Resource recovery with membrane filtration

CIP, and Water Applications
Agenda

▶ Introduction
▶ Background and opportunities
▶ Recovery applications using filtration
  - CIP liquids & Water recovery
▶ Recovered water and infrastructure
  - Where it can be used
  - How to handle, store, and distribute water
  - On-site customer support
Presented by Tetra Pak Filtration Solutions

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By summer, four million people in the city of Cape Town – one of Africa's most affluent metropolises – may have to stand in line surrounded by armed guards to collect rations of the region's most precious commodity: drinking water.


During the last drought, in 2015, Californians were ordered to cut their water use by an average of 25% statewide.

https://calmatters.org/environment/2021/06/california-water-shortage/
Recovery drivers

What is driven recovery...

► Lack of water
► Costs on water and wastewater
► Wastewater discharge limits
► Expansion challenges
► Consumer awareness
► Incentives supporting reduction
Water resource in raw food

Milk is 87% Water

Don’t loose what you can USE

Treated excess water can be used in processing, as it’s quality is often better than the existing tap water.
Our recovery focus

Water intake reduced

Raw milk

Dairy with optimized water recovery & reuse

Source water

Reduce water intake

Optimization of wastewater treatment capacity

Reduced discharge to recipient (river, lake, etc.)

Drinking water guidelines
Food production legislation
Wastewater discharge requirements
CIP recovery – Enhance sustainability profile by minimizing waste, using non-formulated CIP chemicals
What is CIP recovery?

- Cleaning of dirty pure caustic
- Only chemical recovery
- No water or product recovery
Typical CIP recovery setup
Example with NaOH

Contributors with different strength of spent NaOH and volumes

Evaporators
Dryers
VTIS

Filtration recovered 90% volume
Top up with NaOH to reach right % strength

CIP tank recovered X% NaOH 65-70ºC

CIP tank spent NaOH
Flush out 10% volume

Reformulate NaOH for CIP stations
CIP Recovery TCO & Payback

Caustic recovery from evaporators

**Value of caustic**

- **Recoverable caustic**: 100 m³/day
- **Reduced caustic consumption**: 1.02 kEur/day
- **Reduced wastewater neutralization**: 0.6 kEur/day
- **Minimized water/wastewater**: 0.06 kEur/day
- **Minimized heating**: 0.12 kEur/day
- **Potential utility savings**: Yearly (1.8 kEur x 350 days) **633 kEur/day**

**Equipment investment**

- **Filtration solution**: 837 kEur
  - TCO (1 year)
  - **Payback**: 1.3 Year
  - Including discharge costs of concentrate
  - Includes estimated value for Tanks, Pumps, Agitator, Valves Instrumentation and Services
## Potential savings and TCO for CIP recovery

<table>
<thead>
<tr>
<th></th>
<th>No recovery €/day</th>
<th>Recovery solution €/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caustic consumption</td>
<td>1290</td>
<td>266</td>
</tr>
<tr>
<td>Wastewater neutralisation (est.)</td>
<td>760</td>
<td>157</td>
</tr>
<tr>
<td>Water + wastewater</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Heat loss</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td><strong>Total costs per day</strong></td>
<td><strong>2234</strong></td>
<td><strong>423</strong></td>
</tr>
</tbody>
</table>

Savings per year (350 days) **633,850 €**
Potential investments CIP recovery

Example from Scandinavia

<table>
<thead>
<tr>
<th>Description</th>
<th>€</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nano filtration with 10 membranes, Hardware only</td>
<td>300.000</td>
</tr>
<tr>
<td>Nano filtration, Installation &amp; Integration Services</td>
<td>130.000</td>
</tr>
<tr>
<td>Two (2) of Tanks, Pumps, Agitator, Valves Instrumentation and Services (estimated value)</td>
<td>400.000</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td><strong>830.000</strong></td>
</tr>
</tbody>
</table>

ROI 830.000/633.850 €
1,3 year

Rough estimation:
- 5 tons/h 10 membranes: 300.000 Euro
- 10 tons/h 20 membranes: 400.000 Euro
- 20 tons/h 40 membranes: 600.000 Euro
TCO and ROI
Clippings from TCO

► Cost of ownership: € 366.877 /year
► Profit /Added value: € 467.753 /year
► Net profit: € 100.876 /year

Notice: This is without tanks, pipes and buildings

ROI = 0.8 year
(Return of investment)
What is important for the case and ROI

Amount and prices:
- Water
- Waste water
- NaOH
- HNO3
- Electricity
- Temperature is nearly constant, the feed is treated hot (60-70°C)
**Principle of CIP recovery**

- Protein, fat, lactose and suspended solids are retained and concentrated.
- Caustic can pass through the membranes and be recovered.

Up to 90% recovery of total spent CIP liquid.
Where are the opportunities

CIP chemical type
► Pure caustic (NaOH)
► Pure acid (HNO₃)

Type of CIP procedure
► CIP procedures that require large volumes of CIP liquids
► CIP of 'hot processes’ as evaporators, dryers, plate heat exchangers
► Up to 90 % recovery of total spent CIP liquid
► Recovery rate may depend on amount of solids in spent liquid (e.g. process performances)
Quality of recovered CIP liquids

- Minimal loss of cleaning strength
- Easy to boost up CIP liquids to required concentration
- High retention of COD and lactose
- Removal of bacteria/spores
- No fat or protein
- Possibility to continuously monitor quality (instrumental/visual)
Water recovery – Minimize water footprint
Water recovery

Recovery potential
► Up to 95% recovery
► Consistent quality
► Very low in organic compounds
► Robust solution

Sources
► Whey
► Milk
► Plant based material
► Permeates from concentration
High potential customers

Example - larger dairies cheese or powders production

- Milk 1000 tons
- Evaporation
- RO Filtration 800 Tons
- Excess water 720 tons
- Waste water 80 tons
- Milk Powder Production

Concentrated product
Treatment and storage

Water recovery example

Evaporator condensate → Filtration recovered 95% volume → Flush out 5% volume → UV filter → Ultra violet light barrier → Storage tank → Boiler water CIP
Handling and distribution
Water recovery

- Storage tank
- Cooling towers
- Boiler water
- Evaporators & spray dryers
- Diafiltration
- Final flush
- CIP station
- CIP filtration

Distribution system
Water recovery: cheese & powder plant

Case overview

Value of water

Recoverable excess water 720 m³/day

Reduced wastewater treatment / discharge costs

Daily: 1.44 kEur/day (2 Eur/m³)
Yearly: 504 kEur/year (350 days)

Minimized water intake

Daily: 0.36 kEur/day (0.5 Eur/m³)
Yearly: 126 kEur/year (350 days)

Potential utility savings

Yearly: 630 kEur/day

Equipment investment

Filtration solution
Cost: 350 kEur
Running costs, yearly (est.): 30 kEur

Potential infrastructure investment budget post filtration solution
Based on 1 year payback
Remaining budget: 250 kEur
Customers in need of assistance

Water recovery

Water assessment
► Assessment of existing processes on site
► Alignment with local legislation
► Suggestion for improvements
► Testing of relevant applications

Pilot trails
► Understand the composition
► Ensure correct treatment train for the specific process
► Validate specific parameters relevant to the production
► Optimization of treatment to local conditions