FILTER AIDED CROSSFLOW MICROFILTRATION OF SETTLED SLUDGE

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Introduction

Sludge settled beneath sedimentation tanks of water treatment works is normally thrown back into the down-stream sector of a river as effluent (as it happens at Sungai Linggi Water Treatment Plant). It usually consists of 2 - 3% solids and therefore it is sometimes worthwhile to recover the treated water by further concentrating or dewatering the sludge.

Dewatering or concentration methods involving filter media normally fail miserably as blinding of media by small particulate solids occurs. Alternative methods, such as crossflow filtration technique has been suggested in trying to improve the results.

Crossflow Filtration

Crossflow filtration involves slurry flow parallel or tangential to the filter media, instead of flowing 'dead end' or onto the filter surface as commonly found in conventional filtration (Figure 1). The high shear resulted from high circulation rate of feed flow reduces the tendency for cake formation on the filter surface. This results in higher filtrate rate couple with longer filtration time being achieved (1). And also, the possibility of a quasi-steady operation with nearly constant flux can be achieved in principle.

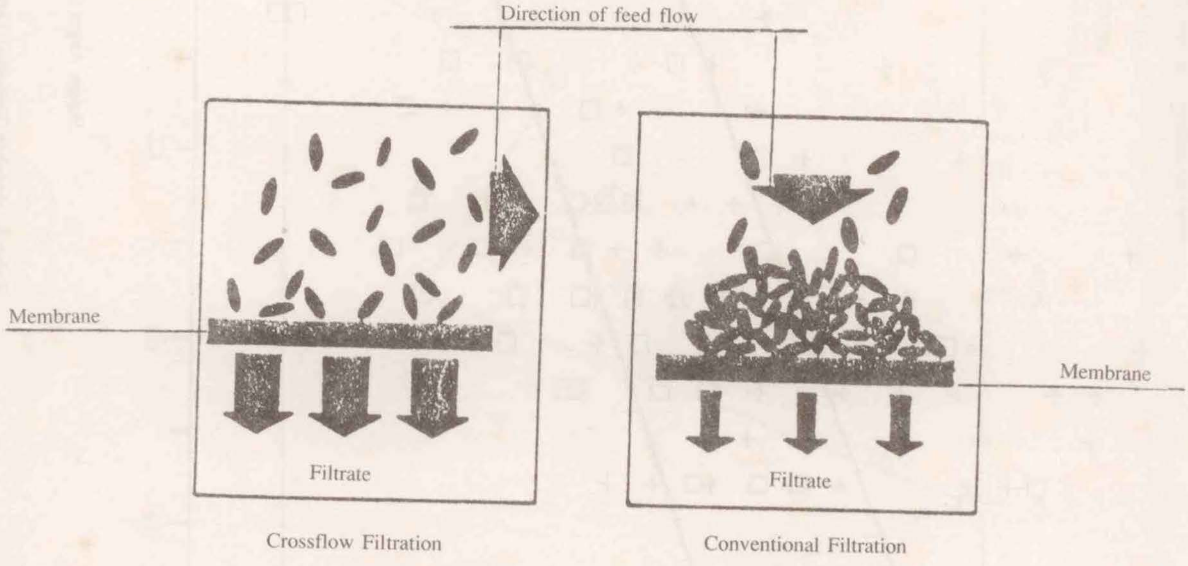

Figure 1 Comparison Between Crossflow & Conventional Filtration

Crossflow filtration is normally used in microfiltration and ultrafiltration. The difference between these two techniques being the size range of particles that can be removed;

Microfiltration : 0.02 to 10 microns or 200 to 10,000 A
(eg. particles, organisms, viruses in suspensions or colloids).

Ultrafiltration : 0.001 to 0.02 microns or 10 to 200 A (or 300 to 300,000 molecular weight based on globular protein).

At present, crossflow microfiltration is being widely used in various areas (3) of water and wastewater treatment, medical, pharmaceutical, food, beverage, electronic, mineral (4,5), chemical processing, petroleum (6) and bio-technological (7) industries. It is mostly used either for recycling of water or recovery of valuable or toxic products, or both.

Experimental

The schematic diagram of the experimental set-up is shown Figure 2. The sludge sample was pumped from the reservoir to the membrane module and the concentrate was recycled back to the reservoir. Filtrate rate produced was measured and its turbidity monitored.

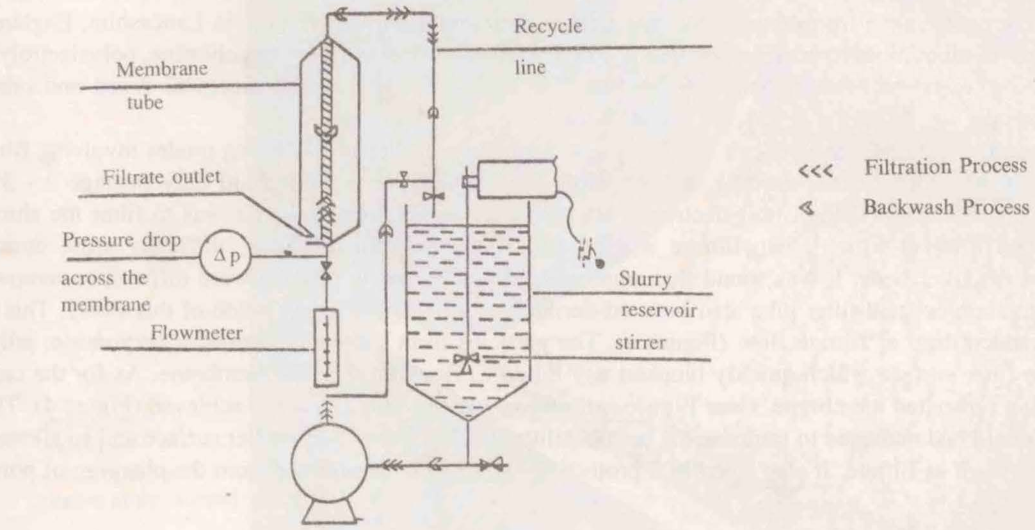

Figure 2 Experimental Set-up

The membrane tube used is made from high density polyethylene using sintering method. Its relevant dimensions and characteristics are as follows;

length - 0.7 m   thickness - 0.32 cm   diameter - 2 cm

average pore diameter - 25 microns   porosity - 25%

Characteristics of the slurry are as follows;

concentration of solids - 0.37% weight

colour - dirty green

average size of solids - 5 microns (using coulter counter)

Two sets of filtration experiments were carried out; the first without filter aid and the second with filter aid (Dicalite 488L). The latter was done by first pumping a known concentration of filter aid into the membrane module until a layer was formed on the filter surface. Then, the normal filtration process of the sludge slurry was carried out (Figure 3).

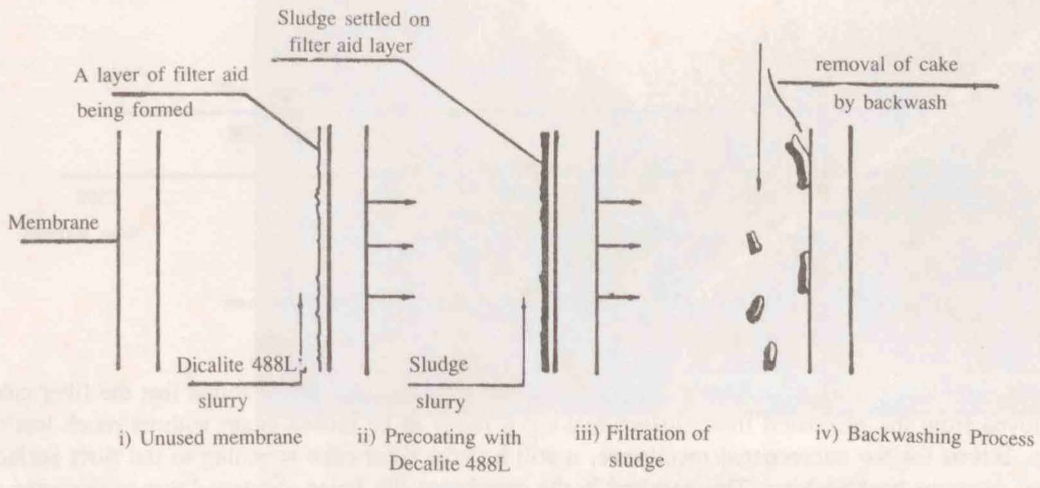

Figure 3 Various Physical Processes That Occur At Membrane Surface

After each run, backwashing of membrane was carried out whereby clean water was pumped in the opposite direction of slurry flow for about 10 minutes. It was an effort to remove any cake formed during the filtration process.

Results and Discussions

Special interest has been focussed on methods of getting a successful filtration of aluminium hydroxide slurry. This slurry was actually taken from a sedimentation tank at Hurlston Treatment Works in Lancashire, England. It consists mostly of aluminium hydroxide precipitate with traces of aluminium sulphate, chlorine, polyelectrolyte and other small objects which are expected to be found in river water, e.g. small pieces of wood and other vegetative materials.

This slurry was found to be very difficult to filter due to its small particle size. Filtering modes involving filter cloths failed miserably due to the blinding of filter cloth. Sedimentation method could only manage 2 - 3% concentration of solids, even though polyelectrolyte was used. The only success so far was to filter the slurry through deep bed filter in which clean filtrate was produced. However in the latter, difficulty arose during backwashing of the filter beds. It was found that small particles collected in the bed were difficult to remove.

Blinding of the unprecoated filter tube also occured during the crossflow microfiltration of this slurry. This is shown from sudden drop of filtrate flow (Figure 4). The particles from the slurry formed a very dense, jelly-like cake at the filter surface which quickly blocked any liquid to flow through the membrane. As for the case of filtration using precoated membrane, clear filtrate and reasonable filtration rate were achieved (Figure 4). The presence of filter aid had managed to improve the permeability of cake formed at the filter surface and so allowed liquid to flow through as filtrate. It also acted as a protective layer for the membrane from the plugging of pores by small particles.

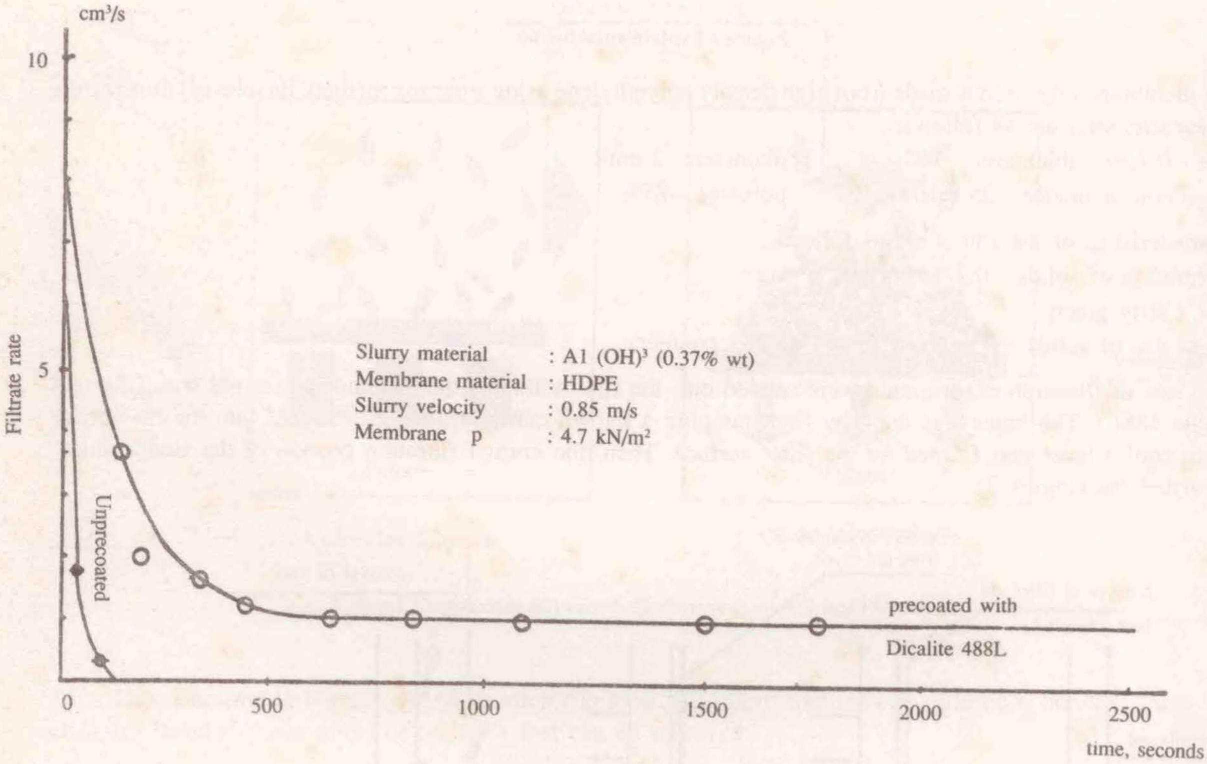

Figure 4 Filtrate Rate Versus Time For Precoated And Unprecoated Membrane

Using filter aid has another advantage. During the backwashing of filter tube, it was found that the filter cake was easily removed from the precoated filter surface making it ready to be reused again without much lost of its permeability. But as for the unprecoated membrane, it still had the filter cake attaching to the filter surface eventhough after vigorous backwashing. This resulted in the membrane life being shortened due to plugging of pores.

The difference of the filter surfaces for these two cases after backwashing can be seen in Figure 5.

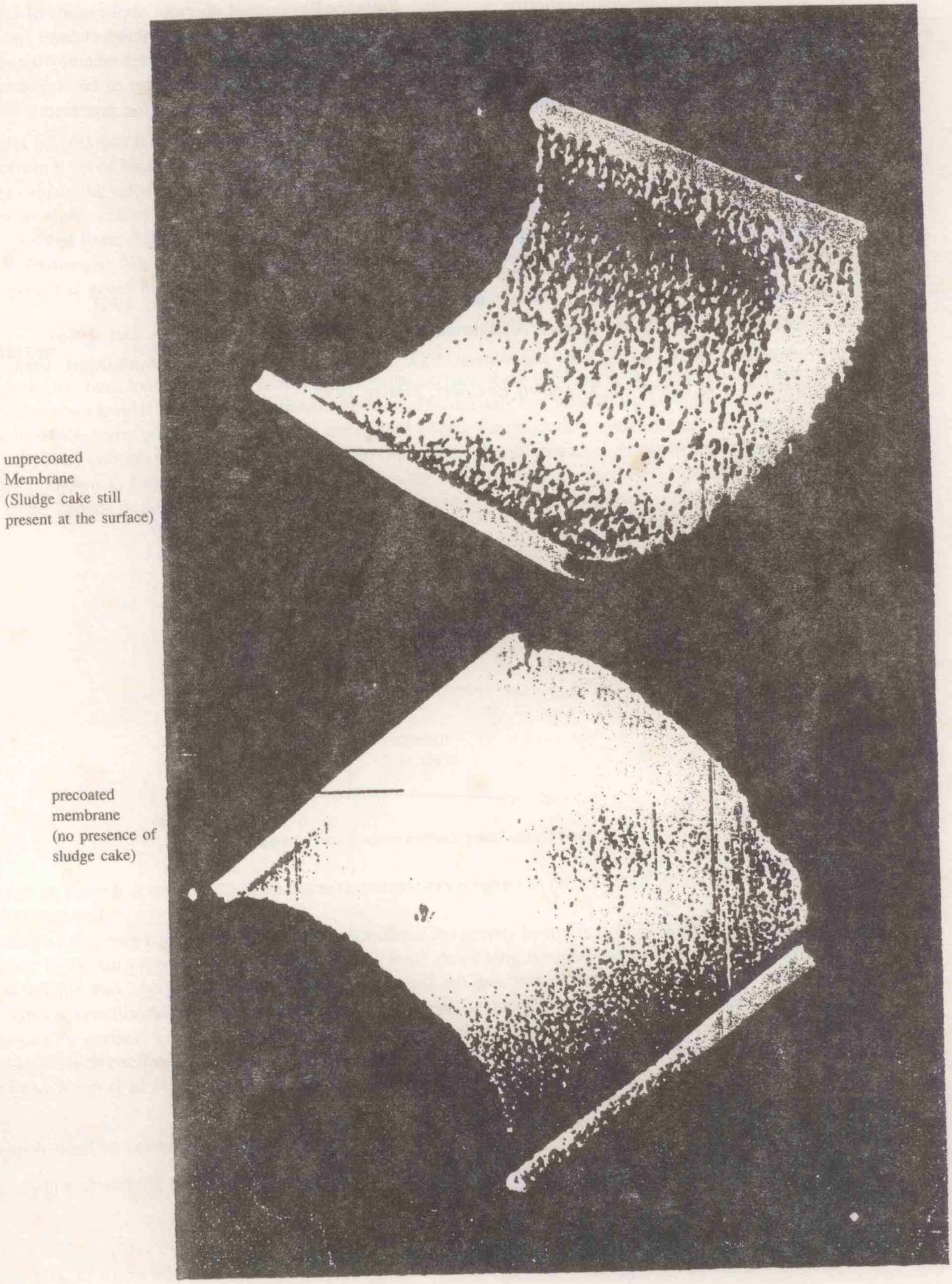

Figure 5 Comparison Between Filter Surfaces Of Unprecoated And Precoated Membrane After Backwashing

Conclusion

The success of using filter aid in filtering very difficult sludge has opened up more applications of crossflow microfiltration for separation purposes. Eventhough it is not economically viable to use this technique indomestic water treatment inatallations, it would be a useful separation technique for similiar slurries whereby the effective recovery of valuable or environmentally dangerous materials is a more important factor to be considered than the equipment investment cost (example slurries from herbicide or pesticide formulation processes).

References

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