POMEVap technology

- Alfa Laval’s solution to palm oil mill effluent (POME)
Agenda
- What we’ll talk about today

• Sustainability at Alfa Laval
• Challenges faced by palm oil mills in treating effluent
• POMEVap – Alfa Laval’s solution for tackling palm oil mill effluent
• Recovery of oil from palm oil mill effluent (added income)
• Towards zero liquid discharge in palm oil mills
• Recap and Q&As
Our core technologies promote:

- Responsible use of natural resources
- Reduced environmental impact from industrial processes
- Improved energy efficiency and heat recovery
- Better water treatment and reduced emissions
Turning wastewater into a valuable resource
- Alfa Laval’s POMEVap solution

Value from wastewater
Sustainable and efficient, Alfa Laval’s POMEVap
- Creates clean, reusable water
- Recovers valuable by-products or resources, such as oil
Challenges of treating palm oil mill effluent
Industry trends
- Growth in global palm oil production

Number of mills in the world ≈ 1,500
(Majority is in Malaysia, Indonesia, Thailand, Colombia, India and Africa)

Source: FAO, 2016a
## Typical palm oil mill effluent loads

Palm oil mill effluent generation = 0.5–0.7 times mill capacity

<table>
<thead>
<tr>
<th>Mill capacity (tons/hr (FFB))</th>
<th>POME tons/hr</th>
<th>Oil in POME tons/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>15–21</td>
<td>0.15–0.21</td>
</tr>
<tr>
<td>45</td>
<td>22.5–31.5</td>
<td>0.22–0.31</td>
</tr>
<tr>
<td>60</td>
<td>30–42</td>
<td>0.3–0.42</td>
</tr>
<tr>
<td>75</td>
<td>37.5–52.5</td>
<td>0.37–0.52</td>
</tr>
<tr>
<td>90</td>
<td>45–63</td>
<td>0.45–0.63</td>
</tr>
</tbody>
</table>
# Palm oil mill effluent or POME

- **Typical characteristics and properties**

<table>
<thead>
<tr>
<th>Colour: Dark brown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp: ≈ 80°C</td>
</tr>
<tr>
<td>Water: 94–95 %</td>
</tr>
<tr>
<td>Non-oil solids: 4–5 %</td>
</tr>
<tr>
<td>Oil: 0.8–1.0 %</td>
</tr>
<tr>
<td>Non-toxic</td>
</tr>
<tr>
<td>pH: 3.4–5.2</td>
</tr>
<tr>
<td>BOD: 10,000–45,000 ppm</td>
</tr>
<tr>
<td>COD: 15,000–100,000 ppm</td>
</tr>
</tbody>
</table>

**BOD** – Biological Oxygen Demand indicates the degree of pollution in the water or the amount of oxygen required by aerobic bacteria to remove organic matter from wastewater via decomposition.

**COD** – Chemical Oxygen Demand is the oxygen required by chemical to destroy all organic matter in the wastewater.
Conventional POME treatment practices
- Typical palm oil mill process and POME generation points

![Diagram showing the process of conventional POME treatment practices]

- Fresh fruit bunches
- Sterilizer (Direct injection)
- Thresher
- Digester and pressing
- Clarification
- Drying
- Sludge pit
- Hydrocyclone washwater
- Sterilizer condensate
- Motive steam, 3 barg
- Mill boiler
- Crude palm oil
- Open ponding
- Treated effluent
- Fresh water
- Crude palm oil
- Drying
- Clarification
- Digester and pressing
- Thresher
- Sterilizer (Direct injection)
- Fresh fruit bunches
Stringent wastewater discharge standards

Acceptable conditions of sewage discharge of standards A and B

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Standard A</th>
<th>Standard B</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Temperature</td>
<td>°C</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>(b) pH value</td>
<td>–</td>
<td>6.0–9.0</td>
<td>5.5–9.0</td>
</tr>
<tr>
<td>(c) BOD5 at 20°C</td>
<td>mg/L</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>(d) COD</td>
<td>mg/L</td>
<td>120</td>
<td>200</td>
</tr>
<tr>
<td>(e) Suspended solids</td>
<td>mg/L</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>(f) Oil and grease</td>
<td>mg/L</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td>(g) Ammoniacal nitrogen (enclosed water body)</td>
<td>mg/L</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>(h) Ammoniacal nitrogen (river)</td>
<td>mg/L</td>
<td>10.0</td>
<td>20.0</td>
</tr>
<tr>
<td>(i) Nitrate — Nitrogen (river)</td>
<td>mg/L</td>
<td>20.0</td>
<td>50.0</td>
</tr>
<tr>
<td>(j) Nitrate — Nitrogen (enclosed water body)</td>
<td>mg/L</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>(k) Phosphorus (enclosed water body)</td>
<td>mg/L</td>
<td>5.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Note! Standard A is applicable to discharges into any inland waters within catchment areas listed in the Third Schedule, while standard B is applicable to any other inland waters of Malaysian waters.

Source: Dept of Environment, Malaysia

Drinking water
BOD: 1–2 ppm

River water
BOD: < 5 ppm
Challenges of palm oil mill effluent
- A recap

- Open ponding requires huge space
- Methane (GHG) emissions to the atmosphere
- Methane capture and reuse systems don’t offer a complete solution
- No resource recovery
- Issues with the discharge of treated effluent/re-use
Alfa Laval POMEVap
Based on AlfaFlash technology, POMEVap efficiently separates effluent into:

- **Water** in the form of process condensate (~300–500 ppm BOD)

- **Solids** in the form of concentrate (sludge with ~40% solids)
POMEVap – Sustainable way of treating POME

- Benefits of the Alfa Laval POMEVap

Minimizes mill water consumption
Condensate can be re-used

Resource recovery
Separated oil and sludge as added income

Less space
POMEVap requires only ≈ 300 m²

No methane emissions
**Probably the best evaporation technology available for fouling applications**

- Forced circulation with suppressed boiling
- Heats the liquid under pressure inside the heat exchanger
- The heated liquid is discharged to the cyclone vessel where the pressure is lower, and flashing will occur
- Flash = Rapidly boil off
AlfaFlash
- Probably the best evaporation technology in the market for fouling applications

- High liquid circulation rates → high turbulence and high shear rate
- Self-cleaning effect → cleaning/preventing fouling
- Significantly improved CIP efficiency and maximum uptime

AlfaFlash concept

1. No shear
   \[ V = 0 \quad \tau = 0 \]

2. Insufficient shear for solids removal
   \[ V = \text{low} \quad \tau = \text{low} \]

3. Sufficient shear for solids removal (self-cleaning)
   \[ V = \text{high} \quad \tau = \text{high} \]
AlfaFlash for less fouling
- Better fouling resistance due to high shear rate and low viscosity

Non-Newtonian Liquids

![Graph showing apparent viscosity vs. shear rate for Conventional heat exchangers and AlfaFlash. The graph illustrates the lower apparent viscosity of AlfaFlash at higher shear rates compared to Conventional heat exchangers.](image-url)
WideGap as AlfaFlash PHE – Wide Open for POME
- Handles liquids with suspended solids efficiently

Alfa Laval WideGap heat exchanger
- Optimal plate gap and pattern
- Lower fouling rate, more uptime
AlfaFlash – Fouling performance from POME tests
- Before and after: Trial on palm oil mill effluent

Before cleaning (one week operation on POME)

After hot-water flushing
POMEVap evaporator – How it works
POMEVap system
- Customized configurations to meet the mill’s needs

Example – Triple-effect POMEVap system for mill with 30 tons of FFB/hr
POMEVap – Installed and commissioned
- For mill with 60/80 tons of FFB/hr

Cyclone separation vessels and decanter
Recirculation pumps
POMEVap – Installed and commissioned
- For mill with 60/80 tons of FFB/hr

- Visual impression of concentrated product
- Concentrate disposal
- POMEVap condensate
- Mineral water
Challenges faced by palm oil mills

- Open ponding requires huge space
  - Solved
- Methane (GHG) emission to atmosphere
  - Solved
- No resource recovery
- Issues with discharge of treated effluent/re-use

POMEVap system designed to tackle palm oil mill effluent
POMEVap + decanter solution for oil recovery

- Adding a decanter to the system to recover the oil

POMEVap + decanter solution for oil recovery

POMEVap + decanter solution for oil recovery

POMEVap

POME

(5% NOS + 1% oil)

Decanter

Process condensate

Concentrate

Cake

Heavy phase

Light phase recovered oil

(40–50% recovery)
POMEVap + decanter – Installed and commissioned
- 60/80 tons of FFB/hr

<table>
<thead>
<tr>
<th>Sample</th>
<th>Oil content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw POME</td>
<td>1.30</td>
</tr>
<tr>
<td>Decanter feed</td>
<td>2.10</td>
</tr>
<tr>
<td>Heavy phase</td>
<td>0.55</td>
</tr>
<tr>
<td>Cake</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Results: Soxhlet extraction

Raw POME – Decanter feed – Heavy phase – Light phase
**POMEVap + decanter solution for oil recovery**

- Combining decanter for oil recovery

<table>
<thead>
<tr>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill capacity (FFB/hr)</td>
<td>45 FFB tons/hr</td>
</tr>
<tr>
<td>Mill capacity (FFB/year)</td>
<td>270,000 FFB tons/year*</td>
</tr>
<tr>
<td>POME factor</td>
<td>0.60 –</td>
</tr>
<tr>
<td>Total POME generated</td>
<td>162,000 tons/year</td>
</tr>
<tr>
<td>Oil recovery from 1 to 0.5%</td>
<td>810 tons/year</td>
</tr>
<tr>
<td>Oil price</td>
<td>650 USD/ton</td>
</tr>
<tr>
<td>Added income due to oil recovery</td>
<td>526K USD/year</td>
</tr>
<tr>
<td>Payback for POMEVap</td>
<td>3-4 years</td>
</tr>
</tbody>
</table>

*Based on running hours of 6,000 hr/year
Challenges faced by palm oil mills

- Open ponding requires huge space ✔ Solved
- Methane (GHG) emission to atmosphere ✔ Solved
- No resource recovery ✔ Solved
- Issues with discharge of treated effluent/re-use
Towards zero-liquid discharge in palm oil mills
Towards zero liquid discharge in palm oil mills

- Re-use of process condensate from POMEVap

Fresh fruit bunches → Mill boiler

Sterilizer (Direct injection) → Thresher → Digester and pressing → Clarification → Drying

Hydrocyclone washwater, 4% of POME

Sterilizer condensate, 36% of POME

Sludge pit

Separator sludge, 60% of POME

Crude palm oil

Motive steam, 4 barg

Cooling tower

Generated steam, 3 barg

Evaporation loss

Concentrate and crude oil as by-products

POMEVap

SteamVap
The Alfa Laval SteamVap is based on AlfaVap technology, a rising film plate evaporator.

**Components**

1. Evaporator PHE
2. Vapour separation vessel
3. Frame with pumps
4. Vapour outlet for discharging steam
Towards zero liquid discharge in palm oil mills
- Key benefits to mill owners

- A complete solution to solve POME issues
- Reduced boiler feedwater consumption (additional income)
- Recovery of oil from POME (additional income)
- Sludge reuse as a by-product (additional income)
- Based on proven, reliable technologies
- Land previously used for ponding can be used for other meaningful purposes
- The concept can be easily applied to existing as well as new installations
- Assists palm oil mills to achieve sustainable operation
POMEVap system – compact design

- A comparison

POMEVap system vs. Falling Film system

8 metres

POMEVap plate evaporator

16 metres

Shell-and-tube falling film evaporator
Focus on R&D

To develop the POMEVap solution, Alfa Laval has tested the POME concentration using Alfa Laval’s evaporation test unit for an extended trial period (≈ 4 weeks) at customer mill sites in Malaysia.
What can POMEVap do for you?

- Input data needed for budgetary quote

- **Design inputs**: Feed rate, feed concentration, feed temperature

- **Utility**: Available steam temperature, ambient air temperature, available power (kW)

- **Oil content** in the POME feed
Our evaporation system portfolio
- Broad solutions for easy-to-handle and more challenging liquids

AlfaVap
AlfaCond

AlfaFlash
ViscoVap
ConVap
AlfaVap InLine
FilmVap
Thanks for joining!

Do you want to get in touch?

Reach out and send an e-mail to: amol.hukkerikar@alfalaval.com

The presentation and the recording of this webinar will be sent out to the participants soon!

For more information

- Alfa Laval POME management
- Alfa Laval AlfaFlash evaporation systems
Q&As