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Leachate Treatment by Membrane Bioreactor Technology

By Ivan Cooper, Chair of the Leachate Management Committee

For a successful operation, a comprehensive understanding of flow, strengths and variabilities is required, and pilot scale testing is recommended to confirm design parameters. Further, the process can incorporate nitrification of ammonia concentrations and well as COD removal. Removal of nitrates formed with ammonia nitrification requires special consideration for denitrification in a separate anoxic step.

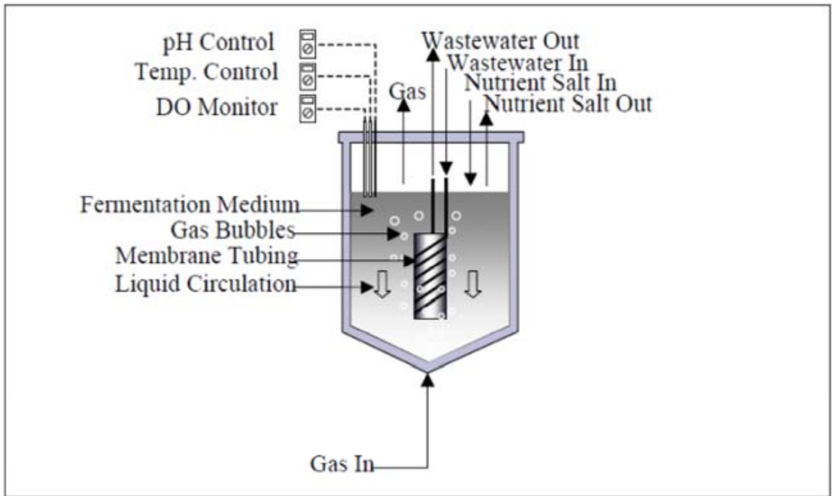
The technology is basically the suspended growth activated sludge process with a membrane separation unit replacing a clarifier. Since the membranes are microfilters or ultrafilters with very small pores (0.003 to 0.01 micron size pores), screening of particles large enough to block the pores are used. The reactor volume is significantly less conventional activated sludge processes due to the higher mixed liquor concentrations (15,000 mg/L to more than 25,000 mg/L) compared to conventional activated sludge systems that may operate at 2,500 to 4,000 mg/L MLSS concentrations.

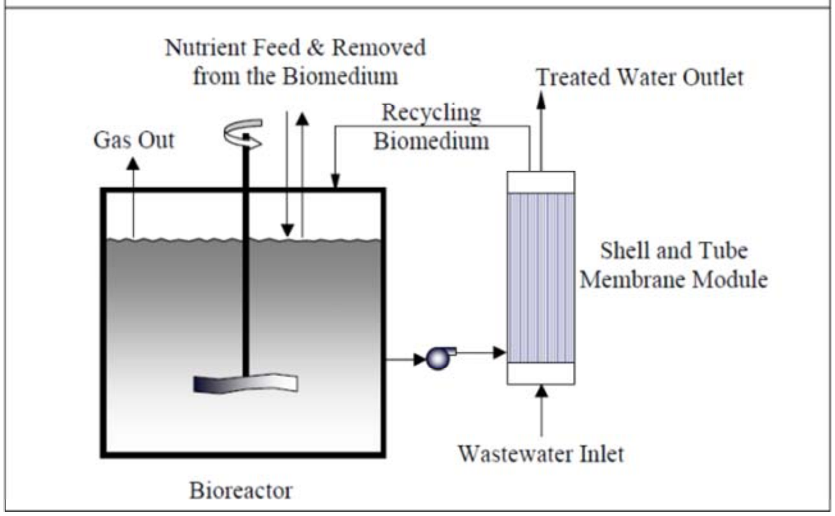
Certification Recognition

MBRs have been installed with two basic configurations, either internal/submerged, where the membranes are submerged in and integral to the biological reactor; and an external/sidestream, where the mixed liquor is pumped from the aeration tanks to external membranes, often installed as a separate process, usually in a building and requires intermediate pumping. The external unit operates at lower pressures and significantly lower power demands than an external unit due to reduced pumping costs.

Example of an external ultrafilter used in a leachate MBR treatment system

Comparison of Schematic of Internal MBR (Upper Figure) and External MBR (Lower Figure)





Operation Considerations

Further, temperature control, especially for sites that require nitrification is also critical. Most effective operation means controlling temperature around 95 - 100 degrees F, and adding heat or providing cooling may be considered. Pretreatment prior to membranes to remove solids has been shown to be critical for maintaining throughput.

Fouling of the membranes is a frequently reported problem, as buildup of both carbonate scale and biological slime can blind the membrane over time and increase the transmembrane pressure (TMP). Membrane cleaning requirements require the removing biological and mineral scale with both acid wash and caustic washes, using city water equivalent quality at elevated temperatures.

Operator controls also include maintaining adequate biomass to control the food to microorganism (F/M ratio) to prevent membrane biological fouling from extracellular polysaccharide substances (EPS), and release of cellular "sticky" material when cells die (soluble microbial products or SMP) that causes more frequent membrane fouling and reduces uptime. These controls also may limit foaming that has been seen at various sites. While a high quality effluent can be achieved with a MBR, some of the many operation challenges to be addressed for achieving consistent effluent quality include a higher level of operator training than other technologies. Other limitations include the inability to remove constituents that cause UV interference when treated leachate is discharged to a municipal wastewater treatment plant employing ultraviolet disinfection, as constituents such as humic and fulvic acids are not removed by the MBR system. Further processing with reverse osmosis or other additional technologies may be employed.

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