

# High Recovery Water Reclamation Process

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## Abstract:

Reclaimed water is an important source of water globally. Typically, the recovery of water reclamation process by membrane technology, i.e., microfiltration/ultrafiltration-membrane bioreactor (MF/UF-MBR) and reverse osmosis (RO), is limited to 75-80% due to fouling of RO membrane. Here, a novel nanofiltration-based MBR and RO system, i.e., NF-MBR+RO, was developed and demonstrated at lab- and pilot-scale to achieve  $\geq 90\%$  recovery. The novel low-pressure hollow fiber NF membrane only requires an operating pressure of  $< 2$  bar, possesses a positively charged selective layer, molecular weight cut off (MWCO) of  $< 500$  Da, and rejection of  $Mg^{2+}$  and  $Ca^{2+}$  is at  $\sim 90\%$ . It has very low rejection of  $Na^+$  ions ( $< 15\%$ ) while maintaining high rejection of the divalent ions, which is the key to achieve such a low operating pressure condition. In addition, the bioprocess is customized, i.e., using a moving bed biofilm reactor, for elevated salt environment in the bioreactor. When coupled with the optimized biological process with biodegradation efficiency of  $> 90\%$ , the NF-MBR produces superior quality of permeate, i.e., DOC of  $< 2$  mg/L, as well as less sludge production. Thus, membrane fouling in downstream RO process can be alleviated significantly, which allows higher recovery. The technical economic feasibility study of NF-MBR+RO was compared to MF/UF-MBR+RO.

**Keywords:** Membrane bioreactor, nanofiltration, reverse osmosis, water reclamation, high recovery