Super Concentrated Coconut Water
Using Aquaporin Inside® forward osmosis

**UNIQUE CUTTING-EDGE PROCESS**

- **IMPROVED LOGISTICS**
  Improved coconut water distribution logistics

- **SUPER CONCENTRATION**
  Super concentrated coconut water with significant volume reduction

- **RETENTION OF NUTRIENTS**
  Highest retention of valuables, nutrients, and aromas

- **NOVEL PRODUCTS**
  Novel products derived from super concentrated coconut water

- **HIGH EFFICIENCY**
  Achieve super concentrated 65°Brix coconut water at lower energy costs

- ✓ Significant improvement in coconut water distribution logistics through product volume reduction
- ✓ Achieve super concentrated 65°Brix coconut water at lower energy costs
- ✓ Complete retention of nutrients and sensory profile of coconut water after concentration
- ✓ Novel products can be derived from super concentrated coconut water
- ✓ Aquaporin Inside® FO process can be easily retrofitted to existing processes and customized according to manufacturing needs
- ✓ Simple flush cleaning with water to regain process performance
Coconut water, coconut milk, coconut oil or just the coconut on its own. The world has gone coconuts in the last decade. Global demand for this tropical wonder fruit has skyrocketed by 500%. The supply however, has not been keeping up. To continue the boom, there is a pressing need for coconut processors to adopt innovative technologies. Forward osmosis is one such novel technology that is now ready to take on the coconut challenge.

**IMPROVED COCONUT WATER LOGISTICS & NOVEL PRODUCTS**

**Conventional process**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coconut water extraction</strong></td>
<td>Deshelling</td>
</tr>
<tr>
<td><strong>92-95% water content</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pre-concentration</strong></td>
<td>Reverse osmosis</td>
</tr>
<tr>
<td><strong>Increase total solids content</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Further concentration</strong></td>
<td>Multi effect evaporator</td>
</tr>
<tr>
<td><strong>35-40% water content</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Packing</strong></td>
<td>Plastic bag in drums</td>
</tr>
</tbody>
</table>

**Benefits of forward osmosis**

- **Coconut water extraction**
  - Deshelling
  - 92-95% water content

- **Super concentration**
  - Forward osmosis
  - 10-20% water content after concentration

- **Higher quality coconut water & reduced volume packaging**

- **Improved coconut water distribution logistics**

- **Retention of nutrients & sensory profile**

- **Super concentration of coconut water by Aquaporin Inside® HFFO2**
- **Lower fouling propensity than RO**

- **Reduced product volume for improved logistics**
- **Higher quality coconut water concentrate with full retention of flavors and aromas**
CASE STUDY

Coconut water concentration using Aquaporin Inside® HFFO2

Method
A lab-scale study using Aquaporin Inside® HFFO2 was carried out to validate technical feasibility. Experiments were performed in FO mode where the active layer of the membrane was facing the feed side.

Results
HFFO2 batch concentration results:

✓ 13x concentration of coconut water in 4 hours (93% recovery using MgCl₂ as osmotic draw solute)
✓ Negligible reverse salt flux & complete preservation of nutrients and sensory profile

Excellent coconut water quality
Based on encouraging results from the FO trial tests our test partner, Silvermill, has decided to conduct further in-house trials on fresh coconut water.

<table>
<thead>
<tr>
<th>Mode of operation</th>
<th>Feed solution in batch mode</th>
<th>Draw solution in continuous mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed solution</td>
<td>60L pasteurized coconut water (5°Brix)</td>
<td>2.5 MgCl₂</td>
</tr>
<tr>
<td>Draw solution</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Operating conditions | 0.7 LPM feed inlet | 0.5 LPM draw inlet | < 1.0 bar TMP
                      | FO mode (feed in lumen side), co-current, 25°C |
| Membrane type     | Aquaporin Inside® Hollow Fiber Forward Osmosis Element (2.3m²) |
| Membrane QC       | Before and after coconut water concentration |

Before concentration by FO | After Concentration by FO
--- | ---
pH | 4.9 | 4.5 |
Brix | 5°Brix | 65°Brix |
Mg concentration | 110 ppm | 1900 ppm (145 ppm after 13x dilution) |
Color | Pale yellow | Dark brown |
Aroma & taste | Natural fresh coconut aroma and taste | Strong natural fresh coconut aroma and taste |
Texture | Liquid | Viscous |
Quality control test

FO membrane performance is fully recovered after cleaning.

Incorporating Aquaporin Inside® FO concentration process

**Concentration of coconut milk**

Extraction from white kernel & water slurry

**Further concentration**

Aquaporin Inside® forward osmosis

- Significant improvement in coconut milk distribution logistics through product volume reduction
- Super concentrated coconut milk at up to 50% fat content
- Superior non-thermal concentration process which preserves nutrients and sensory profile
- Novel high-quality products

**Extended FO advantage to coconut milk**

Super concentrated & higher quality coconut milk

Improved coconut milk distribution logistics

Novel coconut based products

Preservation of nutrients & sensory profile

**Membrane QC tests before and after applications with subsequent cleaning**

<table>
<thead>
<tr>
<th>Jw (LMH)</th>
<th>Jv (GMH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>15.13</td>
</tr>
<tr>
<td>After</td>
<td>14.55</td>
</tr>
</tbody>
</table>
CONCLUSIONS

Aquaporin Inside® FO can be easily retrofitted to existing processes to attain higher quality coconut water products at higher concentrations. In conclusion, FO can deliver novel and high quality products while improving overall distribution logistics.

About Aquaporin

Aquaporin A/S is a global water technology company located in Denmark.

Aquaporin is dedicated to revolutionizing water purification with its’ novel membrane technology.

The main goal of Aquaporin is to develop the Aquaporin Inside® technology which is capable of separating and purifying water from all other compounds.

The Aquaporin Inside® platform uses biotechnological principles in a technological context, which is a novel upcoming field with large commercial perspectives. This is a field where Denmark has taken an early global lead.

About Pure Water Enterprises Pvt. Ltd.

Pure Water Enterprises Pvt. Ltd. is a leading environment technology and service distributor over the last 20 years in Western India.

It is located in Mumbai, the commercial capital and gateway for the largest industrial zones in India.

Pure Water Enterprises has successfully forged strong relationships with more than 1000 end-users, systems integrators, and consultants in the region. Pure Water Enterprises provides both facilities to carry out trials and systems for commercial applications. For more information, please contact Pure Water’s experts at info@purewaterent.net or +91 22-24715665.