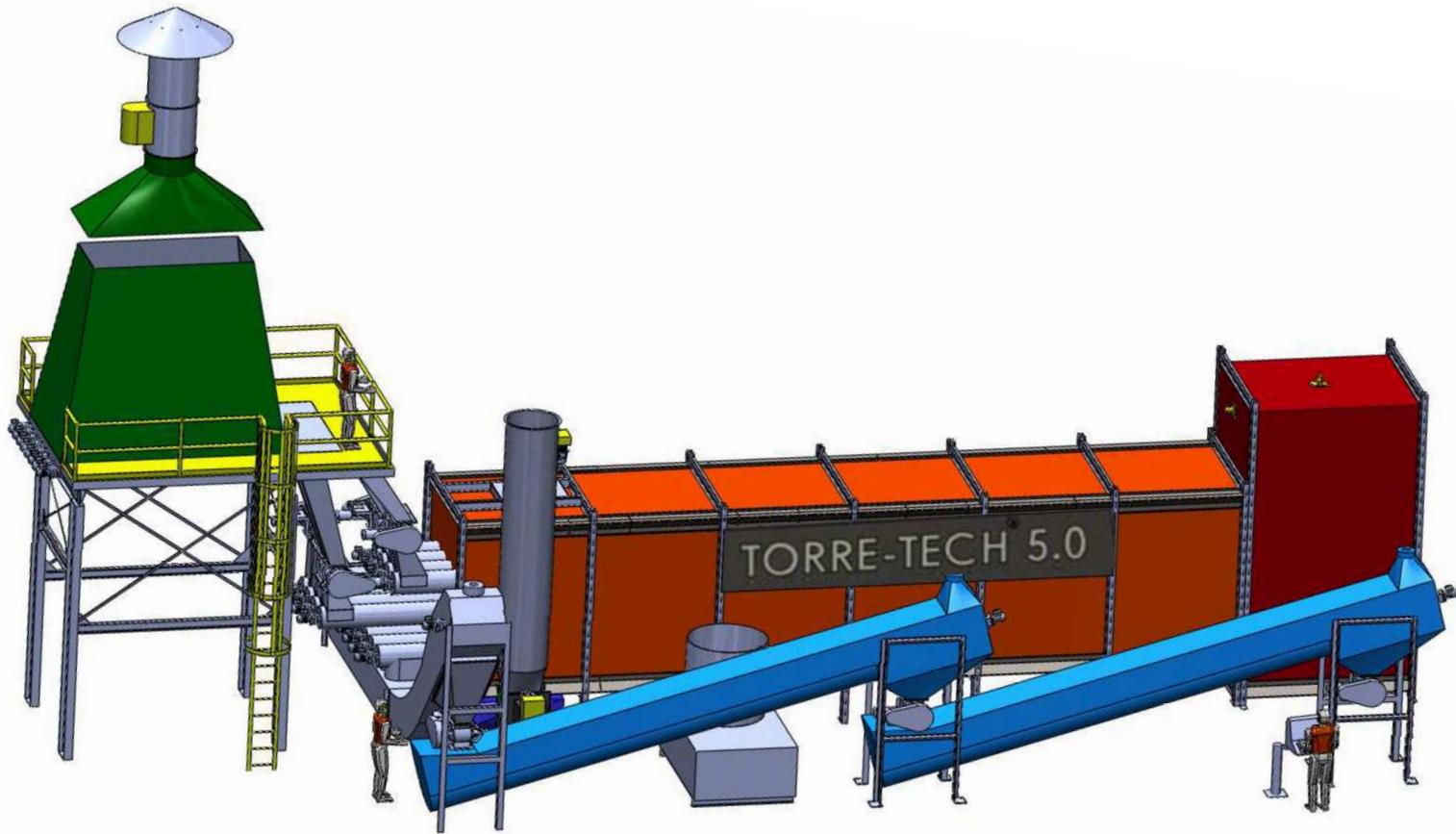
- At torrefaction temperatures, hemicellulose is the primary wood polymer that is degraded into:
 - Permanent gases include H_2 , CH_4 , aromatics, CO , CO_2 , C_xH_y
 - Condensable liquids include acids, ketones, furans, alcohols, terpenes, phenols, waxes, tanins, water
 - Solids include char, new and existing sugar structures and new polymers and ash.
- All of the wood polymers undergo dehydration reactions that destroy $-OH$ groups that are responsible for hydrogen bonding with water: this severely reduces the tendency of densified torrefied wood to absorb water.





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ATP's Manufacturer: The Kusters Zima Corporation

101 Zima Park Drive / I-85 Business
Spartanburg, S.C. 29301
Tel: (864) 576-0660

8.74 Acres (35,362 Sq. Meters)

Building Constructed in 1969

80,128 Total Manufacturing Sq. Ft.
(7,444 Sq. Meters)

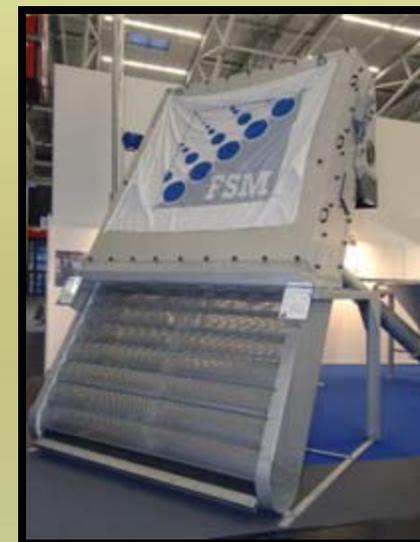
Kusters Zima has over 40 years experience in engineering and manufacturing machinery for many various industries.

- Complete Metal Fabrication including Welding, Cutting, Forming and Piping.
- Machining Capabilities that include CNC Turning and Vertical Milling Centers.
- Complete Mechanical and Electrical Engineering with the latest Software Versions of SolidWorks and AutoCad.
- Complete Mechanical and Electrical Assembly and F.A.T. for Production Machines and Prototypes.
- Installation and Start-up Supervision.



Complete Manufacturing

- **Water & Waste Water Equipment**
 - Grit Removal & Washing
 - Course & Fine Screenings
 - Classifiers
 - CSO Screens
 - Dewatering
- **Carpet & Textile Equipment**
 - Continuous Preparation
 - Dye Washers & Scour Ranges
 - Steamers
 - Liquid Dispensing
 - Water & Dry Lint Removal Systems
- **Contract Sales**
 - Piece Parts & Components
 - Customer Specific Design & Build
 - Build to Print



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