Development and trials of a small-capacity pilot flash dryer for cassava-derived products

Arnaud Chapuis
Scientist - Process engineering
Cirad, France
arnaud.chapuis@cirad.fr

A. Chapuis, T. Tran, F. Giraldo, M. Moreno, M. Precoppe, J. Moreno, H. Pallet, J. Belalcazar, D. Dufour

25th October 2018
Small-scale flash dryers: issues and challenge

- Sun drying has many limitations:
  - Land requirement
  - Product quality: contamination + drying time
  - Economic risk: dependence on weather conditions

→ Increasing capacity requires a more reliable process

Sun drying, 2 t/day (Colombia)
Drying time: 6 hours
Small-scale flash dryers: issues and challenge

- Artificial drying is energy-intensive and costly
  - 70-80% of energy use
  - Up to 30% of processing cost

➔ To be profitable, it must be energy-efficient

Flash drying, 400 t/day (Thailand)
Drying time: 2 seconds
Approach to downscaling flash drying technology

- No consensus on the design of flash dryers: Diversity of shapes and operating conditions
- Most small-scale flash dryers in are inefficient
Approach to downscaling flash drying technology

- MODELLING AND SIMULATIONS
  
  [Graphs showing energy consumption vs. pipe length with specific temperatures and air velocities.]

  Validated with data from industrial dryers

- DESIGN GUIDELINES
  for an energy-efficient flash dryer

  - **Pipe length**: > 20 m
  - **Air velocity**: 10 – 15 m/s
  - **Air temperature**: 180 °C
  - **Air / Starch ratio**: 9 – 11

Development of a pilot flash dryer

Pipe dimensions:
- Diameter: 15 cm
- Length: 15 - 35 m
- Height: 7m

TECHNICAL SPECIFICATIONS

- Drying capacity: 50-100 kg/h dry starch

- Product moisture:
  - Inlet: 35-40% w.b.
  - Outlet: 12-13% w.b.

- Operating conditions:
  - Air velocity: 10-25 m/s
  - Air temperature: 130-200°C
  - Pipe length: 16-35 m
Drying experiments: trials description

- **Drying material:**
  - Native cassava starch from a local cassava processor
  - Pre-drying in the sun to reach 35 – 40% moisture content

- **9 trials, screening of operating conditions:**
  - Air velocity: 12 to 20 m/s
  - Air temperature: 140 to 180°C
  - Dying length: 19 m and 29 m
  - Feed rate: 50 – 150 kg/h
Drying experiments: results

- Stability of operation
Drying experiments: results

- Energy consumption

It is possible to build small-capacity flash dryers with high efficiency!
Drying experiments: results

- **Energy consumption**

<table>
<thead>
<tr>
<th>TRIAL #</th>
<th>MJ/ton water evaporated</th>
<th>MJ/ton starch</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>4000</td>
<td>2500</td>
</tr>
<tr>
<td>5</td>
<td>4000</td>
<td>2500</td>
</tr>
<tr>
<td>6</td>
<td>4000</td>
<td>2500</td>
</tr>
<tr>
<td>7</td>
<td>4000</td>
<td>2500</td>
</tr>
<tr>
<td>8</td>
<td>5000</td>
<td>2500</td>
</tr>
<tr>
<td>9</td>
<td>4000</td>
<td>2500</td>
</tr>
</tbody>
</table>

**Pipe length**: 19 m, 29 m

**Feed rate**: 78 kg/h, 52 kg/h

**Temperature**: 180°C, 135°C

**Output moisture**: 11.5%, 14%

GELATINIZATION < 1%
Research and development perspectives

- Scaling project: 3 pilot sites in DRC, Nigeria and Uganda
  - Partnership with local cassava processors and equipment manufacturers
  - Co-design, construction and installation of flash dryers
  - Capacity building of stakeholders and performance follow-up

- Research and innovation topics:
  - Mechanical dewatering
  - Renewable energy supply: biogas, solid biomass
  - Drying other powder products: other starches and flours, peels, fibers

Supported by the RTB Scaling Fund!
Thank you!

A. Chapuis, T. Tran, F. Giraldo, M. Moreno, M. Precoppe, J. Moreno, H. Pallet, J. Belalcazar, D. Dufour