Fiber and Chemical Division, Business Unit BioFuel

BioFuel Equipment - derived from Pulp & Fiberboard applications for Ligno-Cellulosic BioFuel & BioChemicals Technology
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**Company profile**

A world market leader in most business areas

- **HYDRO**
  40-45%*
  Electromechanical equipment for hydropower plants (mainly turbines and generators); pumps; turbo generators

- **PULP & PAPER**
  30-35%*
  Systems for the production of all types of pulp and of certain paper grades (tissue, cartonboard); boilers

- **SEPARATION**
  10%*
  Equipment for the mechanical and thermal solid/liquid separation for municipalities and various industries

- **METALS**
  10%*
  Systems for the production and processing of stainless steel and carbon steel strips; industrial furnaces

- **FEED & BIOFUEL**
  5%*
  Systems for the production of animal feed pellets (pet and fish food) and biomass pellets (wood, straw)

* Long-term average share of the Group’s total order intake
ANDRITZ global presence:
Over 16,700 employees - 180 service and manufacturing sites around the globe
ANDRITZ biomass technologies

Ways of converting biomass into heat, electricity and fuels

### Solid biomass

**Thermo-chemical conversion**
- Biomass preparation
  - Drying
  - Pelletizing
- Gasification
- Syn-gas
  - Integrated gasification combined cycle
  - Synthetic natural gas
  - Bio-Diesel Fischer-Tropsch
  - Dimethylether
- Pyrolysis
- Pyrolysis oil
- Oil boiler
- Bio-Diesel 1st generation
- Bio-Ethanol 2nd generation
- Biofuel
- Biofuel
- Heat/electric power

**Bio-chemical conversion**
- Bio-Diesel 1st generation
- Biofuel
- Biofuel
- Biofuel
- Biofuel
- Biofuel
- Biofuel
- Biofuel

**Mechanical-chemical conversion**
- Pressing of oil out of seeds and oil rich plant + conversion
- Bio-Diesel 1st generation
- Biofuel

**Process offered by ANDRITZ**
ANDRITZ in 2nd Generation Ethanol and Butanol Production

Typical 2nd Generation Ethanol/Butanol Mill

Andritz areas of interest

[Diagram showing the process flow of biomass handling, pre-treatment system, enzymatic hydrolysis, stillage treatment, evaporation, fermentation for C5 and C6, distillation, power boiler, lignin separation, and drying.]
Energy and Biomass

ANDRITZ in 2nd Generation Ethanol Production

Andritz equipment for Ethanol processes

Biomass reactors

Liquid/solid separation

Drying
Energy and Biomass

ANDRITZ in 2nd Generation Ethanol Production

- Non-food raw materials only (Wood chips and residuals, Energy woods, Cereal Residues, Sugar Production Residue, Forages & grasses)

- Focus on Biochemical pathway using chemical pre-treatment and enzymatic or bacterial generation of sugars for fermentation to ethanol and butanol

- ANDRITZ is working with this emerging industry on customized demo scale and commercial production systems based on established Andritz know-how in
  - Biomass handling
  - Reactor design for pre-treatment and enzymatic hydrolysis
  - Liquid/Solids Separation, including pressing, filtration and evaporation
  - 12 lab/pilot/demo systems (Springfield, Forintek, IHD Dresden, Glens Falls, QUT Queensland, Zeachem, Borregaard and others)
  - 2 commercial system (M&G Chemtex, Italy, undisclosed)
Feed-Stock Handling

- Stoker Silo (moving floor)
- Stacking & Blending
- Portal Cranes
- Reclaiming
Reactor & Gasifier Feed Equipment
Plug Screw Feeders, MSD’s & Rotary Valves

- Rotary Valves / Rotary Feeders

- MSD Impressafiners, a high compression screw device, feeding various reactors with low and high density feed-stocks

- This is an Andritz Plug Screw Feeder running at well over 1500 bdmt/d of wood chips
Plug Screw Feeder / MSD
Physical Principle of Operation

Material Handling

Flow of material

Inlet Housing

Screw 3D-Design

Compression Housing
Pressurized Steam / Chemicals Mixing Screw
Andritz Biomass Reactors

- Chemical Pulping Digester at Fibria, Tres Lagoas, Brazil. Start-up April 2009.
- Diam. 10.7m by 58m high
- Processes 7200 BDt/d of eucalyptus wood chips (~31 m³/min)
- BioFuel Pretreatment Reactors presently built are > 30m high
Advanced Steam-Ex Pretreatment - Inclined Drainer
for dissolved pressurized C5 sugar hydrolyzate removal
Hydrolyzate Evaporation
(to increase C5 Sugar Concentrations / remove acetic acid)

- Segregation → good condensate quality
- Spray nozzle liquor distribution → no plugging
- Constant circulation flows independent of capacity
- Easy access in case mechanical cleaning is required (internal platforms)
- Special design of discharge points of transfer piping to prevent accumulation of suspended materials and fibers

Example – Black Liquor Evaporation at Bowater, Calhoun - I Effect
Horizontal / Steam-Ex Reactor (Pretreatment)

Vertical Discharge Device
Horizontal / Steam-Ex Reactor (Ligno-Cellulosic Ethanol Pretreatment)

Hydrolyzer / Reactor Discharge - Details
Pretreatment Steam-Ex Reactor Discharge

SED HP-Reactor Vertical Discharge Device
Pressurized Cyclone after SteamEx
(Ligno-Cellulosic Ethanol Pretreatment)

SteamEx’ed Feedstock and Steam in

Pretreated Mat’l to Enzymatic Hydrolysis
View of a commercial scale PreTreatment System
(Advanced SteamEx)

1st Stage Pre-Hydrolysis

2nd Stage SteamEx
Screw-, Belt-, Filter Presses and Centrifuges
for Washing / Dewatering Applications & Slurries / Residual after Bio-Reactors
Biomass dryers

Pneumatic Dryer
with integrated mill and sifter
✓ Biofuel for kiln firing

Drum Dryer
Single or Triple Pass drying
✓ All types of biomass and wood-waste

Belt Dryer
using Low Temperature or Waste Heat
✓ All types of biomass and wood-waste

Fluidized Bed Dryer
Drying and Granulation
✓ dried distiller’s grains
✓ spent grain from bio-ethanol
**Biomass Boilers**

**Andritz BFB Boilers, Green Power up to 100 MWe**

- **Ence Navia, Spain**
  - Steam flow 120 t/h
  - Start-up in October 2008
- **Ence Huelva, Spain**
  - Steam flow 195 t/h
  - Start-up in 2011
- **Portucel Cacia, Portugal**
  - Steam flow 58 t/h
  - Start-up December 2009
- **Portucel Setubal, Portugal**
  - Steam flow 58 t/h
  - Start-up December 2009
- **Fortum Pärnu, Estonia**
  - Steam flow 94 t/h
  - Start-up in December 2010
- **EPS Pulpaca, Venezuela**
  - Steam flow 50 t/h
  - Start-up in 2011
- **Segezha, Russia**
  - Steam flow 238 t/h
  - Start-up in 2013
Biomass Gasification (ThermoChemical Route)

Delivery Portfolio for Gasification

Equipment for Biomass Preparation and Handling

Belt and Drum Dryers

CFB Gasifiers
- air blown
- for boilers and kilns
10 – 150 MWth

BFB Gasifiers
- low pressure, air
Clean gas to:
- engines
- boilers
10 – 50 MWth

BFB Gasifiers
- high pressure, air/oxygen

Gasifier Gas Cleanup for BFB Gasifiers
- Partial cooling, filtering
  - for turbines and boilers
- Tar reforming, gas cooling, filtering
  - for engines and BTL

- diesel
- ethanol
- gasoline
- SNG
- IGCC
<150 MWth
Pelletizing Equipment – Solid BioFuel
Patented Advanced Steam-Ex™ Process Concept
for commercial scale systems Andritz is building
Example of a Demo Pretreatment System for SteamExplosion – for ligno-cellulosic Ethanol
Pretreatment Equipment – derived from Pulp Mill Applications are Proven in large Scale

-> and minimize Scale-Up Challenges