Potable water from wastewater and beyond

Bart Van der Bruggen

Department of Chemical Engineering, KU Leuven, Belgium
W. de Croylaan 46, B-3001 Leuven, Belgium
Tel. +32 16 322340
Fax +32 16 322991
bart.vanderbruggen@cit.kuleuven.be

The Holy Grail of water technology is a full recycle of all wastewater as potable water (or water of a similar quality) after treatment by enhanced separation. Traditional wastewater treatment systems, mainly based on activated sludge treatment, have a high water loss through the sludge produced, generate a large volume of secondary waste and have insufficient quality of the product water. Newer technologies – often based on membranes – may be of help in increasing the water recovery. However, those membrane processes that yield a good water quality (typically better than with traditional processes) in fact suffer intrinsically from low water recoveries. Reverse osmosis, for example, might result in a loss of 50% of water. This depends on the kind of feedwater, but using wastewater a high water recovery is difficult because of the risk of membrane fouling. Thus, combined or hybrid solutions are needed. This presentation will describe three potential approaches based on membranes:

1. to use extensive pretreatment prior to membrane filtration, so that suspected foulants and scalants are removed in advance. It is postulated that pretreatment of reverse osmosis or nanofiltration systems alone is not sufficient to come to a zero liquid discharge (or full recovery) system, although increased water recoveries are technically feasible.

2. to develop hybrid systems making use of classical processes, adjusted by membrane separations to allow a full recycle of reject water in a closed system. A logical alternative is to further treat concentrate streams resulting from membrane purification by classical processes. Comparative research on pellet softening, rapid filtration, RO, brine concentrators and evaporation ponds to achieve zero liquid discharge concluded that a good practice for scalants removal might be the use of a pellet reactor, which is an efficient and cost-effective method [1]. In addition, it might be needed to use an additional separation process to allow a full recycle of the concentrate. Electrodialysis is a good candidate for this [2]. For remediation of organic foulants, advanced oxidation and adsorption are the most described technologies. Organic pollutants in reverse osmosis (RO) concentrates from wastewater reclamation are mainly comprised of low molecular weight biorefractory compounds; oxidation, adsorption and microfiltration can be used to effectively remove them [3].

3. to develop integrated membrane processes resulting in a full recovery of not only water, but also other water constituents. This requires enhanced fractionation, which is difficult with classical processes, although some of the side products could have (some) value, such as the pellets, which can be used in e.g., agriculture. Fractionation using membrane processes is
challenging as well, but is important in view of a shift from ‘zero liquid discharge’ to ‘zero discharge’ (in which the ‘zero’ is usually to be read as ‘nearly zero’). A possible scheme for zero discharge for wastewater from a textile company is shown in Figure 1 [4].

![Figure 1: Scheme for integrated wastewater treatment in the textile industry following the ‘zero discharge’ approach [4] (MF: microfiltration, MC: Membrane crystallizer, NF : nanofiltration, MD : membrane distillation)](image)

Here, recycled water is only one of the resulting streams from the wastewater. Other processes involved in the fractionation produce salts (which can be directly reused in dye baths, in this case), and energy. This could be further extended towards, for example, nutrient recovery (mainly phosphates, in a configuration inspired by Figure 1), or even chemicals when the organic fraction is used for further reaction by, e.g., pyrolysis.

References