BEET PULP PROCESSING OPTIMIZATION
(DRYING, PELLETIZING)

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BEET PULP PROCESSING CHALLENGES

- **Fossil fuel reduction**
  - Fuel costs
  - CO₂ tax

- **Compliance with ever more severe emission limit values**
  - Dust
  - V.O.C.
  - NOₓ
  - Odors
  - ...

Through reliable coupling solutions, inside:
- beet (sugar/alcohol) plant
- or beet pulp drying unit

Beet plant

Drying Unit

Pressed pulp
BEET PULP PROCESSING

Typical Scheme

Sugar loss in pulp:
0.2-0.3 % / beet
(1-2 % beet sugar content)
# PULP DRYING TECHNOLOGIES

<table>
<thead>
<tr>
<th></th>
<th>Belt drier</th>
<th>Direct fired</th>
<th>« turbo »</th>
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<tbody>
<tr>
<td>Hot stream in contact</td>
<td>air</td>
<td>Combustion flue gas</td>
<td>Superheated steam</td>
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<tr>
<td>with pulp</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>remarks</td>
<td>Possibly wet air recycling</td>
<td>+wet flue gas recycling</td>
<td>With some air</td>
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<td>Inlet T (°C)</td>
<td>70-110</td>
<td>650-900</td>
<td>400-450</td>
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<tr>
<td>Pressure inside dryer</td>
<td>atmospheric</td>
<td>atmospheric</td>
<td>atmospheric</td>
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<tr>
<td>Indirect heat</td>
<td>Hot waters; steam…</td>
<td>Hot waters (combustion air heating)</td>
<td>Combustion flue gas</td>
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<td>exchanger : hot stream</td>
<td></td>
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<tr>
<td>Fuel consumption type</td>
<td>(no)</td>
<td>Fossil; others</td>
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<tr>
<td>Fuel consumption</td>
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<tr>
<td>kWh/t H2O</td>
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<td>800</td>
<td>800</td>
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<td>Power consumption</td>
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<td></td>
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<tr>
<td>kWh/ t H2O</td>
<td>40</td>
<td>20</td>
<td>50</td>
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<td>Heat recovery by</td>
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<tr>
<td>coupling kWh/ t/H2O</td>
<td></td>
<td></td>
<td>500</td>
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<td>Product temperature</td>
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<td>&lt;100</td>
<td>&lt;100</td>
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## MAGUIN RECENT DRYER PROJECTS

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<tr>
<th>Inlet Product</th>
<th>Dryer Type</th>
<th>Drying Capacity $T,H_2O/\text{h}$</th>
<th>Operating Company</th>
<th>Site</th>
<th>Country</th>
<th>Commissioning year</th>
<th>Fuel</th>
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<tr>
<td>Beet pulp</td>
<td>(existing 3-pass drum)</td>
<td>25</td>
<td>SIDESUP</td>
<td>Engenville</td>
<td>France</td>
<td>2007</td>
<td>Conversion to biomass (wood pellets, cereals)</td>
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<tr>
<td>DDGS (cereals)</td>
<td>Turbo 3-pass drum</td>
<td>$2 \times 27 = 54$</td>
<td>BENP Lillebonne</td>
<td>Lillebonne</td>
<td>France</td>
<td>2007</td>
<td>Natural gas</td>
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<td>DDGS (cereals)</td>
<td>Turbo 3-pass drum</td>
<td>32</td>
<td>CRISTANOL</td>
<td>Bazancourt</td>
<td>France</td>
<td>2008</td>
<td>Natural gas, biogas, fusel oil</td>
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<tr>
<td>Beet pulp</td>
<td>Belt</td>
<td>10 ($\rightarrow 21$)</td>
<td>CRISTAL UNION</td>
<td>Bazancourt</td>
<td>France</td>
<td>2009</td>
<td>None</td>
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<td>Beet pulp</td>
<td>3-pass drum</td>
<td>65</td>
<td>NILE SUGAR</td>
<td>Nile delta</td>
<td>Egypt</td>
<td>2010</td>
<td>Fuel oil $\rightarrow$ natural gas</td>
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<tr>
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<td>3-pass drum</td>
<td>72</td>
<td>DAKAHLLIA SUGAR Co.</td>
<td>Nile delta</td>
<td>Egypt</td>
<td>2011</td>
<td>Mix : fuel-oil/natural gas</td>
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<td>55</td>
<td>ALEXANDRIA SUGAR Co.</td>
<td>Nile delta</td>
<td>Egypt</td>
<td>2012</td>
<td>Natural gas + boiler flue gas</td>
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<td>3-pass drum</td>
<td>26</td>
<td>KRISTALL</td>
<td>Vyselky</td>
<td>Russia</td>
<td>2012</td>
<td>Natural gas</td>
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<tr>
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<td>KRISTALL</td>
<td>Leningradsky</td>
<td>Russia</td>
<td>2012</td>
<td>Natural gas</td>
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<td>Beet pulp</td>
<td>3-pass drum</td>
<td>28</td>
<td>MRYIA</td>
<td>Khorostkiiv</td>
<td>Ukraine</td>
<td>2013</td>
<td>Coal</td>
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<td>Beet pulp</td>
<td>3-pass drum</td>
<td>36</td>
<td>DELTA SUGAR Co. (DELTA II)</td>
<td>-</td>
<td>Egypt</td>
<td>2013</td>
<td>Dual oil/gas</td>
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## FUEL ISSUES

### Energy Economics

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<th>15</th>
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<table>
<thead>
<tr>
<th>Fossil CO₂/energy</th>
<th>light fuel-oil</th>
<th>heavy fuel-oil</th>
<th>natural gas</th>
<th>coal</th>
<th>wood pellets</th>
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<tbody>
<tr>
<td>€/MWh</td>
<td>270</td>
<td>281</td>
<td>205</td>
<td>342</td>
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<td>€/MWh</td>
<td>4,1</td>
<td>4,2</td>
<td>3,1</td>
<td>5,1</td>
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<tr>
<td>€/MWh</td>
<td>50</td>
<td>35</td>
<td>30</td>
<td>30</td>
<td>17</td>
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<tr>
<td>€/MWh</td>
<td>54</td>
<td>39</td>
<td>33</td>
<td>35</td>
<td>17</td>
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</table>
3-PASS DRUM DRYER

Example with coal furnace

coil hearth
wet pulp
3-pass drum dryer
dried pulp
to stack
COMBUSTION

Natural gas combustion furnace

Semi wet biomass screw furnace

Wet biomass screw furnace

Heavy-oil furnace

Natural gas burner

Coal furnace
COMBINED 3-PASS & BELT-DRYERS

Bazancourt scheme:
former 2 coal fired 3-pass drum dryers
(wet bulb T°75°C),
70 t H₂O / h
+ condenser
+ belt dryer

Fossil fuel 610 kWh/t H₂O
3-PASS DRUM DRYER

Example with coal furnace

- Wet pulp enters the 3-pass drum dryer.
- Coal is used in the coal hearth to provide heat.
- Dried pulp is then sent to the stack.

Diagram shows the flow of materials through the dryer.
Drying + Milling + Pelleting of Sawdust

- Flash and pneumatic drying in flight during a few seconds at moderate temperature to avoid product combustion.
- Limited dwell time of the product in the drum, 8 minutes permitting a quick regulation.
- Particle drying homogeneity.

Fan designed by Maguin, especially for wet air.

Design/Manufacture handling air-locks reclaimer screw.

Mechanical action of blade.

Colour and quality of the product produced.
BELT DRYER: OTHER COUPLINGS

- Coupling with beet plant:
  - Hot condensates:
    - Temperature up to 90°C
    - Availability: 290 t/h / 10 000 t/d beet
  - Hot-condenser bottom waters:
    - Temperature 50°C
    - Availability: 350 t/h / 10 000 t/d beet
  - Steam (2\textsuperscript{nd} effect, 3\textsuperscript{rd} effect...)
  - Flue gas (boiler, ...)
  - ...

...
BELT DRYER

air
BELT DRYER

Bazancourt, France, 2009. 10 t H₂O / h
3-stage belt dryer.
Width 4,7 m. Length 3 x 25 m (belt surface 350 m²)
T hot air 70°C. 70 000 Nm³ / t H₂O.
BELT DRYER

air
CONDENSER AFTER TWIN 3-PASS DRYERS

Bazancourt
« TURBO » 3-PASS DRYER
« TURBO » 3-PASS DRYER

Cristanol 2 project: cereal DDGS

- Towards pelleting
  - Bran
  - Muds 80°C
  - Mixer 1
- Flue gases
  - Natural gas, biogas, fusel oil.
  - Syrup
  - Mixer 2

- Condensate 87°C
- Vapour condensing

- Dryer
  - 400°C
  - H₂O/air > 7 kg/kg
  - Wet Bulb 97°C

- Exchanger
  - 750°C
  - 150°C
  - 120°C

- Temperature probe
- Pre-concentrated spent wash

- 150°C
« TURBO » 3-PASS DRYER: ADVANTAGES

- Indirect heating:
  - pulp quality
  - Fuel choice: flexibility (biogas, biomass…)
- Energy recovery:
  - High condensation yield
  - At $T > 97^\circ C$ ($H_2O/air \gg 7 \text{ kg/kg}$)
- Low Emissions:
  - Dust
  - V.O.C. (CO, CH$_4$, …)
  - NO$_x$
  - Odors
COUPLING INSIDE DRYING UNIT: "TURBO" 3-PASS DRYER & BELT DRYER in //

10 000 t/d beet. Wet Pulp 35%DM.

Belt/turbo: +50% H₂O
Fuel: 530 kWh/t H₂O

Evaporation:
- 25.4 t/h
- 38.4 t/h total evaporation

Wet Pulp:
- 35% DM
- 62.8 t/h
- 22.0 t/h DM

Dried Pulp:
- 90% DM
- 24.4 t/h

Fuel:
- 530 kWh/t H₂O

Air:
- 562 000 Nm³/h

Temperature:
- 92°C
- 65°C
- 268 m³/h
- 31°C
- 24 m³/h
COUPLING INSIDE DRYING UNIT: "TURBO" 3-PASS DRYER & BELT PRE-DRYER

10 000 t/d beet. Wet Pulp 35%DM.

- evaporation: 25.4 t/h
- 44% DM 118° C
- wet bulb 94.8° C
- 24.4 t/h 90% DM
- 6500 m²
- 3100 m²
- 10° C 137 000 m² 92° C
- 40° C 89° C 268 m³/h
- 35% DM 62.8 t/h 270 m²
- 24 m³/h 65° C
- total evaporation: 38.4 t/h

Belt/turbo: +50% H₂O
Fuel: 530 kWh/t H₂O

10 000 t/d beet. Wet Pulp 35%DM.
ADDITIONAL COUPLING WITH FACTORY: "TURBO" 3-PASS DRYER & BELT PRE-DRYER

10,000 t/d beet. Wet Pulp 35%DM. +Hot condensates from Beet factory

Belt/turbo: +140% H₂O
Fuel: 340 kWh/t H₂O

Evaporation:
- 16.1 t/h 47% DM 118° C
- 24.4 t/h 90% DM

Wet bulb:
- 94.8° C

Dried pulp:
- 24.4 t/h 90° C

Gas:
- 964,000 Nm³/h

Fuel:
- 340 kWh/t H₂O
### CASE SUMMARY

Beet plant 10 000 t/d, 100 days/campaign

<table>
<thead>
<tr>
<th></th>
<th>base*</th>
<th></th>
<th></th>
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<th></th>
<th></th>
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<tbody>
<tr>
<td>biomass conversion</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>surpressing 30→35%DM</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>belt dryer</td>
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<td>turbo dryer</td>
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<tr>
<td>beet plant condensates</td>
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<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
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<tr>
<td>Drying→90%DM: th. energy/H₂O kWh/t</td>
<td>800</td>
<td>800</td>
<td>610</td>
<td>530</td>
<td>340</td>
<td>800</td>
<td>800</td>
<td>610</td>
<td>530</td>
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<tr>
<td>Drying: th.energy / b. kWh/t</td>
<td>110**</td>
<td>74</td>
<td>56</td>
<td>49</td>
<td>31</td>
<td>110</td>
<td>110</td>
<td>74</td>
<td>56</td>
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<tr>
<td>fuel cost*** / beet campaign k€</td>
<td>3 207</td>
<td>2 439</td>
<td>1 859</td>
<td>1 616</td>
<td>1 036</td>
<td>3 207</td>
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<td>969</td>
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<td>Δ biomass conversion k€</td>
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<td>Δ belt dryer k€</td>
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<td>Δ beet plant condensates k€</td>
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<td>-579</td>
<td></td>
</tr>
</tbody>
</table>

* 3-pass drum dryer, natural gas
** Sugar plant excluding drying: Western Europe 220 kWh/t b.
*** included: CO₂ tax

► Short R.O.I.
BEET PULP PROCESSING: CONCLUSIONS

- First, pressing improvement. Target 40%DM?
- Drying: couplings
  - inside Drying unit:
    - belt dryer,
    - + turbo 3-pass drum dryer. Fuel flexibility. Low emissions.
  - + with beet plant:
    - medium temperature streams (hot condensates, …) towards belt dryer.
    - This coupling: flexible, reliable, no bottleneck.
    - Each plant may have its own energy scheme. Case studies to be made.
- Compliance with emission limits
- High-quality pulp
- Possibility of use in off beet season (alfalfa…)
- Short R.O.I.