The reported research concerns ultrafiltration (UF) membranes in drinking water applications. Seasonal surface water quality impacts on UF performance were identified and managed with the development of a dynamic chemically enhanced backwash protocol. A subsequent analysis of UF process data revealed limitations with the use of specific flux, transmembrane pressure (TMP), and other normalization techniques for low pressure membrane processes. Accordingly, a new and alternative benchmark, termed the TMP balance, is presented to isolate the pressure contribution of membrane fouling and morphology changes. The TMP balance, demonstrated using over 9000 hours of UF pilot runtime data, enables direct process performance comparisons at different operating fluxes while distinguishing between physically and chemically unresolved fouling. UF process optimization may achieve significant performance improvements. A five component approach is developed for the systematic optimization of UF processes on the basis of TMP variations. Terms are defined for assessing process event performance, a new process utilization term is presented to benchmark UF productivity, and new measures for evaluating maintenance procedures are discussed. A correlation between process utilization and operating pressures is established and a sustainable process utilization of 93.5% is achieved. UF process capabilities may be further enhanced by pre-coating media onto the membrane surface. Silicon dioxide (SiO2) and powdered activated carbon (PAC) are evaluated as pre-coating materials, and the applicability of the TMP balance for assessing pre-coated membrane performance is demonstrated. The first use of SiO2 as a support layer for PAC in a membrane pre-coating application is presented, and the combined SiO2-PAC pre-coating successfully reduced physically unresolved fouling and enhanced UF membrane organics removal capabilities.

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Approved for distribution by Dr. Steven J. Duranceau, Committee Chair, on March 4, 2013.

The public is welcome to attend.