[19] Broom, G. P., Squires, R. C., Simpson, M. P. J. & Martin, I. (1994). The treatment of heavy metal effluents by crossflow microfiltration. *Journal of Membrane Science*, *87*, 219-230.
[20] California Department of Public Health, (2006) A brief history of NDMA findings in drinking water, Retrieved March 17, 2009 from http://www.cdph.ca.gov/certlic/drinkingwater/Pages/NDMAhistory.aspx.
[21] Cartinella, J. L., Cath, T. Y., Flynn, M. T., Miller, G. C., Hunter, K. W. & Childress, A. E. (2006). Removal of natural steroid hormones from wastewater using membrane contactor processes. *Environmental Science & Technology*, *40*, 7381-7386.
[22] Chang, S., Waite, T. D., Ong, P. E. A., Schäfer, A. I. & Fane, A. G. (2004). Assessment of trace estrogenic contaminants removal by coagulant addition, powdered activated carbon adsorption and powdered activated carbon/microfiltration processes. *Journal of Environmental Engineering*, *130*, 736-742.
[23] Chang, S., Waite, T. D., Schafer, A. I. & Fane, A. G. (2003). Adsorption of the endocrine-active compound estrone on microfiltration hollow fiber membranes. *Environmental Science & Technology*, *37*, 3158-3163.
[24] Chian, E. S. K., Bruce, W. N. & Fang, H. H. P. (1975). Removal of pesticides by reverse osmosis. *Environmental Science & Technology*, *9*, 52-59.
[25] Childress, A. E. & Elimelech, M. (1996). Effect of solution chemistry on the surface charge of polymeric reverse osmosis and nanofiltration membranes. *Journal of Membrane Science*, *119*, 253-268.
[26] Choo, K. H., Kwon, D. J., Lee, K. W. & Choi, S. J. (2002). Selective removal of cobalt species using nanofiltration membranes. *Environmental Science and Technology*, *36*, 1330-1336.
[27] Clara, M., Strenn, B., Gans, O., Martinez, E., Kreuzinger, N. & Kroiss, H. (2005). Removal of selected pharmaceuticals, fragrances and endocrine disrupting compounds in a membrane bioreactor and conventional wastewater treatment plants. *Water Research*, *39*, 4797-4807.
[28] Comerton, A. M., Andrews, R. C., Bagley, D. M. & Hao, C. (2008). The rejection of endocrine disrupting and pharmaceutically active compounds by NF and RO membranes as a function of compound and water matrix properties. *Journal of Membrane Science*, *313*, 323-335.
[29] Comerton, A. M., Andrews, R. C., Bagley, D. M. & Yang, P. (2007). Membrane adsorption of endocrine disrupting compounds and pharmaceutically active compounds. *Journal of Membrane Science*, *303*, 267-277.
[30] Couffin, N., Cabassud, C. & Lahoussine-Turcaud, V. (1998). A new process to remove halogenated VOCs for drinking water production: vacuum membrane distillation. *Desalination*, *117*, 233-245.
[31] Cyna, B., Chagneau, G., Bablon, G. & Tanghe, N. (2002). Two years of nanofiltration at the Méry-sur-Oise plant, France. *Desalination*, *147*, 69-75.
[32] Davis, T. A., Volesky, B. & Mucci, A. (2003). A review of the biochemistry of heavy metal biosorption by brown algae. *Water Research*, *37*, 4311-4330.
[33] de Pinho, M. N., Semião, V. & Geraldes, V. (2002). Integrated modeling of transport processes in fluid/nanofiltration membrane systems. *Journal of Membrane Science*, *206*, 189-200.
[34] Devitt, E. C., Ducellier, P. C., Cote, P. & Wiesner, M. R. (1998). Effects of natural organic matter and the raw water matrix on the rejection of atrazine by pressure-driven membranes. *Water Research*, *32*, 2563-2568.
[35] Ducom, G. & Cabassud, C. (1999). Interests and limitations of nanofiltration for the removal of volatile organic compounds in drinking water production. *Desalination*, *124*, 115-123.
[36] Elimelech, M., Chen, W. H. & Waypa, J. J. (1994). Measuring the zeta (electrokinetic) potential of reverse osmosis membranes by a streaming potential analyzer. *Desalination*, *95*, 269-286.
[37] Escher, B. I., Pronk, W., Suter, M. J. F. & Maurer, M. (2006). Monitoring the removal efficiency of pharmaceuticals and hormones in different treatment processes of source-separated urine with bioassays. *Environmental Science & Technology*, *40*, 5095-5101.
[38] Fatin-Rouge, N., Dupont, A., Vidonne, A., Dejeu, J., Fievet, P. & Foissy, A. (2006). Removal of some divalent cations from water by membrane-filtration assisted with alginate. *Water Research*, *40*, 1303-1309.
[39] Favre-Reguillon, A., Lebuzit, G., Foos, J., Guy, A., Draye, M. & Lemaire, M. (2003). Selective concentration of uranium from seawater by nanofiltration. *Industrial & Engineering Chemistry Research*, *42*, 5900-5904.
[40] Favre-Reguillon, A., Lebuzit, G., Murat, D., Foos, J., Mansour, C. & Draye, M. (2008). Selective removal of dissolved uranium in drinking water by nanofiltration. *Water Research*, *42*, 1160-1166.
[41] Gaid, A., Bablon, G., Turner, G., Franchet, J. & Christophe Protais, J. (1998). Performance of 3 years operation of nanofiltration plants. *Desalination*, *117*, 149-158.
[42] Gallenkemper, M., Wintgens, T. & Melin, T. (2003). Nanofiltration of endocrine disrupting compounds. *Water Science and Technology: Water Supply*, *3*, 321-327.
[43] Geraldes, V., Semiao, V. & Norberta de Pinho, M. (2002). The effect on mass transfer of momentum and concentration boundary layers at the entrance region of a slit with a nanofiltration membrane wall. *Chemical Engineering Science*, *57*, 735-748.
[44] Göbel, A., McArdell, C. S., Joss, A., Siegrist, H. & Giger, W. (2007). Fate of sulfonamides, macrolides, and trimethoprim in different wastewater treatment technologies. *Science Of The Total Environment*, *372*, 361-371.
[45] Goss, K. & Schwarzenbach, P. (2003). Rules of thumb for assessing equilibrium partitioning of organic compounds: successes and pitfalls. *Journal of Chemical Education*, *80*, 450-455.
[46] Green, T. A., Roy, S. & Scott, K. (2001). Recovery of metal ions from spent solutions used to electrodeposit magnetic materials. *Separation and Purification Technology*, *22-23*, 583-590.

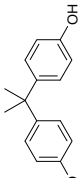
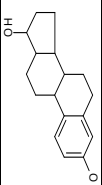
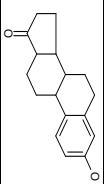
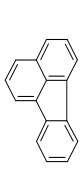
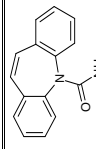
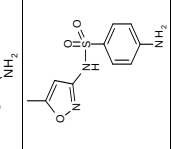
[47] Groundwater Replenishment System, (2004) Orange County's historic water factory 21 stops producing highly purified water, Retrieved March 17, 2009 from http://www.gwrsystem.com/news/releases/040121.html.
[48] Hansch, C., Leo, A. & Hoekman, D. (1995). *Exploring QSAR: hydrophobic, electronic, and steric constants*. Washington, DC.: American Chemical Society.
[49] Haslam, E. (1996). Natural polyphenols (vegetable tannins) as drugs: possible modes of action. *Journal of Natural Products*, *59*, 205-215.
[50] Heberer, T. (2002). Tracking persistent pharmaceutical residues from municipal sewage to drinking water. *Journal of Hydrology*, *266*, 175-189.
[51] Heijman, S. G. J., Verleifde, A. R. D., Cornelissen, E. R., Amy, G. & van Dijk, J. C. (2007). Influence of natural organic matter (NOM) fouling on the removal of pharmaceuticals by nanofiltration and activated carbon filtration. *Water Science and Technology: Water Supply*, *7*, 17-23.
[52] Higuchi, A., Yoon, B.-O., Asano, T., Nakaegawa, K., Miki, S., Hara, M., He, Z. & Pinnau, I. (2002). Separation of endocrine disruptors from aqueous solutions by pervaporation. *Journal of Membrane Science*, *198*, 311-320.
[53] Higuchi, A., Yoon, B. O., Kaneko, T., Hara, M., Maekawa, M. & Nohmi, T. (2004). Separation of endocrine disruptors from aqueous solutions by pervaporation: dioctylphthalate and butylated hydroxytoluene in mineral water. *Journal of Applied Polymer Science*, *94*, 1737-1742.
[54] Hu, J. Y., Chen, X., Tao, G. & Kekred, K. (2007). Fate of endocrine disrupting compounds in membrane bioreactor systems. *Environmental Science & Technology*, *41*, 4097-4102.
[55] Hu, J. Y., Jin, X. & Ong, S. L. (2007). Rejection of estrone by nanofiltration: Influence of solution chemistry. *Journal of Membrane Science*, *302*, 188-196.
[56] Jin, X., Hu, J. & Ong, S. L. (2007). Influence of dissolved organic matter on estrone removal by NF membranes and the role of their structures. *Water Research*, *41*, 3077-3088.
[57] Johnson, A. C. & Sumpter, J. P. (2001). Removal of endocrine-disrupting chemicals in activated sludge treatment works. *Environmental Science & Technology*, *35*, 4697-4703.
[58] Joss, A., Andersen, H., Ternes, T., Richle, P. R. & Siegrist, H. (2004). Removal of estrogens in municipal wastewater treatment under aerobic and anaerobic conditions: consequences for plant optimization. *Environmental Science & Technology*, *38*, 3047-3055.
[59] Joss, A., Keller, E., Alder, A. C., Göbel, A., McArdell, C. S., Ternes, T. & Siegrist, H. (2005). Removal of pharmaceuticals and fragrances in biological wastewater treatment. *Water Research*, *39*, 3139-3152.
[60] Joss, A., Zabczynski, S., Göbel, A., Hoffmann, B., Löffler, D., McArdell, C. S., Ternes, T. A., Thomsen, A. & Siegrist, H. (2006). Biological degradation of pharmaceuticals in municipal wastewater treatment: Proposing a classification scheme. *Water Research*, *40*, 1686-1696.
[61] Khan, S. J., Wintgens, T., Sherman, P., Zaricky, J. & Schafer, A. I. (2004). Removal of hormones and pharmaceuticals in the advanced water recycling demonstration plant in Queensland, Australia. *Water Science and Technology*, *50*, 15-22.
[62] Kim, S. D., Cho, J., Kim, I. S., Vanderford, B. J. & Snyder, S. A. (2007). Occurrence and removal of pharmaceuticals and endocrine disruptors in South Korean surface, drinking, and waste waters. *Water Research*, *41*, 1013-1021.
[63] Kimura, K., Amy, G., Drewes, J. & Watanabe, Y. (2003). Adsorption of hydrophobic compounds onto NF/RO membranes: an artifact leading to overestimation of rejection. *Journal of Membrane Science*, *221*, 89-101.
[64] Kimura, K., Amy, G., Drewes, J. E., Heberer, T., Kim, T.-U. & Watanabe, Y. (2003). Rejection of organic micropollutants (disinfection by-products, endocrine disrupting compounds, and pharmaceutically active compounds) by NF/RO membranes. *Journal of Membrane Science*, *227*, 113-121.
[65] Kimura, K., Toshima, S., Amy, G. & Watanabe, Y. (2004). Rejection of neutral endocrine disrupting compounds (EDCs) and pharmaceutical active compounds (PhACs) by RO membranes. *Journal of Membrane Science*, *245*, 71-78.
[66] Kiso, Y., Nishimura, Y., Kitao, T. & Nishimura, K. (2000). Rejection properties of non-phenylic pesticides with nanofiltration membranes. *Journal of Membrane Science*, *171*, 229-237.
[67] Kolpin, D. W., Furlong, E. T., Meyer, M. T., Thurman, E. M., Zaugg, S. D., Barber, L. B. & Buxton, H. T. (2002). Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999-2000: A national reconnaissance. *Environmental Science & Technology*, *36*, 1202-1211.
[68] Körner, W., Bolz, U., Süßmuth, W., Hiller, G., Schuller, W., Hanf, V. & Hagenmaier, H. (2000). Input/output balance of estrogenic active compounds in a major municipal sewage plant in Germany. *Chemosphere*, *40*, 1131-1142.
[69] Kosutic, K., Dolar, D., Asperger, D. & Kunst, B. (2007). Removal of antibiotics from a model wastewater by RO/NF membranes. *Separation and Purification Technology*, *53*, 244-249.
[70] Koyuncu, I., Arikan, O. A., Wiesner, M. R. & Rice, C. (2008). Removal of hormones and antibiotics by nanofiltration membranes. *Journal of Membrane Science*, *309*, 94-101.
[71] Kryvoruchko, A. P., Yurlova, L. Y., Atamanenko, I. D. & Kornilovich, B. Y. (2004). Ultrafiltration removal of U(VI) from contaminated water. *Desalination*, *162*, 229-236.
[72] Kubli-Garfias, C. (1998). Comparative study of the electronic structure of estradiol, epiestradiol and estrone by ab initio theory. *Journal of Molecular Structure: THEOCHEM*, *452*, 175-183.

[73] Kuster, M., José López de Alda, M. & Barceló, D. (2004). Analysis and distribution of estrogens and progestogens in sewage sludge, soils and sediments. *Trends in Analytical Chemistry*, *23*, 790-798.
[74] Kwon, J. H., Liljestrand, H. & Katz, L. E. (2006). Partitioning of moderately hydrophobic endocrine disruptors between water and synthetic membrane vesicles. *Environmental Toxicology and Chemistry*, *25*, 1984-1992.
[75] Lambert, J., Avila-Rodriguez, M., Durand, G. & Rakib, M. (2006). Separation of sodium ions from trivalent chromium by electrodialysis using monovalent cation selective membranes. *Journal of Membrane Science*, *280*, 219-225.
[76] Lyko, S., Wintgens, T. & Melin, T. (2005). Estrogenic trace contaminants in wastewater - possibilities of membrane bioreactor technology. *Desalination*, *178*, 95-105.
[77] Manem, J. & Sanderson, R. (1996). Membrane bioreactors. In J. Malleviale, P. E. Odendaal and M. R. Wiesner (Eds.), *Water Treatment Membrane Processes*, (pp. 17.1-17.31). New York: McGraw-Hill.
[78] Marder, L., Bernardes, A. M. & Zoppas Ferreira, J. (2004). Cadmium electroplating wastewater treatment using a laboratory-scale electrodialysis system. *Separation and Purification Technology*, *37*, 247-255.
[79] Marder, L., Sulzbach, G. O., Bernardes, A. M. & Ferreira, J. Z. (2003). Removal of cadmium and cyanide from aqueous solutions through electrodialysis. *Journal of the Brazilian Chemical Society*, *14*, 610-615.
[80] McCallum, E. A., Hyung, H., Do, T. A., Huang, C.-H. & Kim, J.-H. (2008). Adsorption, desorption, and steady-state removal of 17β-estradiol by nanofiltration membranes. *Journal of Membrane Science*, *319*, 38-43.
[81] Melin, T., Jefferson, B., Bixio, D., Thoeye, C., De Wilde, W., De Koning, J., van der Graaf, J. & Wintgens, T. (2006). Membrane bioreactor technology for wastewater treatment and reuse. *Desalination*, *187*, 271-282.
[82] Mitch, W. A., Gerecke, A. C. & Sedlak, D. L. (2003). A N-Nitrosodimethylamine (NDMA) precursor analysis for chlorination of water and wastewater. *Water Research*, *37*, 3733-3741.
[83] Mitch, W. A., Sharp, J. O., Trussel, R. R., Valentine, R. L., Alvarez-Cohen, L. & Sedlak, D. L. (2003). N-Nitrosodimethylamine (NDMA) as a drinking water contaminant: a review. *Environmental Engineering Science*, *20*, 389-404.
[84] Mulder, M. (1996). *Basic principles of membrane technology*. Dordrecht: Kluwer Academic Publishers.
[85] Neale, P. A., Escher, B. I. & Schäfer, A. I. (2008). Quantification of solute-solute interactions using negligible-depletion solid-phase microextraction: measuring the affinity of estradiol to bulk organic matter. *Environmental Science & Technology*, *42*, 2886-2892.
[86] Neale, P. A. & Schäfer, A. I. (2009). The influence of pH on losses of analyte estradiol in sample pre-filtration. *Environmental Engineering Science*, (*in press*) DOI:10.1089/ees.2008.0291.
[87] Ng, H. Y. & Elimelech, M. (2004). Influence of colloidal fouling on rejection of trace organic contaminants by reverse osmosis. *Journal of Membrane Science*, *244*, 215.
[88] Nghiem, L. D. (2005) Removal of emerging trace organic contaminants by nanofiltration and reverse osmosis. PhD, University of Wollongong.
[89] Nghiem, L. D. & Coleman, P. J. (2008). NF/RO filtration of the hydrophobic ionogenic compound triclosan: Transport mechanisms and the influence of membrane fouling. *Separation and Purification Technology*, *62*, 709-716.
[90] Nghiem, L. D. & Hawkes, S. (2007). Effects of membrane fouling on the nanofiltration of pharmaceutically active compounds (PhACs): Mechanisms and role of membrane pore size. *Separation and Purification Technology*, *57*, 176-184.
[91] Nghiem, L. D., Manis, A., Soldenhoff, K. & Schäfer, A. I. (2004). Estrogenic hormone removal from wastewater using NF/RO membranes. *Journal of Membrane Science*, *242*, 37-45.
[92] Nghiem, L. D. & Schäfer, A. I. (2006). Critical risk points of nanofiltration and reverse osmosis processes in water recycling applications. *Desalination*, *187*, 303-312.
[93] Nghiem, L. D., Schäfer, A. I. & Elimelech, M. (2005). Nanofiltration of hormone mimicking trace organic contaminants. *Separation Science and Technology*, *40*, 2633-2649.
[94] Nghiem, L. D., Schäfer, A. I. & Elimelech, M. (2005). Pharmaceutical retention mechanisms by nanofiltration membranes. *Environmental Science & Technology*, *39*, 7698-7705.
[95] Nghiem, L. D., Schäfer, A. I. & Elimelech, M. (2006). Role of electrostatic interactions in the retention of pharmaceutically active contaminants by a loose nanofiltration membrane. *Journal of Membrane Science*, *286*, 52-59.
[96] Nghiem, L. D., Schäfer, A. I. & Waite, T. D. (2002). Adsorption of estrone on nanofiltration and reverse osmosis membranes in water and wastewater treatment. *Water Science & Technology*, *46*, 265-272.
[97] Nghiem, L. D., Vogel, D. & Khan, S. (2008). Characterising humic acid fouling of nanofiltration membranes using bisphenol A as a molecular indicator. *Water Research*, *42*, 4049-4058.
[98] Nguyen, T. Q. & Nobe, K. (1987). Extraction of organic contaminants in aqueous solutions by pervaporation. *Journal of Membrane Science*, *30*, 11-22.
[99] Oh, J. I., Urase, T., Kitawaki, H., Rahman, M. M., Rahman, M. H. & Yamamoto, K. (2000). Modeling of arsenic rejection considering affinity and steric hindrance effect in nanofiltration membranes. *Water Science & Technology*, *42*, 173-180.
[100] Orange County Water District - Groundwater Authority, (2002) Orange County Water District takes a proactive stance on contaminants of concern, Retrieved March 17, 2009 from http://www.ocwd.com/_html/_pr/_pr02/pr02_0129_dioxane.htm.
[101] Orange County Water District, (2007) OCWD set to build advanced water quality assurance laboratory, Retrieved March 17, 2009 from http://www.ocwd.com/fv-98.aspx.

[102] Piccolo, A. (1994). Interactions between organic pollutants and humic substances in the environment. In N. Senesi and T. M. Miano (Eds.), *Humic substances in the global environment and implications on human health*, (pp. 961-979). Amsterdam: Elsevier.
[103] Plakas, K. V., Karabelas, A. J., Wintgens, T. & Melin, T. (2006). A study of selected herbicides retention by nanofiltration membranes - the role of organic fouling. *Journal of Membrane Science*, *284*, 291-300.
[104] Plumlee, M. H., López-Mesas, M., Heidlberger, A., Ishida, K. P. & Reinhard, M. (2008). N-nitrosodimethylamine (NDMA) removal by reverse osmosis and UV treatment and analysis via LC-MS/MS. *Water Research*, *42*, 347-355.
[105] Pronk, W., Biebow, M. & Boller, M. (2006). Electrodialysis for recovering salts from a urine solution containing micropollutants. *Environmental Science & Technology*, *40*, 2414-2420.
[106] Pronk, W., Palmquist, H., Biebow, M. & Boller, M. (2006). Nanofiltration for the separation of pharmaceuticals from nutrients in source-separated urine. *Water Research*, *40*, 1405-1412.
[107] Pronk, W., Zuleeg, S., Lienert, J., Escher, B. I., Koller, M., Berner, A., Koch, G. & Boller, M. (2007). Pilot experiments with electrodialysis and ozonation for the production of a fertiliser from urine. *Water Science & Technology*, *56*, 219-227.
[108] Rabiet, M., Togola, A., Brissaud, F., Seidel, J.-L., Budzinski, H. & Elbaz-Poulichet, F. (2006). Consequences of treated water recycling as regards pharmaceuticals and drugs in surface and ground waters of a medium-sized mediterranean catchment. *Environmental Science & Technology*, *40*, 5282-5288.
[109] Radjenovic, J., Petrovic, M. & Barcelo, D. (2007). Analysis of pharmaceuticals in wastewater and removal using a membrane bioreactor. *Analytical And Bioanalytical Chemistry*, *387*, 1365-1377.
[110] Radjenovic, J., Petrovic, M., Ventura, F. & Barceló, D. (2008). Rejection of pharmaceuticals in nanofiltration and reverse osmosis membrane drinking water treatment. *Water Research*, *42*, 3601-3610.
[111] Raff, O. & Wilken, R.-D. (1999). Removal of dissolved uranium by nanofiltration. *Desalination*, *122*, 147-150.
[112] Rosa, M. J. & de Pinho, M. N. (1995). The role of ultrafiltration and nanofiltration on the minimisation of the environmental impact of bleached pulp effluents. *Journal of Membrane Science*, *102*, 155-161.
[113] Safe, S. H. (2000). Endocrine disruptors and human health: is there a problem? An update. *Environmental Health Perspectives*, *108*, 487-493.
[114] Sanli, O. & Asman, G. (2000). Removal of Fe (III) ions from dilute aqueous solutions by alginic acid-enhanced ultrafiltration. *Journal of Applied Polymer Science*, *77*, 1096-1101.
[115] Schäfer, A. I. (2001). *Natural organic matter removal using membranes: principles, performance and cost*. Boca Raton: CRC Press.
[116] Schäfer, A. I., Fane, A. G. & Waite, T. D. (Eds.) (2005). Oxford: Elsevier.
[117] Schäfer, A. I., Mastrup, M. & Jensen, R. L. (2002). Particle interactions and removal of trace contaminants from water and wastewaters. *Desalination*, *147*, 243-250.
[118] Schäfer, A. I., Nghiem, L. D. & Oschmann, N. (2006). Bisphenol A retention in the direct ultrafiltration of greywater. *Journal of Membrane Science*, *283*, 233-243.
[119] Schäfer, A. I., Nghiem, L. D. & Waite, T. D. (2003). Removal of the natural hormone estrone from aqueous solutions using nanofiltration and reverse osmosis. *Environmental Science & Technology*, *37*, 182-188.
[120] Schultz, M. M. & Furlong, E. T. (2008). Trace analysis of antidepressant pharmaceuticals and their select degradates in aquatic matrixes by LC/ESI/MS/MS. *Analytical Chemistry*, *80*, 1756-1762.
[121] Seah, H., Poon, J., Leslie, G. & Law, I. B. (2003). Singapore's NEWater demonstration project - another milestone in indirect potable reuse. *Water*, 43-46.
[122] Seidel, A., Waypa, J. J. & Elimelech, M. (2001). Role of charge (Donnan) exclusion in removal of arsenic from water by a negatively charged porous nanofiltration membrane. *Environmental Engineering Science*, *18*, 105-113.
[123] Sindicat des Eaux d'Ile de France, (2007) Bilan de la qualité des eaux brutes, produites et distribuées en 2007, Retrieved March 17, 2009 from http://www.sedif.com/le_sedif/iso_album/bilan_qualite_des_eaux_2007.pdf.
[124] Sindicat des Eaux d'Ile de France, (2007) Rapport annuel, Retrieved March 17, 2009 from http://www.sedif.com/le_sedif/iso_album/sedif_rap_annuel_2007.pdf.
[125] Singapore Public Utilities Board, P., (2002) Singapore water reclamation study - expert panel review and findings, Retrieved March 17, 2009 from http://www.pub.gov.sg/newater/AboutNEWater/Documents/review.pdf.
[126] Strathmann, H. (2004). *Ion exchange membrane separation processes*. Amsterdam: Elsevier.
[127] Teng, Z., Yuan Huang, J., Fujita, K. & Takizawa, S. (2001). Manganese removal by hollow fiber micro-filter. Membrane separation for drinking water. *Desalination*, *139*, 411-418.
[128] Ternes, T. A. & Joss, A. (Eds.) (2006). London: IWA.
[129] Tortajada, C. (2006). Water Management in Singapore. *Water Resources Development*, *22*, 227-240.
[130] Turek, M., Dydo, P., Trojanowska, J. & Bandura, B. (2007). Electrodialytic treatment of boron-containing wastewater. *Desalination*, *205*, 185-191.
[131] Tyler, C. R., Jobling, S. & Sumpter, J. P. (1998). Endocrine disruption in wildlife: a critical review of the evidence. *Critical Reviews in Toxicology*, *28*, 319-361.
[132] Uludag, Y., Özbelge, H. Ö. & Yilmaz, L. (1997). Removal of mercury from aqueous solutions via polymer-enhanced ultrafiltration. *Journal of Membrane Science*, *129*, 93-99.

[133] Urkiaga, A., Bolaño, N. & De Las Fuentes, L. (2002). Removal of micropollutants in aqueous streams by organophilic pervaporation. *Desalination*, *149*, 55-60.
[134] Van der Bruggen, B., Milis, R., Vandecasteele, C., Bielen, P., Van San, E. & Huysman, K. (2003). Electrodialysis and nanofiltration of surface water for subsequent use as infiltration water. *Water Research*, *37*, 3867-3874.
[135] Van der Bruggen, B., Schaep, J., Maes, W., Wilms, D. & Vandecasteele, C. (1998). Nanofiltration as a treatment method for the removal of pesticides from groundwaters. *Desalination*, *117*, 139-147.
[136] Van der Bruggen, B., Schaep, J., Wilms, D. & Vandecasteele, C. (1999). Influence of molecular size, polarity and charge on the retention of organic molecules by nanofiltration. *Journal of Membrane Science*, *156*, 29-41.
[137] Ventresque, C., Gisclon, V., Bablon, G. & Chagneau, G. (2000). An outstanding feat of modern technology: the Méry-sur-Oise nanofiltration Treatment plant (340,000 m3/d). *Desalination*, *131*, 1-16.
[138] Weber, S., Gallenkemper, M., Melin, T., Dott, W. & Hollender, J. (2004). Efficiency of nanofiltration for the elimination of steroids from water. *Water Science and Technology*, *50*, 9–14.
[139] Weston, D. P., You, J. & Lydy, M. J. (2004). Distribution and toxicity of sediment-associated pesticides in agriculture-dominated water bodies of California's Central Valley. *Environmental Science & Technology*, *38*, 2752-2759.
[140] Wilf, M., Hydranautics, a Nitto Denko Corporation. (1998) Advanced membrane technology for water reclamation, Retrieved 17-03-2009 from http://www.membranes.com/docs/papers/18_watertech.pdf.
[141] Williams, M. E., Hestekin, J. A., Smothers, C. N. & Bhattacharyya, D. (1999). Separation of organic pollutants by reverse osmosis and nanofiltration membranes: mathematical models and experimental verification. *Industrial & Engineering Chemistry Research*, *38*, 3683-3695.
[142] Williams, R. J., Johnson, A. C., Smith, J. J. L. & Kanda, R. (2003). Steroid estrogens profiles along river stretches arising from sewage treatment works discharges. *Environmental Science & Technology*, *37*, 1744-1750.
[143] Wu, Y., Kong, Y., Liu, J., Zhang, J. & Xu, J. (1991). An experimental study on membrane distillation-crystallization for treating waste water in taurine production. *Desalination*, *80*, 235-242.
[144] Xu, P., Drewes, J. E., Bellona, C., Amy, G., Kim, T.-U., Adam, M. & Heberer, T. (2005). Rejection of emerging organic micropollutants in nanofiltration-reverse osmosis membrane applications. *Water Environment Research*, *77*, 40-48.
[145] Xu, P., Drewes, J. E., Kim, T.-U., Bellona, C. & Amy, G. (2006). Effect of membrane fouling on transport of organic contaminants in NF/RO membrane applications. *Journal of Membrane Science*, *279*, 165-175.
[146] Yoon, Y., Westerhoff, P., Snyder, S. A. & Wert, E. C. (2006). Nanofiltration and ultrafiltration of endocrine disrupting compounds, pharmaceuticals and personal care products. *Journal of Membrane Science*, *270*, 88-100.
[147] Yoon, Y., Westerhoff, P., Snyder, S. A., Wert, E. C. & Yoon, J. (2007). Removal of endocrine disrupting compounds and pharmaceuticals by nanofiltration and ultrafiltration membranes. *Desalination*, *202*, 16-23.
[148] Yoon, Y., Westerhoff, P., Yoon, J. & Snyder, S. A. (2004). Removal of 17β–estradiol and fluoranthene by nanofiltration and ultrafiltration. *Journal of Environmental Engineering*, *130*, 1460-1467.
[149] Younes, M. (1999). Specific issues in health risk assessment of endocrine disrupting chemicals and international activities. *Chemosphere*, *39*, 1253-1257.
[150] Yuan, W. & Zydney, A. L. (2000). Humic acid fouling during ultrafiltration. *Environmental Science and Technology*, *34*, 5043-5050.
[151] Zhang, Y., Causserand, C., Aimar, P. & Cravedi, J. P. (2006). Removal of bisphenol A by a nanofiltration membrane in view of drinking water production. *Water Research*, *40*, 3793-3799.
[152] Zolotarev, P. P., Ugrozov, V. V., Volkina, I. B. & Nikulin, V. M. (1994). Treatment of waste water for removing heavy metals by membrane distillation. *Journal of Hazardous Materials*, *37*, 77-82.
[153] Zuccato, E., Calamari, D., Natangelo, M. & Fanelli, R. (2000). Presence of therapeutic drugs in the environment. *The Lancet*, *355*, 1789-1790.

Table 1 – Selected xenobiotics chemical properties

Compound	Molecular Formula	CAS No.	Molecular Structure	Molecular weight (g/mol)	Solubility (mg/L)	pK_a	Log K_{ow}	Dipole moment (Debye)	H acceptor (A)/ donor (D) capacity of the compound[1]
Endocrine Disrupting Chemicals									
Bisphenol A (Endocrine Disruptor)	$C_{15}H_{16}O_2$	80-05-7		228	120 [a,b]	9.28 [c]	3.32 [d]	1 -1.4 [a,b,e]	2 strong D [OH]/2 weak A [π electrons]
Estradiol (Natural Steroidal Hormone)	$C_{18}H_{24}O_2$	50-28-2		272	3.6 -13 [b,f]	10.23 [c]	4.01 [g]	2.2 [h]	2 strong D [OH]/1 weak A [π electrons]
Estrone (Natural Steroidal Hormone)	$C_{18}H_{22}O_2$	53-16-7		270	13 -30 [f,i]	10.34 [c]	3.13 [g]	2.1 [h]	1strong D [OH]/1 strong and 1 weak A [=O, π electrons]
Fluoranthene (Polycyclic Aromatic Hydrocarbon)	$C_{16}H_{10}$	206-44-0		202.3	<1	NA	5.2 [j]	NA	3 weak A [π electrons]
Pharmaceuticals									
Carbamazepine (Antiepileptic)	$C_{15}H_{12}N_2O$	298-46-4		236	17.7 [b,k]	<1 [d]	2.45 [d]	3.2-3.6 [b,k]	1strong D [NH_2]/2 strong and 2 weak A [=O, N, 2 π electrons]
Sulfamethoxazole (Sulfonamide antibiotic)	$C_{10}H_{11}N_3O_3S$	723-46-6		253	600-610 [b,k]	1.8, 5.7 [d,k]	0.89 [b,d,k]	5.4 -6.3 [b,k]	2 strong D [NH, NH_2]/4 strong and 1 weak A [2 =O, N, O, π electrons]

[a] [93], [b] [65], [c] [74], [d] [128], [e] [88], [f] [91], [g] [48], [h] [72], [i] [119], [j] [148], [k] [94].

[1] The H acceptor and donor groups of the compound are identified in brackets [group]

Semião, A.J.C. ; Schäfer, A.I. (2010) Xenobiotics removal by membrane technology: An overview,
(In) Xenobiotics in the Urban Water Cycle: Mass Flows, Environmental Processes and Mitigation Strategies, Bester, K. ; Kümmerer, K. ; Fatta-Kassinos, D. (Eds)
Springer Environmental Book Series, Environmental Pollution, Vol. 16,
Springer, Hardcover, ISBN: 978-90-481-3508-0, 480 pp.

Table 2 - Membrane processes and contaminants dimensions (adapted from [6, 7, 77, 84, 115])

Particle size (μm)/Pore size (μm)	Ionic Range		Molecular Range		Macromolecular Range	Microparticle Range
	0.001		0.01	0.1	1	10
Molecular Weight (g/mol)	100	200	1000	100000	500000	
Solutes	Aqueous salt		Virus		Bacteria	
	Xenobiotics: metal ions		Protein			
			Microsolutes			
	Xenobiotics: pharmaceuticals, steroid hormones, personal care products, pesticides, etc.		Humic acids			
Membrane Separation Processes	Electrodialysis					
	Reverse osmosis			Membrane Distillation		
		Nanofiltration		Microfiltration		
	Pervaporation		Ultrafiltration			
				Membrane Bio-Reactor		

Figures

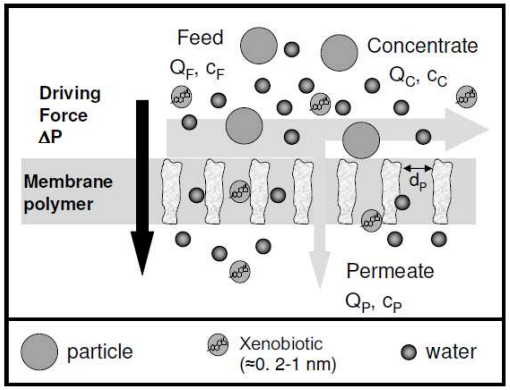


Figure 1 – Pressure-driven membrane schematic with pore size d_p (microfiltration, ultrafiltration, nanofiltration and reverse-osmosis)

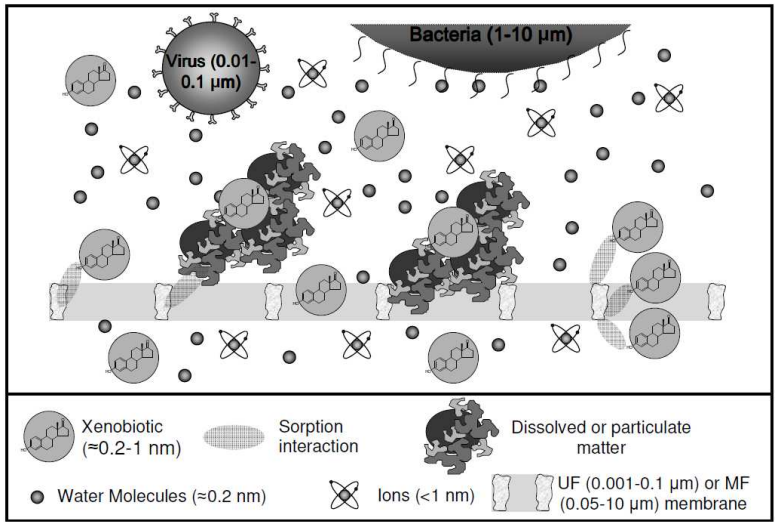


Figure 2 – Retention mechanisms by MF and UF membranes

Semião, A.J.C. ; Schäfer, A.I. (2010) Xenobiotics removal by membrane technology: An overview,
(In) Xenobiotics in the Urban Water Cycle: Mass Flows, Environmental Processes and Mitigation Strategies, Bester, K. ; Kümmerer, K. ; Fatta-Kassinos, D. (Eds)
Springer Environmental Book Series, Environmental Pollution, Vol. 16,
Springer, Hardcover, ISBN: 978-90-481-3508-0, 480 pp.

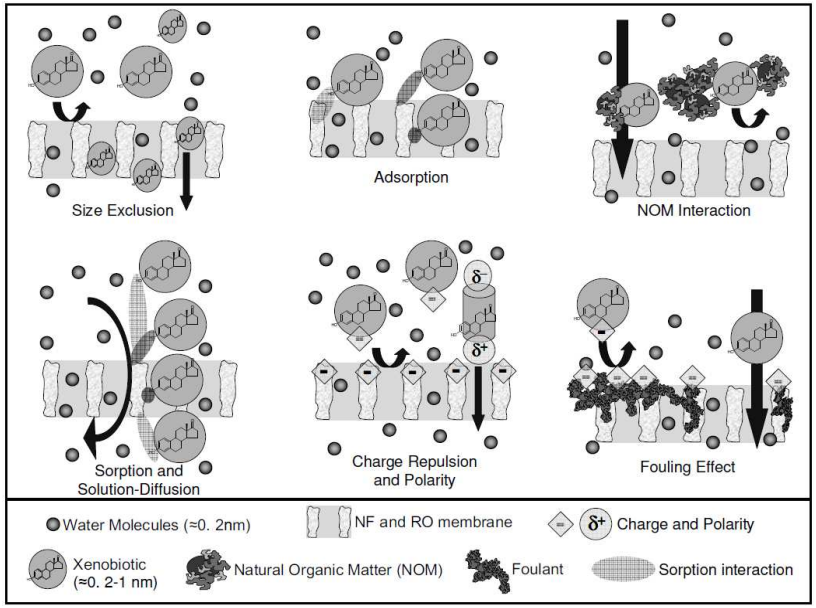


Figure 3 – Retention mechanisms by NF and RO membranes

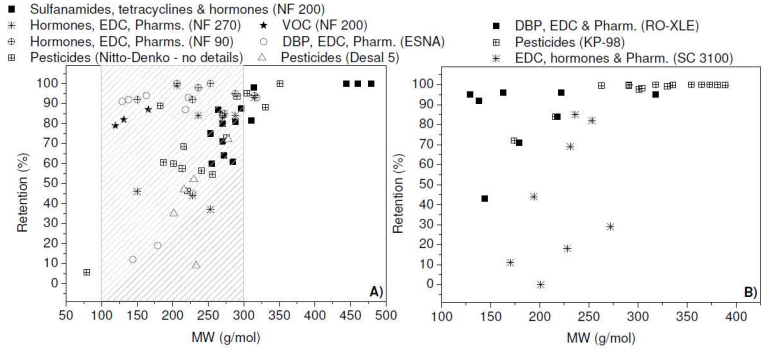


Figure 4 – Xenobiotics retention by NF (A) and RO (B) membranes as a function of MW – the shaded area corresponds to the MWCO of the NF membranes (adapted from [24, 14, 35, 66, 64, 65, 88, 70]) with EDC: Endocrine Disrupting Chemicals, Pharm: Pharmaceuticals, VOC: Volatile Organic Carbon, DBP: Disinfection By-products and the membrane used specified in [ ]

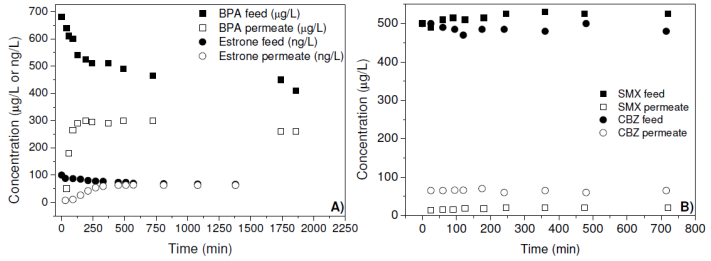


Figure 5 – BPA, estrone (A), SMX and CBZ (B) feed and permeate concentrations progress with time in NF (A and B adapted from [93, 56] and [94] respectively)

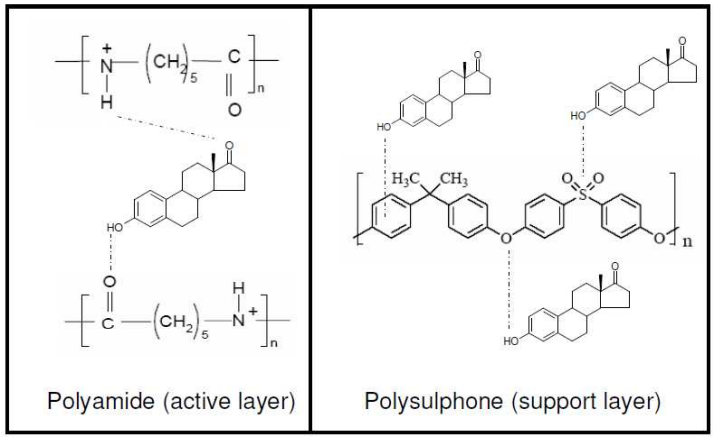


Figure 6 – H-bonding between xenobiotics and polyamide and polysulphone membranes

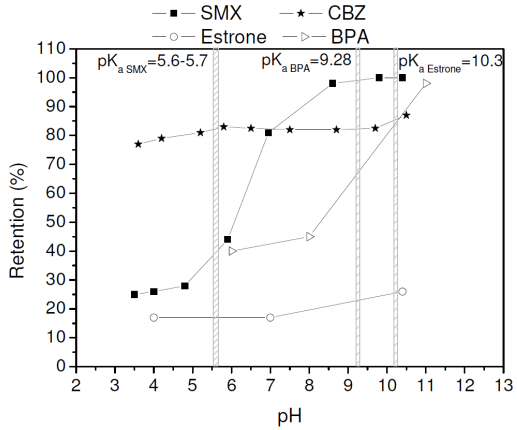


Figure 7 – SMX, estrone, BPA and CBZ retention as a function of pH (adapted from [93, 94, 55, 97])