

# CONTROLLING HAZARDOUS CHEMICAL COMPOUNDS BY NANOFILTRATION/REVERSE OSMOSIS IN WATER AND WASTEWATER TREATMENT

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## INTRODUCTION

This research identifies the removal mechanisms of a wide range of low concentration volatile and semi-volatile organics which are of industrial and environmental significance found in ground waters and other water resources for drinking water purpose as well as in highly contaminated leachate from solid waste disposal posing a danger to human health and the aquatics by nanofiltration/reverse osmosis. Forty solutes which could be carcinogenic and/or endocrine disrupting chemicals were used for experiments. The VOCs include low molecular weight priority pollutants such as toluene and trichloroethylene, etc. and SVOCs including plastic additives like alkyl phenol, bisphenol A, phthalate acid esters, phosphoric acid esters and others and natural hormones like 17 $\beta$  estradiol, etc. Performance were obtained for ten different membranes using a laboratory test cell with simulated raw water containing these pollutants in low-pressure nanofiltration(NF) process ranging from 0.1 MPa to 0.3 MPa.

## REJECTION OF HAZARDOUS COMPOUNDS BY NANOFILTRATION

In establishing the retention pattern and characteristic of solutes, investigation was made using solute sizes and properties. The conventional molecular weight was deficient in explaining many cases of solute retention. Retention was considered as a function of size related characteristics (calculated molecular radius and width and the Stokes radius) and solute interaction with membrane material. Molecular sizes were computed for these solutes for their molecular widths and lengths. Of the four methods of sizes were used, the molecular width gave the highest accuracy of prediction of retention from the solute sizes. The molecular width was the dominant single descriptor of retention by size exclusion and a better parameter than the molecular weight. The molecular width concept explained the fact that solutes with branched atomic configuration (like the phosphoric acid esters) were rejected more than other solutes. The experiments indicated almost complete removal of the SVOCs by the tight NF membranes, while the retention obtained by the loose membranes was dependent on solute species. Compounds with flat shaped structure like 2-H-Bezothiazol and dimethyl

phthalate were more permeable than other target solutes within the same molecular size range. The pattern of retention noticeably varied for each membrane depending on the solute type. The retentions of most VOCs were lower than the chloride retention by the membranes. Retention of solutes were significantly higher by the tighter membranes than by the loose membranes. Transmembrane pressure experiments showed that at 0.1 MPa, volume flux decrease with a corresponding decrease in solute retention but the reverse was the case at 0.3 MPa. Retention increased slightly with the increase in applied pressure and in good agreement with model predictions. This increase is attributed to the higher permeate flux obtained as applied pressure increased resulting in lower solute concentration in the permeated water. Retention was dependent on membrane type and solute size though other factors such as by solute-membranes effectively retained virtually all of the semi-volatile compounds at greater than 90% but not the volatile organic compounds. The low desalting membrane UTC60, rejected most of the VOCs at lower than 20%.

### **REJECTION MECHANISMS**

The size configurations of molecules have been identified to greatly influence the permeation or retention, yet the size parameter was thought to be incomplete as a single parameter in describing retention of organic solutes. Membrane retention is not simply a filtration process. In establishing a basis for this and to enhance further the description of the retention for organic solutes, correlation incorporating the sieving mechanism and the solute-membrane interaction parameter was considered. A combination of molecular width, length and logarithm of octanol-water coefficient partition coefficient ( $K_{ow}$ ) demonstrating the solute-membrane interaction gave the best description of solute retention by membranes. Multi-linear regression analysis with parameters showed that more hydrophilic solute molecules with a smaller width and length will easily pass through the membrane. Comparisons were made of retention correlated with size parameters. Further experiments were conducted to evaluate the extent of membrane damage due to long-term use. The results from these experiments reveal a large decline in flux for membrane immersed in activated sludge. Generally retention pattern in many cases were unchanged.