**TSI Direct Contact Rotary Single-Pass-Recycle Dryer System**

- 95% of Biomass Dryer Systems in North America are Direct Contact Rotary Dryers

- Rotary Single-Pass-Recycle Dryer System characteristics:
  - Low operating costs, low maintenance costs, and high uptime
  - Single Pass ensures Gas Classification Particle Drying
  - Recycle minimizes emissions and improves energy efficiency
  - High production capacities
  - Design flexibility
  - Quick deliveries, installations, and ramp ups
95% of Biomass Dryer Systems in North America are Direct Contact Rotary Dryers

- Weyerhaeuser (World’s largest forest product company)
- Georgia Biomass (World’s largest Pellet Plant)
- Louisiana Pacific Corporation (World’s largest OSB producer)
- Kior (biomass to biofuels company)
- Green Circle (World’s second largest Pellet Plant)
- JM Huber (multinational supplier of engineered materials)
- Georgia Pacific Corporation (operates World’s largest OSB plant)
- SmartPly Europe (Europe’s producer of OSB products)
- Masisa (major supplier of engineered wood products in South America)
Low Operating & Maintenance Costs and High Uptime

- Rotary Dryer Systems utilize low gas flow thus minimizing Brake Horse Power exerted by its Induced Draft Fan
- Four motors run the Dryer System
- Annual maintenance costs low
- Typically Rotary Dryer Systems operate around 95% of the time
Gas Classification Particle Drying

- Roseburg Forest Products (Dillard, OR)
  - Originally six 8’ diameter 3-Pass Drums:
    - 3 Drums drying shavings from 50% to 3% moisture content wet-weight-basis
    - 3 Drums drying sawdust from 35% to 3% moisture content wet-weight-basis

- Single 18’ diameter Drum:
  - Drying both shavings and sawdust from 50% & 35% respectively to 3% moisture content wet-weight-basis
Roseburg Forest Products (Dillard, OR)
Recycle System

• Typically recycles 50% of Dryer System exhaust flue gas and up to 75% depending on Dryer Drum design inlet temperatures
• Improves energy efficiency by 25%
• Lowers emissions and size of Pollution Control Equipment (if required)
• Increases humidity of the drying gas thus providing for better conditioning of the biomass
• Reduces oxygen level within the Dryer System thus minimizing sparks carried over from the Heat Energy System

Hot Gas

Requires 25% Less Heat
Typical Recycle System
High Production Capacities

- TSI Rotary Single-Pass-Recycle Dryer Systems can handle various production capacities and some of the highest production capacities in the world.
- Currently TSI Dryer Systems handle anywhere between 1 ton/hr up to 60 tons/hr for a single Dryer System when drying from 50% moisture content to 3% moisture content wet-weight-basis
  - Rotary Dryer Systems are easily scalable
  - Modular construction
  - Small foot print
  - Easy manufacturing
Masisa (Porto Alegre, Brazil)
Ø24’x140’ Long Drum - 60 tons/hr (50% to 3% m.c.)
Martco (Oakdale, LA)
Ø20’x100’ Long – 40 tons/hr (50% to 6% m.c.)
Louisiana Pacific Corp.
Ø20’x100’ Long – 30 tons/hr (50% to 4%)
Lee Energy Solutions
Ø14’x70’ Long – 20 tons/hr (50% to 10% m.c.)
Design Flexibility

• Combine multiply biomass streams at various moistures and dry to specified moisture content
• Combine various size biomass streams and dry to specified moisture content
• Minimize power consumption of the Dryer System
  – Higher Dryer Drum inlet temperatures
  – Hopper/Multi-Clone exhaust system
• Minimize energy consumption of the Dryer System
  – Able to process low energy flue gas from other plant processes
• Minimize emissions and possibly eliminate need for Pollution Control Equipment
  – USA (only country in the world that regulates Volatile Organic Compounds (VOC)
  – Hardwoods emit less VOCs when compared to Softwoods
Delivery, Installation, Ramp-up

- Typical TSI Rotary Dryer System equipment delivery is between 4 and 6 months.

- Typical installation of a TSI Rotary Dryer System ranges between 2 and 5 months.

- Typical ramp-up of a TSI Rotary Dryer System ranges between 7 and 30 days.

- Return on investment between 6 and 12 months.