

IMPACT OF ENERGY FLUCTUATION ON PERMEATE QUALITY IN AUTONOMOUS AND DIRECTLY COUPLED RENEWABLE ENERGY POWERED NANOFILTRATION AND REVERSE OSMOSIS SYSTEMS

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Autonomous membrane systems provide a unique opportunity to overcome challenges of lacking or dysfunctional water supply, sewage and electricity infrastructure which is the case in many rural areas worldwide¹. Membrane technology provides a unique advantage where water is available yet through predominantly dissolved contaminants such as TDS, fluoride, arsenic, uranium, nitrate and many other inorganic as well as organic contaminants not usable. Coupling membrane processes directly to renewable energies such as wind or photovoltaics is important to realise robust and decentralised systems for remote areas. However this poses particular challenges in terms of system operation, maintenance, as well as water quality².

Following several years of laboratory studies as well as field work with real waters the impact of such fluctuation has been studied for short term operation with a unique system^{3,4}. To do so, the nature of fluctuations for both wind and solar resources was investigated to understand the impact on the membrane system^{5,6}. This information was then transferred into suitable experimental protocols to study the amplitude, frequency and intermittency of fluctuations in a systematic manner⁷. In the process the resulting operation – and the safe operating window – was determined as a function of minimum power requirements². Short term energy buffering was investigated via super-capacitor banks⁸.

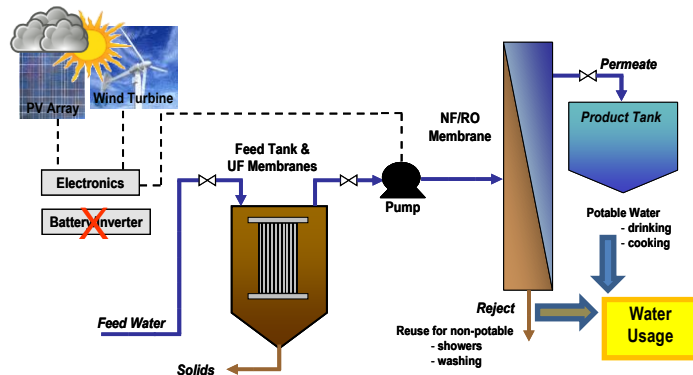


Figure 1 Directly-coupled wind/solar submerged UF-NF/RO system

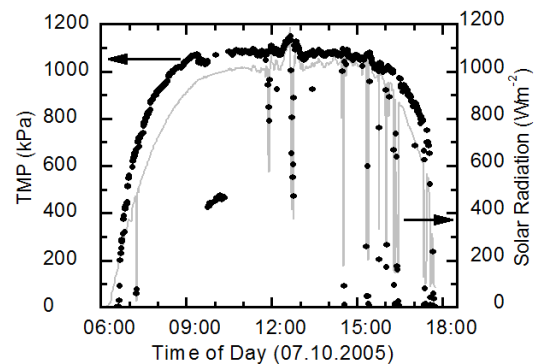


Figure 2 System pressure fluctuation with solar irradiance

In terms of water quality, the results with both synthetic as well as real waters indicate for a variety of dissolved species that the contaminants that are retained by size exclusion are unaffected by the fluctuation⁹. Contaminants that are retained by other processes respond to the altered conditions in the boundary layer due to the variation of pressure and flow with the fluctuating power supply. This variability may result in increased permeate concentration which negatively correlates with permeate quantity. This variation is indeed negligible in the cumulative water quality even during the treatment of highly saline or fluoride contaminated waters.

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