Filtration is used to dewater effluent, slurry and sludge. Sludge dewatering reduces its water content to be disposed of in landfills and reduces the volume of the residue for more stable and economical operation of the effluent plant. The major sludge dewatering processes include rotary drum vacuum filter, belt filter press and filter press. They use either negative or positive pressure to force water through the filter media, leaving the solids behind.

Today most sludge dewatering uses a filter press with membrane plate to produce a high solids filter cake.

Palm oil milling generates large volumes of effluent with 3%-4% suspended solids. Discharging all the undigested solids into the treatment pond can overwhelm the bacterial activity, making it difficult to reduce the BOD content of the discharge water to permissible limits.

This technology proposes the use of a membrane filter press to remove the solids from sludge before discharge to the effluent plant as a solution to maintaining the high activity of the biological degradation in the effluent pond.

**DESCRIPTION**

The filter comprises a set of recessed membrane plates, pressed against each other by a hydraulic jack from one end of the set. The pressure applied to the joint face of each filter plate must be able to withstand the internal chamber pressure developed by the sludge pumping. The feed port is usually placed in the centre of the plates, allowing good distribution of the flow, right pressure and better drainage of the sludge from the chamber. The sludge gradually accumulates in the filtration chamber until the final compacted cake is formed. The filtrate is collected at the back of the filtration support to drain away through internal ducts.
Dewatering by filter press is an intermittent process. The process involves the following steps:

- **closing of the press**: as the filter is completely empty, the moving head is activated by the jacks that clamps the plates. The closing pressure is self-regulated through the filtration.

- **filling**: during this short phase, the chamber is filled with the sludge to be filtered. The filling time depends on the flow of the feed pump. For sludge of good filterability, it is best to fill the filter quickly to avoid caking in the first chamber before the last ones are filled.

### TABLE 1. TYPICAL PILOT TRIAL RESULTS USING A MEMBRANE FILTER PRESS (470 mm x 470 mm) FOR RECOVERY OF SOLIDS FROM SLUDGE

<table>
<thead>
<tr>
<th>Type of Slurry</th>
<th>Sludge ex-centrifugal separator (3%-4% suspended solids)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge conditioning</td>
<td>Using polymer</td>
</tr>
<tr>
<td>Polymer mixing time</td>
<td>Rapid, 2 min, Slow, 30 min</td>
</tr>
<tr>
<td>Polymer type</td>
<td>Cationic, high molecular weight</td>
</tr>
<tr>
<td>Filtration cycle</td>
<td>90 min</td>
</tr>
<tr>
<td>Feed pressure</td>
<td>2 kg cm(^{-2})</td>
</tr>
<tr>
<td>Squeeze pressure</td>
<td>8 kg cm(^{-2}) max.</td>
</tr>
<tr>
<td>Flux achieved</td>
<td>30 litres per m(^2) per hr</td>
</tr>
<tr>
<td>Solids recovery</td>
<td>(\geq 95%)</td>
</tr>
<tr>
<td>Filter cloth used</td>
<td>High grade PP with mono-multi fibre</td>
</tr>
<tr>
<td>Solids cake moisture</td>
<td>50%, subject to polymer conditioning and squeeze pressure</td>
</tr>
</tbody>
</table>

**Figure 3. Membrane filter press.**

**Figure 4. Sludge, filtrate and solid cake.**
filtration: once the chambers are filled, further input of sludge increases the pressure from the increasingly thicker layer of filtered sludge on the cloths. The filtration can then be stopped manually, by a timer, or, more conveniently by a filtrate flow indicator automatically when no more filtrate is passing through.

filter opening: the moving head is drawn back to disengage the first filtration chamber. The cake is released by its own weight. A mechanized system pulls out the plates one by one, the speed of which can be adjusted for the cake texture.

washing: washing the cloth should be done every 15-30 runs. For mid or large units, this can be done on the press itself using high pressure water sprays (80-100 bar). However, the washing requirements will depend on the type of sludge.

FILTERATION CAPACITY

The capacity of a filter press is ranged from 1.5 to 10 kg solids per m² filter surface.

SLUDGE CONDITIONING

If unconditioned sludge is filtered through plate assembly, the filter cloth gets plugged. Notwithstanding this, the fine particles can pass through and reduce solids recovery efficiency. To reduce the medium blinding and to improve the filter cake structure during filtration, the sludge is conditioned with suitable agents like polymer to neutralize and flocculate the solids. The conditioning produces a rigid sludge with a porosity that allows for effective water drainage.

### TABLE 2. ECONOMICS OF USING A MEMBRANE FILTER PRESS FOR SOLIDS RECOVERY FROM SLUDGE (150 m³ a day) 305 DAYS A YEAR

<table>
<thead>
<tr>
<th>Equipment cost</th>
<th>RM 600 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital costs per year</td>
<td>RM 60 000</td>
</tr>
<tr>
<td>Operating costs</td>
<td></td>
</tr>
<tr>
<td>Filter plate replacement (after 3 years)</td>
<td>30 000</td>
</tr>
<tr>
<td>Filter cloth replacement (after 1 year)</td>
<td>15 000</td>
</tr>
<tr>
<td>Chemicals (flocculent) RM110 per day</td>
<td>35 550</td>
</tr>
<tr>
<td>Repair &amp; maintenance 2.5% of capital</td>
<td>15 000</td>
</tr>
<tr>
<td>Total O&amp;M costs</td>
<td>RM 95 550</td>
</tr>
<tr>
<td>O&amp;M per tonne FFB</td>
<td>RM 0.78</td>
</tr>
<tr>
<td>Estimated value of solids*</td>
<td>RM 146 400</td>
</tr>
<tr>
<td>Saving from effluent plant maintenance**</td>
<td>RM 80 000</td>
</tr>
<tr>
<td>Payback period</td>
<td>8.46 years</td>
</tr>
</tbody>
</table>

Notes: * The estimated solid cake value is RM 80 per tonne @ 45% moisture.
** Pond cleaning not required if solids are recovered before discharge of the effluent into the pond.
**BENEFITS**

The benefits of solids removal from sludge using a membrane filter press include:

- high solids removal;
- production of drier cakes of less volume and reducing the volume of the final sludge;
- remove 50% of the BOD constituents in the waste water;
- high value solids cake produced suitable for compost fertilizer and animal feed;
- low maintenance; and
- possibility of recycling the filtrate after treatment with UF and RO filters as process water.

**THE PROCESS**

Sludge from the collection pit is pumped into a pretreatment tank where a cationic polymer is added to condition the suspended solids. Two-step mixing is employed to ensure formation of stable and big floc aggregates. The mixture is then pumped to a membrane filter press at 2 kg cm$^{-2}$ line pressure using an air operated diaphragm pump or positive displacement pump. The filtration sequence is described above. On completion of the filtration cycle, the solids are removed to the collection bay or vessel by conveyor. The solids are then ready for disposal or transported to the composting plant.

**ECONOMICS**

The equipment cost for a plant to treat 150 m$^3$ sludge a day is RM 600 000 with operation and maintenance at RM 0.78 per tonne FFB processed.

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