MEMBRANE BIOREACTOR TECHNOLOGY FOR TERTIARY TREATMENT OF PALM OIL MILL EFFLUENT (POME)

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With better membrane developed from better understanding of the filtration mechanisms, membrane bioreactor (MBR) systems become a feasible option for aerobic treatment of wastewater, industrial wastewater and potentially for palm oil mill wastewaters. Owing to their ability to produce excellent treatment efficiency, MBRs are increasingly used around the world. MBR installations are also increasing in size. With an absolute barrier against suspended solids, MBRs plants are able to retain very high solids concentrations in the reactor (8000 to 20 000 mg litre^{-1}) with very short solids retention times to allow for smaller aeration basins and yet high BOD removal. An MBR is actually an activated sludge process with the conventional secondary clarifier replaced by a membrane (either for microfiltration or ultrafiltration). The MBR is always operated with a fine screening filter to protect the membrane from abrasive and stringy waste components. Since the MBR-treated effluent has been micro- or ultra-filtered, the suspended solids are typically only near the detection limit and the turbidity < 0.2 NTU. In addition, certain chlorine resistant pathogens, such as Cryptosporidium and Giardia, are also screened off.

MBR PROCESS DESCRIPTION

The typical MBR plant (*Figure 1*) includes an anoxic and aerated regions, external UF membrane module and an internal mixed liquor recycler. Incorporation of anaerobic zones for biological phosphorus removal is also possible, and this has been the focus of recent research. As an alternative to the set-up in *Figure 1*, some plants use submerged membranes instead of external membrane in the bioreactor.

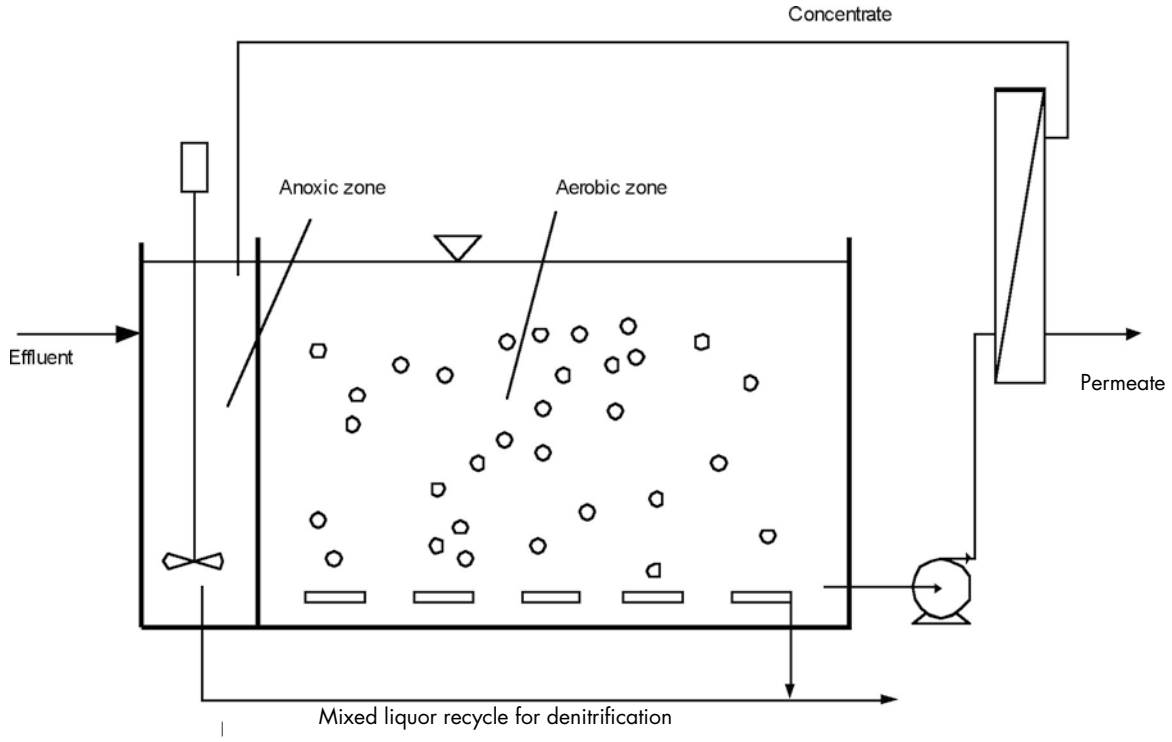

Figure 1. Typical MBR plant layout.

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MBR FOR TERTIARY TREATMENT OF POME

The current treatment system of anaerobic followed by aerobic degradation in palm oil mills is not capable of producing high quality effluent. A possible solution is to use an MBR for tertiary treatment which will allow all the wastewater to be reused.

A pilot MBR was constructed and evaluated recently at POMTEC by MPOB and BACFREE Engineering Sdn Bhd for tertiary treatment of palm oil mill effluent (*Figure 2*). The influent is from the maturation pond of the conventional treatment process. The concentrate from the membrane module is mixed with the influent in the anoxic reactor where dissolved oxygen is maintained at 1 mg litre^{-1}. The aerobic sector is operated with dissolved oxygen of 4 to 5 mg litre^{-1} by bubbling the air through a set of disc diffusers at the bottom of the reactor. A root blower supplies sufficient air to the system. The mixed liquor is concentrated at an UF membrane, with clean filtrate produced at 1800 litre hr^{-1}. The characteristics of the mobile MBR plant are shown in *Table 1*.

Typical operational results of the MBR plant are shown in *Table 2*.

ADVANTAGES OF MBRs

The advantages of MBRs include:

- secondary clarifiers in the activated sludge process eliminated, reducing the plant footprint;
- unlike with using secondary clarifiers, the quality of solids separation is not dependent on the mixed liquor suspended solids concentration, or characteristics. Since elevated mixed liquor concentrations are possible, the aeration basin volume can be reduced, further reducing the plant footprint;
- no reliance having good sludge settleability, hence quite amenable to remote operation;
- can be designed with long sludge age, hence low sludge production; and
- produces a MF/UF quality effluent suitable for reuse, or as high quality feed water for reverse osmosis treatment to potable water.

COST OF THE SYSTEM

The total cost of an MBR plant for tertiary treatment of palm oil mill effluent is about RM 2.3 million for a typical 40 t FFB hr^{-1} palm oil mill. The membrane element is guaranteed for five years.

Figure 2. MBR pilot plant in POMTEC.

TABLE 1. CHARACTERISTICS OF MPOB-BACFREE MBR PILOT PLANT

Item	Anoxic/Selector	Aerobic
Volume, m^3	17	34
Flow rate, $m^3\ hr^{-1}$	2	-
Dissolved oxygen (DO) mg $litre^{-1}$	0/1.5	3.8-5.2
Mixed liquor suspended solids (MLSS) mg $litre^{-1}$	5 800	6 100
Solid retention time (SRT) days	7	7
Hydraulic retention time (HRT) hr	8.5	17
Membrane		
Type	Hollow fibre	
Pore size	0.32 micron	
Dimension	8.0 mm diameter	
Material	PVDF	
Flux area	27 $m^2\ module^{-1}$	
Flux (operating)	1.6 $m^3/m^2.day$	

TABLE 2. TYPICAL RESULTS FROM MPOB-BACFREE MBR PILOT PLANT

	In flow capability	Treated water quality
BOD	50 mg $litre^{-1}$ to 10 000 mg $litre^{-1}$	< 8 mg $litre^{-1}$
COD	100 mg $litre^{-1}$ to 30 000 mg $litre^{-1}$	< 300 mg $litre^{-1}$
TSS	< 8000 mg $litre^{-1}$	< 2 mg $litre^{-1}$

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