Alternative to Membrane Bioreactor to Achieve High Effluent Quality

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Background

Wastewater treatment for water reuse has been growing in the recent years. Demand for reuse water will continue to grow as water supply becomes increasingly limited. To achieve reuse quality effluent, wastewater treatment plants rely on biological treatment and a solid/liquid separation step.

The trend has been the use of membranes in wastewater plants. The prevailing thought has been to utilize Membrane Bioreactors (MBR) which incorporate the membranes in the direct application of mixed liquor suspended solids (MLSS). In this system the solids concentrations are usually 8-10 g/l. While the MBR process can offer advantages with respect to space requirements, the elevated solids concentrations demands a higher energy input.

An alternative to the membrane bioreactor is the application of progressive staged filtration following the biological system. This Multi-Barrier Treatment Process (MBTP) is an innovative solution that integrates the sequencing batch reactor (SBR) process and cloth media filtration (CMF) to produce an exceptionally high quality membrane-feed, with solids less than 5 mg/l. Table 1 summarizes the effluent quality expected from the cloth media filters and the membranes.

Table 1. Multiple-Barrier Process Produces High-Quality Membrane Feed

Parameter	SBR + 10 micron CMF	0.05 - 0.1 micron membranes
BOD	≤ 5 mg/l	≤ 2 mg/l
TSS	≤ 5 mg/l	≤ 2 mg/l
Total N	≤ 3 mg/l	≤ 3 mg/l
Total P	≤ 0.3 mg/l*	≤ 0.1 mg/l*
Turbidity	≤ 3 NTU	≤ 0.2 NTU

*With chemical addition.

While MBR systems have gained increasing popularity over the years, many of the attributes are available in the Multiple-Barrier Treatment Process. Of paramount importance, however, is the quality of the water applied to the membranes. In contrast to the MBR process, the reuse-quality membrane feed of the multi-barrier concept maintains membrane performance while exhibiting exceptionally low energy levels.

Multi-Barrier Treatment Process (MBTP) Advantages

The multiple barrier concept maintains the focus on Nitrogen and Phosphorus removal in the biological reactor, without interference from the membrane operations. With the SBR process facilitating batch settling and decanting, high quality effluent is discharged to Cloth Media Filtration (CMF), producing a membrane feed quality that meets reuse-quality standards. This is

compared to the high MLSS concentration sent directly to the membranes in an MBR system (See figure 1).

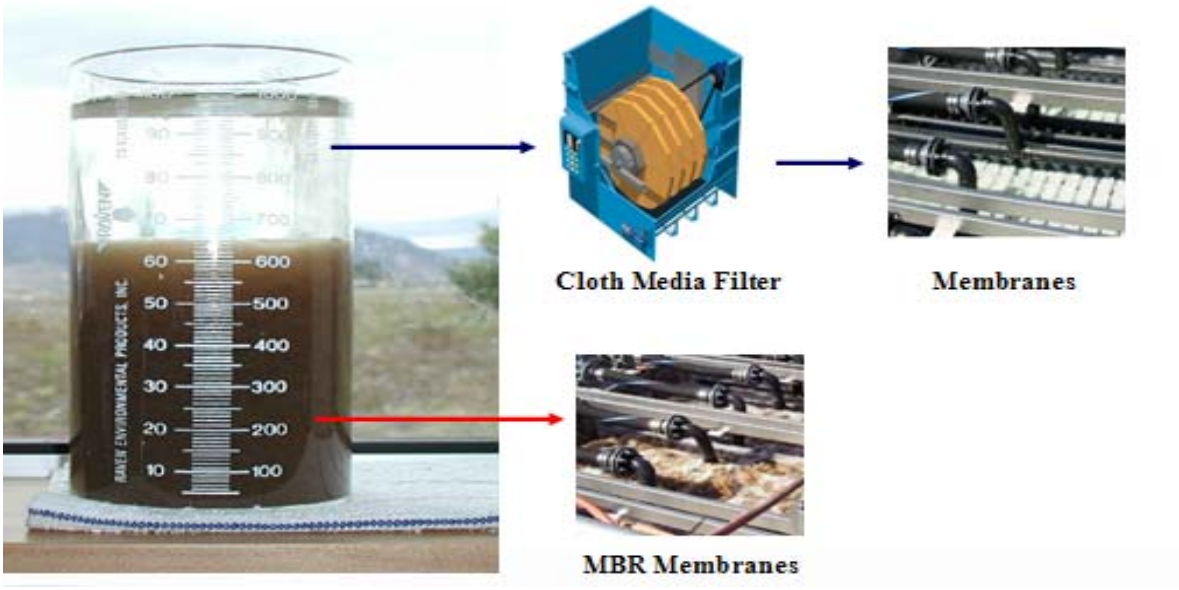

Figure 1. MBR System vs. Multi-Barrier Process: Quality of Water Applied to Membranes

Due to this low solids concentration in the membrane feed, the recirculation rates are reduced considerably, providing another substantial reduction in the power costs. Where an MBR system may require return activated sludge (RAS) pumps at 400-800% of the average design flow, the exceptionally low solids level fed to the membranes in the MBTP reduces this recirculation pump sizing to approximately 5-10% of the average flow rate.

In addition, the screening of fine particles is a critical element to the longevity and O&M attributed to MBR systems. As a mixture of the influent waste constituents and MLSS is directly applied to the membranes in an MBR system, fine screening to levels as low as 0.5 to 3 mm is common. Conversely, the SBR portion of the MBTP incorporates final sedimentation prior to further filtration. As such, the multi barrier process requires no special pre-treatment requirements (i.e. fine screens) as grit, hair, wrappers and other debris are completely removed prior to membrane filtration.

With multiple levels of treatment, flexibility in discharge points is an advantage over conventional MBR systems. With a multiple-barrier layout, the Operator has the ability to discharge high quality effluent directly from the SBR or Cloth Media Filtration system or from the membranes (See Figure 2). Many of the Discharge Permits in place for municipal wastewater systems are seasonal, requiring different quality parameters based upon summer or winter months. With the MBTP concept, the Operator can elect to operate the membranes on an 'as needed' basis. For example, if certain months of the year do not require the quality attainable with membranes, the Operator can send a minimal flow to the membranes, or condition them for storage.

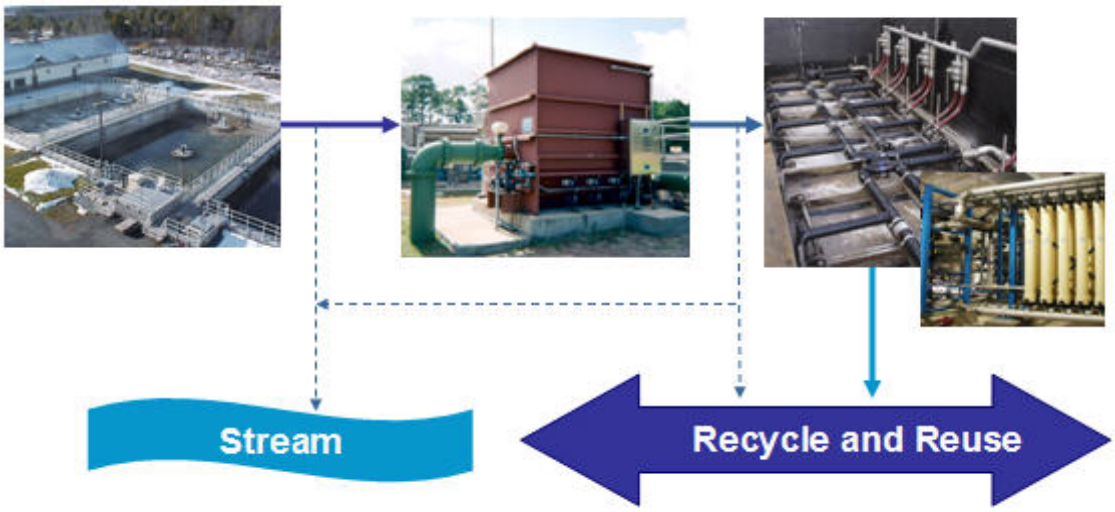

Figure 2. Multiple-Barrier System Treatment Schematic

Many membranes are selected to meet future requirements, and the ability to achieve sub-micron particle separation is not an initial objective. With the MBTP concept, the membranes can be designed into the process flow train, but don't necessarily have to be purchased in the initial plant construction. If the current permit does not require membrane quality effluent, with the multi-barrier approach, the membranes can be added in a later date.

In addition to the flexibility of operation described above, advanced treatment prior to the membranes will substantially reduce the quantity of membranes. Depending on the membrane type selected (submerged or pressure), the membrane area required to process a given flow is as little as 20% of that required with a membrane bioreactor. As membranes typically represent among the highest capital expenditures in new plant construction, the reduced membrane area and the low solids concentration in the membrane tank will result in significant reductions in capital and ownership costs in comparison to MBR systems. Additionally, the cleaning application of the membranes will reduce the mechanical and chemical cleaning costs, further reducing O&M costs.

Furthermore, the MBTP allows for the membranes to be design for only a portion of the flow. The effluent from the membranes can be reused, blended with the effluent from the other treatment processes or even sent to more advanced treatment processes such as, Nano-Filtration or Reversed osmosis system. On the contrary, the membranes for a membrane bioreactor system would have to be designed for the entire plant flow. This added benefit of the multi-barrier process provides significant capital cost savings to the owner.

Conclusion

The Multi Barrier Treatment Process technology provides unique advantages based on the process schematic. These advantages include design & operational flexibility, consistent high quality membrane feed, optional points of discharge, reduced membrane area and lower capital and life cycle costs. A multi barrier process provides the lowest capital and life cycle costs when compared to traditional activated sludge coupled membrane technologies.