20 years of Research in the field of Endocrine disruptors & pharmaceutical compounds

challenges and solutions for the water sector

Comparative efficiency of drinking water treatment processes in removal of pharmaceuticals and EDCs)

Philippe BREANT - Veolia Environnement R&D

Drinking Water Programme Manager

Berlin, 10th February 2010

VEOLIA ENVIRONNEMENT
Recherche & Développement
Centre de Recherche sur l'Eau

VEOLIA WATER

Outline

- Background/Real estate
- Efficiency of processes
- How to optimize
- Conclusion

Background/Real estate

Quality of the resource : numbers of EDCs, Pharmaceuticals and Pesticides are revealed by raw water analysis campaigns.

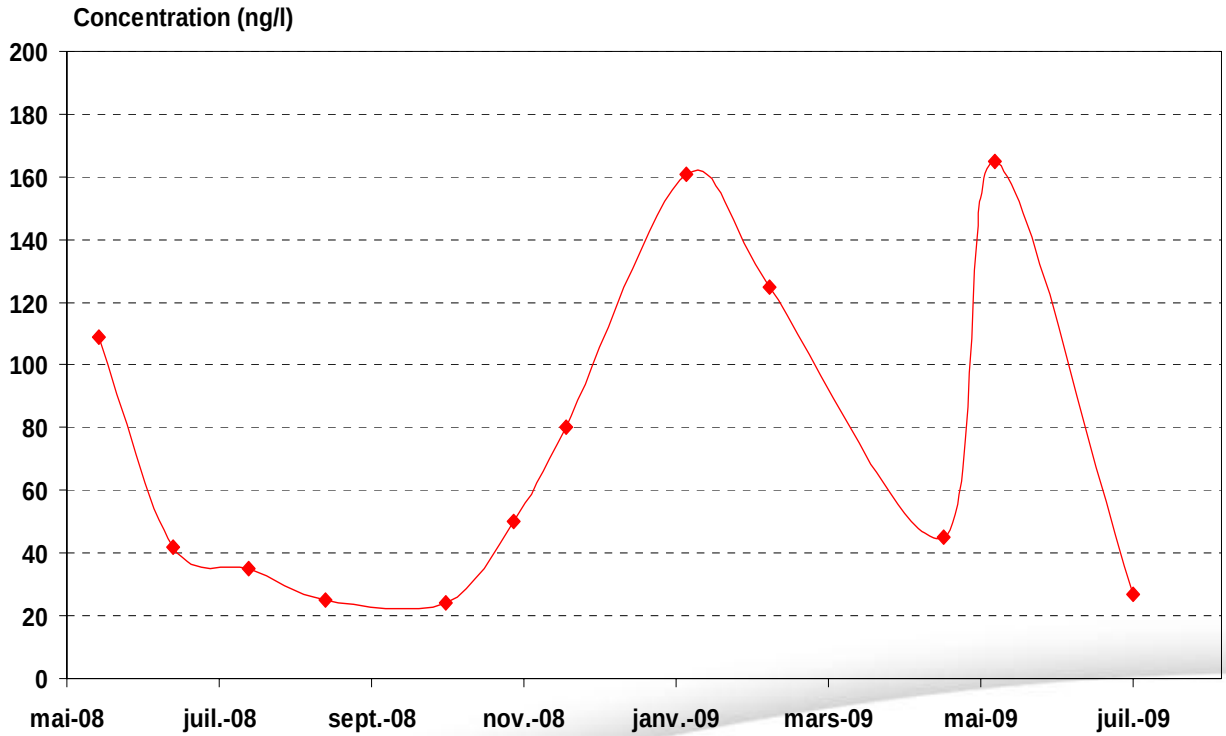
Species	Concentration ($ng.L^{-1}$)	Country
EDCs		
17β-estradiol	**0,2 – 0,6**	**Germany**
Estrone	**0,4** **0,5 – 2,9**	**Germany** **Canada**
Bisphénol A (BPA)	**0,5 – 2,0** **420***	**Germany** **US**
Pharmaceuticals		
Carbamazépine	**ND – 1400** **10 – 30** **29** **ND – 43,2**	**Canada** **Germany** **US** **France**
Bezafibrate	**27**	**Germany**
Ibuprofene	**ND – 0,6** **3,0 – 3,8**	**France** **Canada**
Paracétamol	**ND – 210,1**	**France**
Pesticides		
AMPA	**295**	**France**
DEA	**20**	**France**

Background/Real estate

Increase of concentrations and number of species during years ?

- Few available measurements
- Improvement of analysis methods (decrease of quantification limits)
- Seasons effect :

Evolution of a pharmaceutical concentration on a French river



VEOLIA ENVIRONNEMENT
Recherche & Développement
Centre de Recherche sur l'Eau

VEOLIA WATER

Background/Real estate

How to produce drinking water today in this background ?

We have to propose or adapt the design of drinking water treatment plants in order to :

- Be suitable to micro pollutants removal
- Take into account seasonal effects
- Anticipate probable increase of pollution
- Anticipate future rejection standards
- Efficiency but low carbon footprint and low water footprint !
- Take into account global environmental impact

Efficiency of processes

Main pollutants to remove for Drinking Water Supply

- **Total Suspended Solids (Turbidity)**
  - Clarifier, filtration, Membrane
- **Bacteries, viruses … (E Coli, Cryptospridium, Giardia, rotavirus,…)**
  - filtration, clarifier, Membrane, Disinfection
- **Organic matter (TOC)**
  - Clarifier, PAC, Ozone-GAC, Membrane
- **Emerging pollutants (EDC, pharmaceuticals, pesticides,…)**
  - PAC, Ozone-GAC, Advanced Oxidation, Membrane
- **Total Dissolved Solids (TDS)**
  - Membrane, Distillation, EDR, EDI,…
- **Specific Dissolved Species (Mn, Fe, As, Bromate,…)**
  - Specific processes based on raw water quality and regulation

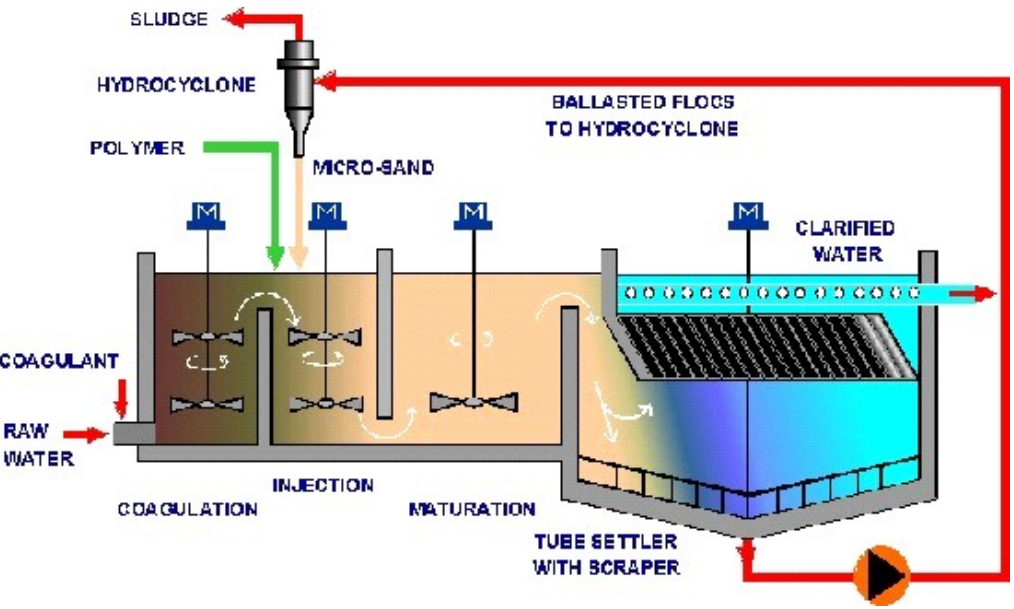
Efficiency of processes

We launch a large campaign of analyses in 2008 and 2009 to mesure the efficiency of different stages of treatment used to produce drinking water :

- Analyses on several drinking water plants
- Analyses on pilot processes with doping
(for pollutants which are not chronic in resources or at very low concentration)
- More than 1000 results sum up by type of treatment in the following slides

Efficiency of processes

Clarification



Pollutants	Removal efficiency
Pharmaceuticals	< 10%
EDCs	< 20%
Pesticides	< 20%
Industrial Chemicals	< 20-40%

Efficiency of processes

O_3 / GAC

Coliban DWTP - Australia

Pollutants	Removal efficiency
Pharmaceuticals	10 - > 90 %
EDCs	> 90 %
Pesticides	20 - 90 %
Industrial Chemicals	40 - 90 %

Efficiency of processes

PAC / UF : Opaline ®

L'Haye-les-Roses DWTP - Paris

Pollutants	Removal efficiency
Pharmaceuticals	50 - > 90 %
EDCs	> 90 %
Pesticides	20 - 90 %
Industrial Chemicals	40 - 90 %

Efficiency of processes

Nanofiltration

Pollutants	Removal efficiency
Pharmaceuticals	50 - > 95 %
EDCs	> 95 %
Pesticides	> 95 %
Industrial Chemicals	> 95 %

Annet / Marne – France
Drinking Water pilote platform

Efficiency of processes

Reverse Osmosis

Ashkelon Desalination plant - Israel

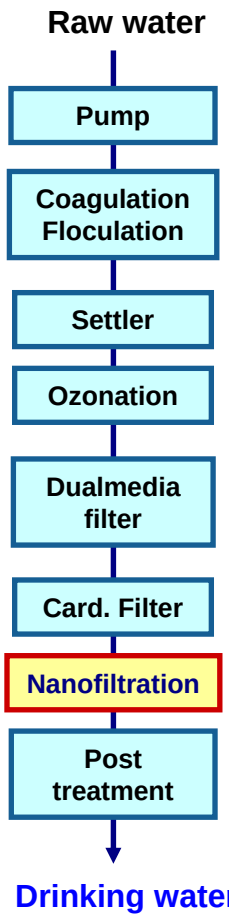
Pollutants	Removal efficiency
Pharmaceuticals	> 95 %
EDCs	> 95 %
Pesticides	> 95 %
Industrial Chemicals	> 95 %

VEOLIA ENVIRONNEMENT
Recherche & Développement
Centre de Recherche sur l'Eau

VEOLIA WATER

Example Méry sur Oise drinking water plant (F) :

- **Main objectives :**
  - **DOC removal,**
  - **Pesticides and others micro-pollutants removal,**
  - **partial softening**
- **140 MLD, built and operated by Veolia Water since 1999**
- **World 's largest nanofiltration plant for surface water**
- **NF 200 membrane, jointly developed with DOW**

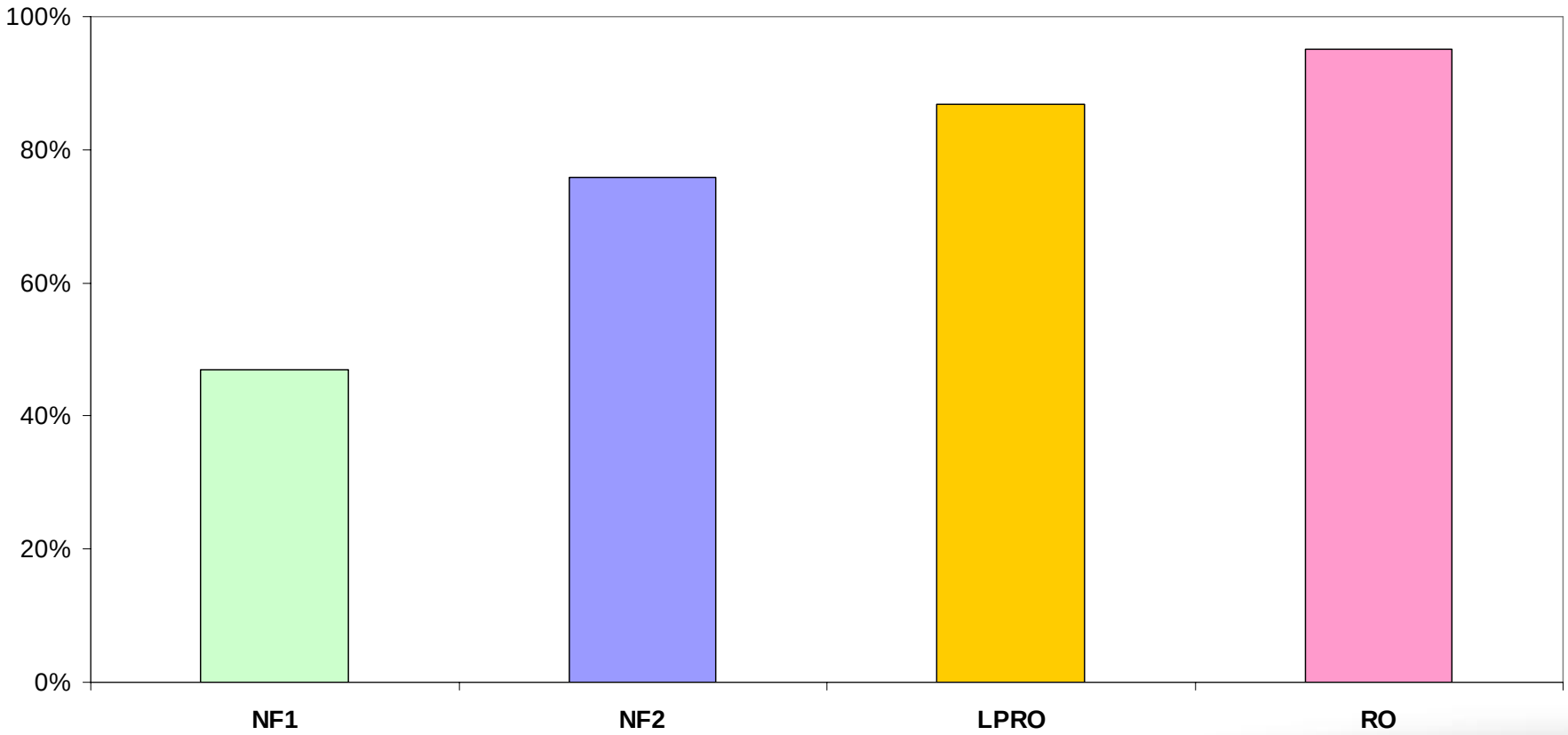


VEOLIA ENVIRONNEMENT
Recherche & Développement
Centre de Recherche sur l'Eau

VEOLIA WATER

Flexibility of Nanofiltration process : example of adaptation

Specific chemical removal performance : paracetamol



Optimization of Drinking Water Processes

Water treatment plant design depends on :

- State of the resource
- Nature of micro pollutants to be removed
- Willingness to anticipate future standards

Membrane processes bring the answer

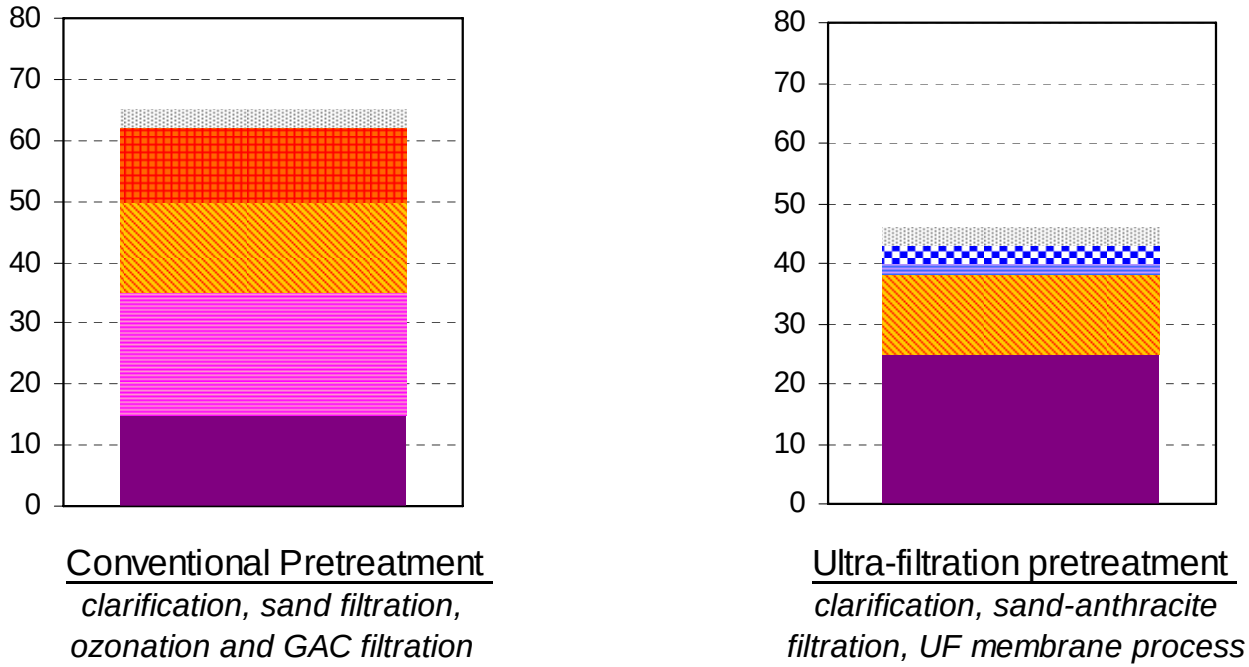
Optimization of Drinking Water Processes

Water treatment plant design have also to deal with global environmental impact :

- Low carbon footprint : process with the lower energy consumption
- Low water footprint : processes with the best efficiency
- Low resource impact : treatment of waste water (backwash filter, concentrate) before discharge in natural environment

Global impact : Comparison of pretreatments

GHG emissions of the potable water supply system in g CO_2-eq/m^3 of pretreated water

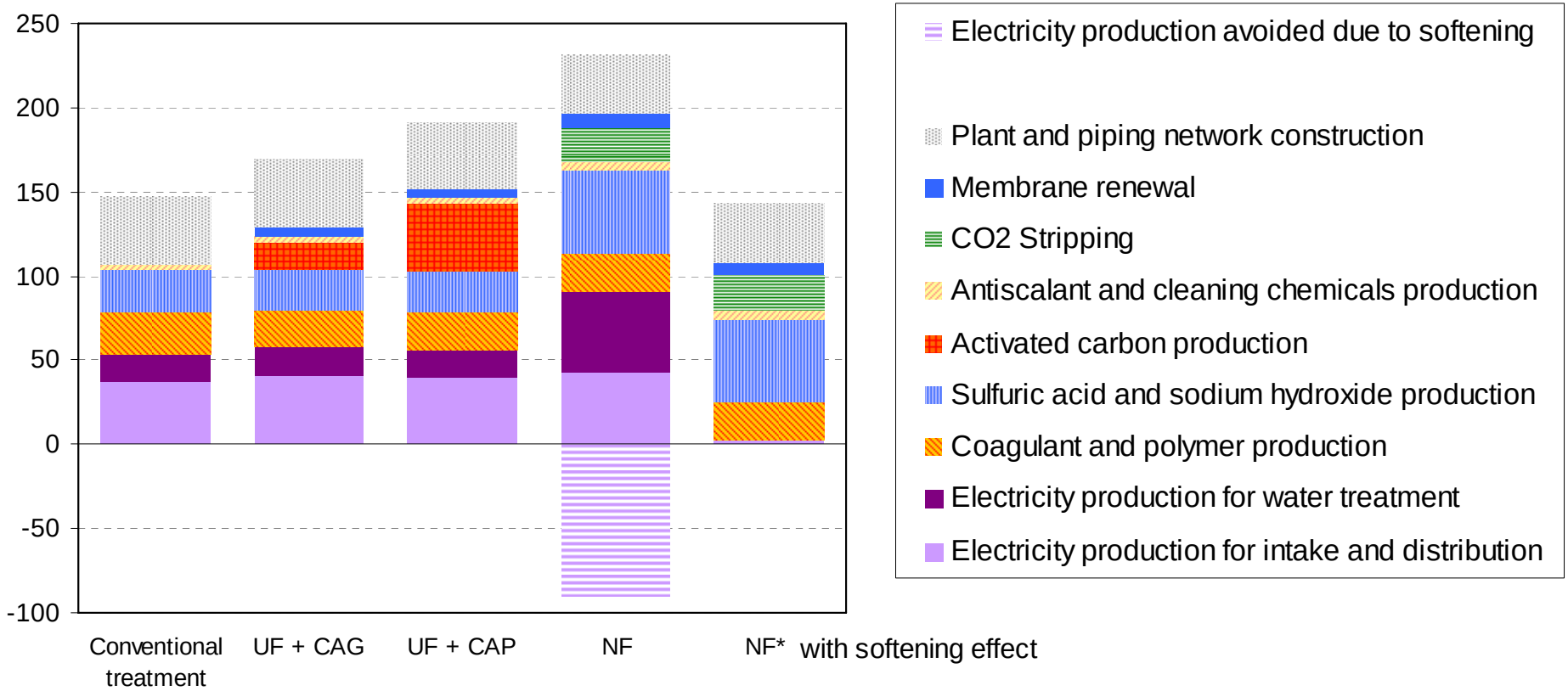


Conventional Pretreatment
clarification, sand filtration, ozonation and GAC filtration

Ultra-filtration pretreatment
clarification, sand-anthracite filtration, UF membrane process

Global impact : comparison of processes

GHG emissions in g CO2-eq/m3 of potable water distributed



with softening effect

VEOLIA ENVIRONNEMENT
Recherche & Développement
Centre de Recherche sur l'Eau

VEOLIA WATER

CONCLUSIONS

- **Membrane processes have gained wide acceptance in the drinking water industry because of their ability to produce a high-quality and consistent water.**
- **Particular interest are Nanofiltration and Reverse Osmosis Low Pressure which are best options for Natural Organic Matter (NOM) and emerging pollutant removal as EDC and pharmaceutical compounds.**
- **Membranes are « adaptable »**
- **Membranes are proposed and compatible with a global environmental approach**
- **New high performance processes can be compatible with reduction of carbon footprint**

Thanks for your attention

VEOLIA ENVIRONNEMENT
Recherche & Développement
Centre de Recherche sur l'Eau

VEOLIA WATER