Comparison of different technologies for the removal of pharmaceuticals from drinking water

Roberta Hofman-Caris [1,], Danny Harmsen [1], Erwin Beerendonk [1], Bas Wols [1], Wolter Siegers [1], Ton H. Knol [2], Emile R. Cornelissen [1]*

Pharmaceuticals in sources for drinking water

Increasing use of pharmaceuticals (>4000 active ingredients)

Pharmaceuticals and metabolites found in drinking water sources

Pharmaceuticals: biologically active, often water soluble, charged compounds

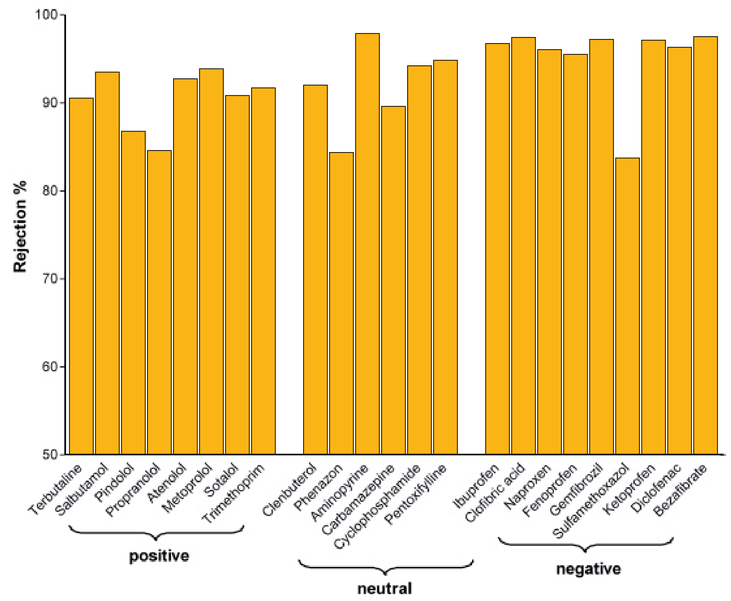
Not only organic micropollutants, but interesting model compounds because of large variety in properties

Adjust purification processes for drinking water for removal of pharmaceuticals.

Goal: Comparison of

- **UV/H_2O_2 processes**
- **(affinity) adsorption**
- **nanofiltration**

Nanofiltration



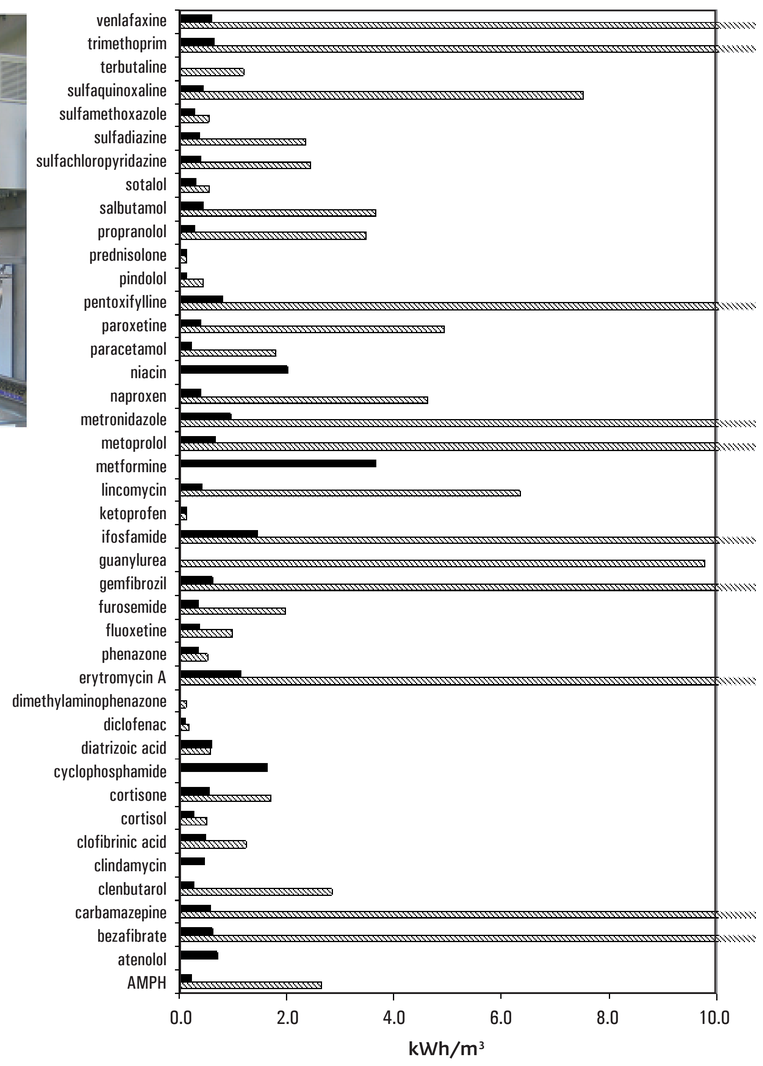
Effect M_w and charge:

Best rejection for negatively charged and neutral compounds

Concentration polarisation phenomena (electrostatic attraction or repulsion)

Specific energy demand of UV process (kWh/m³)

LP reactor at Dunea



E_{EO} for 100% ballast power.
Black bars:
10 mg H_2O_2/L,
dashed bars:
only photolysis

Comparison of UV/H_2O_2 and nanofiltration

Energy demand:

Nanofiltration < 0.3 kWh/m³, RO < 1 kWh/m³

UV/H_2O_2 < 1 kWh/m³

QSARs

UV/H_2O_2:

good QASAR for hydroxyl radical rate constant

- Electronic charges on C atom
- Topological information on molecular size and distance between atoms

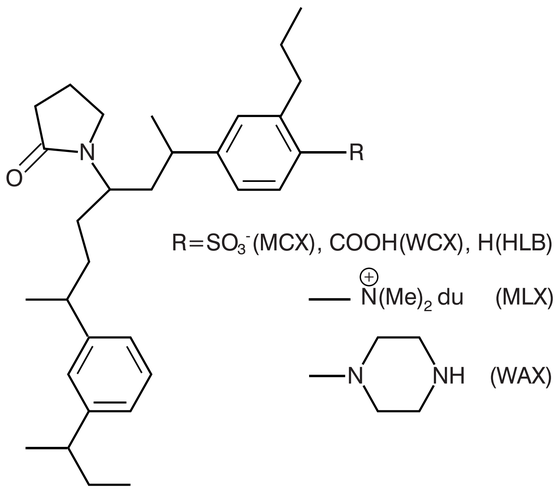
Moderate QSAR for photolysis

- Quantum yield
- Molar absorption
- Problem; validation with external data set

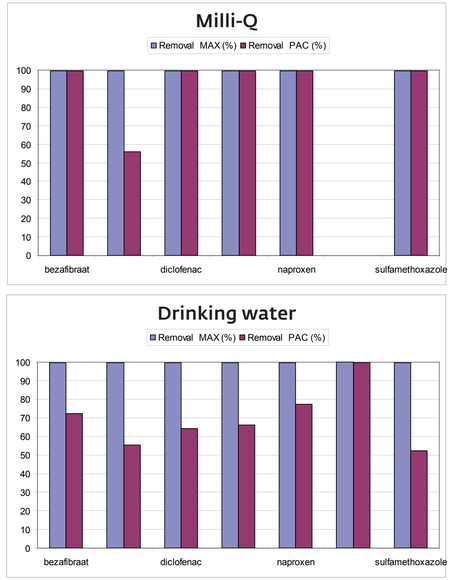
Nanofiltration: high predictability for this type of membrane

- Number of aromatic bonds
- Number of COOH groups on an aromatic ring
- Topological information

Affinity adsorption



Specific interactions with surface active groups: less competition by NOM



Conclusions

- Applicability UV/H_2O_2 processes, nanofiltration, (affinity) adsorption
- Comparison of technologies based on energy demand and molecular properties of compounds
- Water matrix, dealing with concentrates, fouling, formation of by-products, availability of adsorbents, regeneration possibilities etc. have to be taken into account
- Multi barrier approach probably most effective for removal of mixtures of pharmaceuticals

130602rhc

KWR Watercycle Research Institute

dunea DUIN & WATER

[1] KWR Watercycle Research Institute, P.O. Box 1072, 3430 BB Nieuwegein, The Netherlands
[2] Dunea, P.O. Box 34, 2270 AA Voorburg, The Netherlands
* For more information: Roberta.Hofman@kwrwater.nl

This project was conducted within the Joint Research Program of the Dutch water companies.

BTO