

SOLID SEPARATION FROM SLUDGE USING MEMBRANE FILTER PRESS

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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.



Figure 1. Sludge measured by rotary basculator.



Figure 2. Flocculation test.

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.

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Figure 3. Membrane filter press.

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.



Figure 4. Sludge, filtrate and solid cake.

- *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

Type of slurry	Sludge ex-centrifugal separator (3%-4% suspended solids)
Sludge conditioning	Using polymer
Polymer mixing time	Rapid, 2 min Slow, 30 min
Polymer type	Cationic, high molecular weight
Filtration cycle	90 min
Feed pressure	2 kg cm ⁻²
Squeeze pressure	8 kg cm ⁻² max.
Flux achieved	30 litres per m ² per hr
Solids recovery	≥ 95%
Filter cloth used	High grade PP with mono-multi fibre
Solids cake moisture	50%, subject to polymer conditioning and squeeze pressure

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

Equipment cost	RM 600 000
Capital costs per year (constant depreciation 10 years)	RM 60 000
Operating costs	
Filter plate replacement (after 3 years)	30 000
Filter cloth replacement (after 1 year)	15 000
Chemicals (flocculent) RM110 per day	35 550
Repair & maintenance 2.5% of capital	15 000
Total O&M costs	RM 95 550
O&M per tonne FFB	RM 0.78
Estimated value of solids*	RM 146 400
Saving from effluent plant maintenance**	RM 80 000
Payback period	8.46 years

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.

- *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.

FILTRATION 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.

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 pre-treatment 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 m³ sludge a day is RM 600 000 with operation and maintenance at RM 0.78 per tonne FFB processed.

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