TECHNEAU NEWSLETTER

January 2010

Welcome to the eighth issue of the TECHNEAU Newsletter. The newsletter is designed to disseminate news, scientific results and developments to stakeholders. Newsletters are issued every six months, with Newsletter 9 scheduled for June 2010.

TECHNEAU challenges the ability of traditional drinking water supply systems to cope with present and future global threats and opportunities. TECHNEAU will rethink options for water supply and - through innovation, research and development – will provide and demonstrate new and improved technologies for the whole water supply chain.

Newsletter 8 highlights recent activities and outputs from TECHNEAU. The Newsletter can be downloaded from the TECHNEAU website (www.techneau.eu) where comments on the Newsletter or on any project-related issue are welcome.

TECHNEAU publications are issued on the TECHNEAU website and can be downloaded free-of-charge. A list of available publications is shown on Pages 7-8.

## Work Area 7 Case Studies: Riga Workshop

The Work Area 7 (WA7) Case Studies demonstrate the application of technologies, methodologies and management systems developed in TECHNEAU. With all six WA7 Case Studies underway, a WA7 workshop was held in Riga, Latvia, on 4-5 November 2009 to review progress and plan future work.

The workshop - organized by Riga Technical University (RTU) and sponsored by Riga Water - focused on the practical application of TECHNEAU deliverables. Participants from 11 countries listened to the Case Study Leaders and TECHNEAU Researchers describe the application of a range of tools and strategies to solve various problems experienced by the case study end-users (water supply companies).

The workshop was opened by Maris Tralmaks, a Board Member of Riga Water, who welcomed the participants to Riga, and workshop organiser, Talis Juhna (RTU).

An Integrated Project Funded by the European Commission under the Sustainable Development, Global Change and Ecosystems Thematic Priority Area.

Contract Number: 018320
Project Coordinator: Dr. Theo van den Hoven KWR
Project Duration: 1st January 2006 to 31st December 2010

**Talis Juhna (RTU) describes water quality challenges in distribution in Riga and solutions developed in TECHNEAU**

**Day One (4 November)**
Progress reports including results, conclusions and scope of future work were given for the six WA7 Case Studies:

***Windhoek Case Study: Demonstration of a multi-barrier approach to the reclamation and treatment of wastewater to produce drinking water***

Case Study Leader Chris Swartz (Swartz Engineering) reviewed the results of a risk assessment (RA) and sampling regimes carried out at the New Goerangab Water Reclamation Plant (NGWRP) in Windhoek, Namibia. The RA had identified some process weaknesses that were being quantified using Fault Tree Analysis (FTA) so that the case study end-user (WINGOC) could identify appropriate risk reduction measures. A third sampling regime had been carried out to assess the performance of the plant and processes for the removal of specific contaminants including EDCs, algal toxins and pathogens.

A full report of the Windhoek Case Study will appear in the next newsletter.

(Continued on Page 2)

In Issue No.8:

***Lisbon Case Study: Implementation of a monitoring and management strategy to understand and reduce the risk of release of pathogens from biofilms***

Helene Allegre (LNEC) presented progress and described the future programme of work. An initial assessment of the distribution networks for microbiological degradation of water quality had been used in the design of a comprehensive investigative programme to be carried out in 2010. Data collection was underway to facilitate optimisation of the Asseiceira WTP using the TECHNEAU Water Treatment Simulator (WTS). The Resuspension Potential Method (RPM) had been used to identify turbidity 'hot spots' in distribution, enabling the end-user (EPAL) to prioritise their network flushing programme (see Page 3). The cost effectiveness of flushing was being investigated using the TECHNEAU Cost-Benefit Analysis (CBA) tool. The ToxProtect fish biomonitor had been installed and was monitoring water quality at the Aguas do Algarve Alcantarilha WTP.

***Riga Case Study: Implementation of a monitoring and management strategy to reduce the risk of release of water quality deterioration in distribution networks***

Water quality management in drinking water distribution networks is one of the major challenges of cities in developed countries. Typically, problems arise due to both chemical and microbiological deterioration resulting in poor quality water and customer complaints. Case Study Leader Talis Juhna (RTU) and colleagues presented results from the Riga Case Study dealing with such challenges.

RPM had been used to identify turbidity 'hot spots' in distribution and flushing was used successfully to reduce turbidity in two districts of Riga. Optimised flushing intervals were determined using OptFlush - software developed in WA5 - and the TECHNEAU cost-benefit analysis (CBA) tool was demonstrated as a means of identifying the most cost-effective flushing strategy (Janis Rubulis, Daniel Schumann and Laura Sterna).

The microbiological quality of water in distribution was investigated using the Hemoflow sampling system and Fluorescent In-Situ Hybridisation (FISH) monitoring. Results indicated that numbers of *E. coli* immediately after treatment were very low but increased with time in the network. Risks of infection from *Cryptosporidium* and *Giardia* were low (Simona Larsson).

CALUX bioassays were used to analyse raw and drinking waters for a range of EDCs. Hormone activity was detected in all water samples, with discharges from upstream sewage treatment plants being a major contributory factor. The activity level did not exceed concentrations observed in other European cities.

Raw water quality was monitored by the ToxProtect fish biomonitor and the UV/Vis spectrometer. The fish biomonitor was installed to monitor raw water quality to the Daugava WTP and raised several alarms including one as a result of an incident from a pig farm some 20 km upstream of the sampling point that was not picked up by conventional monitoring and analysis. The UV/Vis tracked small changes in raw water quality which confirmed the potential of the spectrometer as a tool to monitor potential risks for water supply (Carsten Lűring).

The UV/Vis spectrometer was also used to monitor drinking water in Riga. Water quality in distribution was monitored in terms of UV/Vis absorption spectra. Using this technique, it was possible to distinguish between drinking waters coming from the different sources used in Riga. Using a new spectral algorithm, it was possible to estimate the TOC content of the water.

Biostability of water and bacterial regrowth potential was assessed using AOC bioassay, flow cytometry (FCM) total cell count (TCC) and FCM viability analysis. Results showed that regrowth did occur during distribution of drinking water in Riga, although no specific risks were identified (Petra Ross).

Data are being collected to enable full demonstrations of the Water Treatment Simulator (WTS), Corrosion Model (CM) and Biological Regrowth Model (BRM) in 2010.

***New Delhi Case Study: Demonstration of monitoring and analysis, and feasibility of the OBM process for developing and newly-industrialised countries***

Gesche Grützmacher (KWB) described progress with the New Delhi Case Study. Water samples had been taken from four field sites in New Delhi (Palla, Najafgarh, Nizamuddin and Mathura) in two campaigns, before and after monsoon, to assess the extent of contamination. Samples were analysed for EDCs (CALUX bioassay) and algal toxins. After the second campaign, problems arose shipping samples from India to Europe and some analysis will need to be repeated. A feasibility study is assessing the potential of the Oxidation-Biofiltration-Membrane (OBM) filtration process for Nizamuddin and similar sites.

A full report of the New Delhi Case Study will appear in the next newsletter.

***Bergen Case Study: Demonstration of the optimized operation of water treatment and distribution***

This case study is at an early stage and a revised programme has been agreed between SINTEF and the end-user, Bergen Water. Bjornar Eikebrokk (SINTEF) described optimization procedures, NOM fractionation and measurement of BDOC that will be used to optimise Enhanced Coagulation (EC) and Ozonation-Biofiltration (OB) at selected full-scale treatment works to maximise NOM removal and minimise regrowth and biofilm formation potentials in the distribution network (see Page 4). Water treatment will also be optimised to minimise the passage of coagulant residuals and turbidity into distribution.

***Amsterdam Case Study: Demonstration of integrated, sustainable and optimized operation of water treatment to achieve biostability in distribution***

Case Study Leader Luuk Rietveld (TUD) described progress with the Amsterdam Case Study. Process models of ozonation and biofiltration are being developed and data are being collected to validate the models. Testing of the OBM process will proceed in conjunction with on-going research on the pilot plant installation at Weesperkarspel WTP.

**Day Two (5 November)**
On the second day, selected integrations from the case studies were presented. The presentations highlighted important engineering, economic and social issues related to the management of water distribution networks, particularly for EU transition countries.

Presentations were given by:

- Chris Fife-Schaw (Surrey University) who described the relationship between the water supplier and consumer in Riga.
- Frederik Hammes (EAWAG) and Linda Mezule (RTU) who described the use of flow cytometry and FISH to monitor bacteria in the distribution network.
- Jan Vreeburg (KWR) and Andreas Korth (KWB) who described the application of RPM and the flushing prediction model for network management.
- Janis Rubulis (RTU) who described unidirectional flushing to control turbidity in the Riga distribution network.
- Barbara Baffoe-Bonnie (WRc) who described the application of the TECHNEAU cost-benefit analysis tool to assess the cost-effectiveness of a range of flushing scenarios for the Riga network.
- Stein W. Osterhus (SINTEF) who described the application of the corrosion model in Riga.

The presentations were followed by a plenary session where a lively exchange of views took place between the participants. Informal presentations were then given describing the Water Treatment Performance Indicator (WTPI), management and application of RPM data in production / operations / asset management / rehabilitation planning and progress on the Distribution Operation and Maintenance Best Practice Manual.

The workshop was closed by Maris Tralmaks (Riga Water) who summarized the experience of Riga Water as an end-user, expressing his thoughts on lessons learned during the case study in Riga and thanking the workshop attendees for a productive and informative meeting.

## Work Area Highlights

**Lisbon Case Study: RPM used to prioritise network flushing (WA7)**

Discolouration of drinking water in distribution networks is a common problem for water suppliers worldwide. The need to address this problem in some parts of their distribution networks is one reason Lisbon waterworks (Empresa Portuguesa das Águas Livres, S.A. – EPAL) is participating in TECHNEAU. In Work Area 5 (WA5), TECHNEAU Partners are collaborating to develop conceptual models that describe and predict the behaviour of particles in distribution while others have developed more practical methods for identifying and mitigating the problem of discolouration.

Modelling and research of discolouration within WA5 has two aims:

- to understand the particle-related processes to help prevent the accumulation of loose particles; and
- to develop and implement practical measures aimed at preventing the resuspension of particles to unacceptable levels.

**Conceptual model**
The conceptual model developed for particle-related processes in distribution is shown in Figure 1. This model includes all the particle-related processes that contribute to discolouration. The main process leading to discolouration is the resuspension of loose particles that have accumulated in the network. The red arrow shows the resuspension process while the blue arrows show the processes that contribute to the accumulation of loose particles.

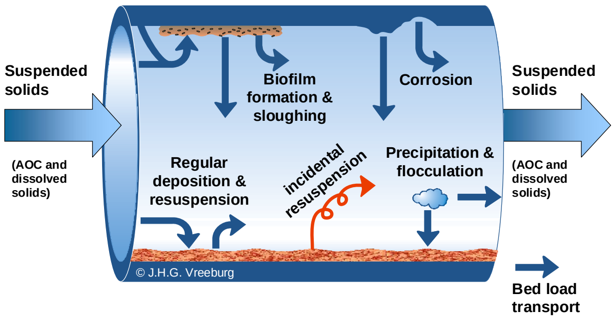


**Figure 1 Conceptual model for particle-related processes in a drinking water network**

**Practical approach**
A new measuring protocol has been developed called the Resuspension Potential Method (RPM) that objectively identifies the *risk* of discolouration. The key to the methodology is a normalised increase in flow in the network to cause a controlled resuspension of particles. A turbidity trace measured during the flow disturbance and the subsequent period of resettlement is converted into a numerical value, i.e. the RPM or the averaged turbidity over the 25-minute measurement period.

Although measurement of the RPM shows a distinct correlation with discolouration complaints, the latter is dependent on the customer being sufficiently dissatisfied with the quality of the water to inform the company. Importantly, whilst the RPM identifies the presence of resuspendable sediment - and this may or may not result in a subsequent discolouration complaint - it is this sediment that can be managed by the water company.

The regular and effective removal of sediment from the network is the most effective operational measure to prevent discolouration complaints. The discolouration risk in different parts of the network can be identified by the RPM and cleaning of the network can be prioritised accordingly.

To measure RPM, EPAL developed a mobile facility that could be used in Lisbon. The battery-operated measuring equipment was installed on a small-wheeled barrow that could be easily manoeuvred manually (Figure 2).

**Figure 2 Trailer-mounted RPM measuring equipment developed by EPAL**

After an initial trial, nine district metered areas (DMAs) were evaluated. RPM was measured and analysed in 3 to 6 locations in each DMA. The results are presented in Table 1.

**Table 1 Results of RPM analyses of 9 zones in EPAL network (adapted from Vreeburg *et al*., 2009)**

| Zone | Turbidity (NTU) | | | | RPM | | | |
|---|---|---|---|---|---|---|---|---|
| | Disturbance | | Reset | Total | Disturbance | | Reset | Total |
| | Max | Avg | Avg | | Max | Avg | Avg | |
| 3070 | 116 | 39.0 | 8.11 | 14.3 | 3.80 | 3.40 | 2.20 | 9.40 |
| **3490** | **96.7** | **37.4** | **20.6** | **24.0** | **3.40** | **3.40** | **3.00** | **9.80** |
| 1220 | 48.7 | 9.72 | 2.56 | 3.99 | 3.40 | 2.60 | 0.60 | 6.60 |
| 3410 | 139 | 28.8 | 8.34 | 12.4 | 3.75 | 3.50 | 2.25 | 9.50 |
| 3440 | 86.3 | 13.0 | 5.95 | 7.36 | 3.40 | 2.60 | 1.40 | 7.40 |
| 3530 | 113 | 24.8 | 7.39 | 10.9 | 3.20 | 2.60 | 1.80 | 7.60 |
| 4100 | 50.3 | 15.7 | 6.78 | 8.56 | 3.33 | 2.67 | 1.67 | 7.67 |
| 5140 | 48.8 | 12.2 | 3.06 | 4.90 | 3.75 | 2.25 | 1.00 | 7.00 |
| 1239 | 67.8 | 13.4 | 10.1 | 10.8 | 3.80 | 2.60 | 1.40 | 7.80 |

From Table 1, Zone 3490 - with the highest values for averaged turbidity and RPM ranking - is identified as highest priority for cleaning.

**Future work**
Measurement of RPM has been demonstrated to identify and prioritise the locations in distribution networks that present the highest risks of discolouration. Cleaning of the networks is planned for the coming months in accordance with these findings. In the future, EPAL expect to implement the RPM as a routine measurement in the management of their distribution networks.

**References**

1. Vreeburg, J. H. G., Menaia, J., Branco, L., Benoliel, M., Aprisco, P., Rebola, N. and Cordeiro, C. (2009). *Conceptual model for discolouration in drinking water systems: Who's to blame and what to do?* TECHNEAU: Safe drinking water from source to tap, Maastricht, IWA Publishing.


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**Bergen Case Study: Linking Water Quality in Distribution to Water Treatment (WA7)**

Water quality in distribution can be affected as a result of particles arising from water treatment, biofilm formation and corrosion processes. Biofilm and corrosion products will also contribute to the particle load and deposition in the network. The goal of network management is to minimise discoloration caused by particle resuspension and other water quality-related problems, thus minimising customer complaints. Basic network management normally removes loose deposits and particles from the network by flushing. However, flushing the network deals with the ***symptoms*** of water quality problems. An alternative approach would be to deal with the ***cause*** of the problems, requiring identification of the cause and origin of particles, corrosion and biofilm formation.

Research in TECHNEAU WA5 has investigated particles, corrosion and biofilm formation and has addressed the link between treatment and distribution [1]. Treatment processes considered most relevant to the deterioration of water quality in distribution include:

- Poor corrosion control: Results in corrosion of pipeline materials, formation of corrosion products and deposits in the network.
- Poor control of substrate and growth-limiting nutrients: Results in biological regrowth and biofilm formation with subsequent biofilm detachment and deposits in the distribution system.
- Poor control of metal coagulant residuals: Results in the post-precipitation of metal hydroxide particles and deposits in the distribution system.
- Poor control of turbidity: Results in particle accumulation and deposits in the distribution system with turbidity peaks associated with filter ripening and high hydraulic flows contributing most significantly to the overall particle discharge.

In the Bergen Case Study, TECHNEAU Partners are addressing three issues:

1) optimization of water treatment operations,
2) optimization of distribution system operations, and
3) developing the link between treatment and distribution.

The case study will identify to what extent optimization of treatment can reduce the problems in distribution, thus reducing the need for flushing and cleaning of the network.

## NOM-fractionation and BDOC measurements

In Bergen, BDOC is the growth-limiting substrate in drinking water. Measurement and control of BDOC in water treatment will thus limit regrowth and biofilm formation potentials in the distribution network.

The regrowth potential must be controlled in order to avoid problems related to bacterial regrowth: detached biofilm, possible incorporation of pathogens in biofilm and deposits, and taste and odour. Acceptable levels of BDOC depend on the distribution system. In distribution systems without residual disinfectant, BDOC levels should be controlled below 0.15-0.3 mg/L, depending on water temperature. In distribution systems with residual chlorine, acceptable levels are higher.

In the case study, BDOC will be determined by application of a rapid NOM fractionation procedure together with a novel six-BDOC-columns-in-series procedure.

NOM fractionation splits the DOC into four fractions:

1) Very Hydrophobic Acids (VHA),
2) Slightly Hydrophobic Acids (SHA),
3) Charged Hydrophilic Acids (CHA), and
4) NEUtral hydrophilic acids (NEU).

The BDOC-columns-in-series approach measures the DOC consumed by adapted bacteria in the biofilm covering glass beads held within six mini-biofilter columns. BDOC is calculated as the difference between the influent and effluent DOC of all six columns. Information on degradation kinetics can be derived from BDOC versus contact time (EBCT) curves.

In TECHNEAU, a good correlation has been found between BDOC and the hydrophilic NOM-fractions, specifically the charged hydrophilic fraction, CHA [2]. This is shown in Figure 1 for a number of untreated Norwegian raw waters, and for the same raw waters treated by enhanced coagulation or ozonation-biofiltration (OB). No correlation was found between BDOC and the hydrophobic fractions, VHA and SHA. Thus, in order to control regrowth and biofilm formation, the CHA (and NEU) fraction concentrations have to be controlled.

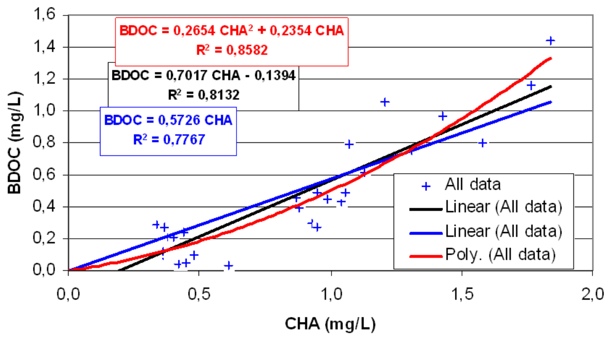
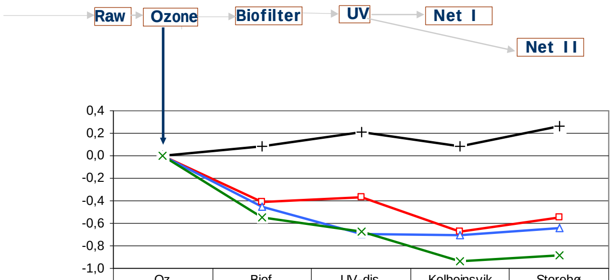



**Figure 1 Correlation between BDOC and the charged hydrophilic (CHA) fraction of DOC in Norwegian waters**

A link was established between the available substrate concentration (BDOC) and the active bacterial cells counts analyzed by flow cytometry (FCM) measurements [3]. For an OB facility outside Bergen, Figure 2 shows the concentration changes through treatment (ozonation, biofiltration, UV disinfection) and in distribution. The increase in cell number and the decrease in substrate (BDOC, CHA+NEU, and CHA) are well correlated, with regression coefficients ($R^2$) of 0.69, 0.82 and 0.85, respectively.

Figure 2 demonstrates well that BDOC and CHA (and NEU) is consumed by the bacteria, and that this substrate is used for growth of new bacteria cells.




| | Oz | Biof | UV-dis | Kolbeinsvik | Storebø |
|---|---|---|---|---|---|
| Cells/10^6 | 0,00 | 0,09 | 0,21 | 0,09 | 0,27 |
| BDOC | 0,00 | -0,41 | -0,37 | -0,67 | -0,54 |
| CHA | 0,00 | -0,45 | -0,69 | -0,71 | -0,64 |
| CHA+NEU | 0,00 | -0,55 | -0,67 | -0,93 | -0,89 |

**Figure 2 Changes in active bacteria cell counts, BDOC, CHA and NEU concentrations during water treatment and distribution in a Norwegian OB facility [2]**

## Particle load

Particle behaviour within distribution networks is largely unknown. However, the following assumptions can be made based on significant similarities between a pipeline and a filter pore:

- Solids accumulation in pipelines involves: a) particle transport to the pipe wall, b) attachment, and c) particle detachment/resuspension
- Peaks are caused by increased velocity in the pipeline (detachment/resuspension of deposits)
- Peaks in turbidity contribute most to the network particle loading
- Particle discharge during filter ripening is partly resuspended material
- Resuspended material from the filters has 'settling capacity' in the network

Links have been established between particle loads from the WTP and sediments in the network [4]. The theoretical effect on the required cleaning frequency of optimised treatment with respect to particles is illustrated in Figure 3.

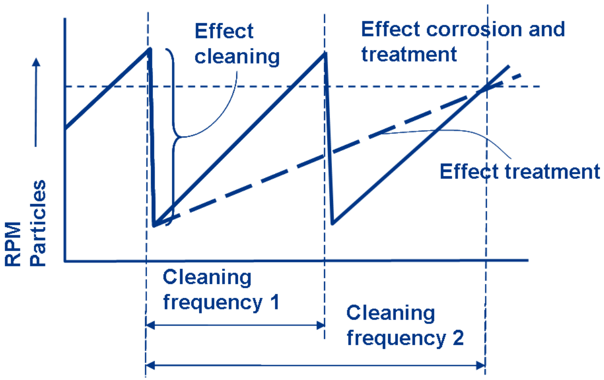



**Figure 3 Effect of optimised treatment on the required cleaning frequency [4]**

**Treatment optimisation**

Typical problems and recommended solutions in the WTP in order to reduce the particle deposition and the regrowth potential in the distribution system are listed below [2].

| Problem | Solution |
|---|---|
| Direct particle discharge during filter ripening | -Prolonged filter-to-waste period<br>-Time-limited coagulant overdosing during initial ripening<br>-Coagulant addition to last portion of backwash water<br>-Effective filter backwash |
| Direct particle discharge during hydraulic peak loads | -Avoid hydraulic peak loads as far as possible (PLC re-programming; increased buffer volumes, etc)<br>-Never run filters to breakthrough or beyond |
| Particle deposition from coagulant post-precipitation | -Avoid excessive residual metal coagulant residuals<br>-Adapt coagulation conditions to the raw water quality at all times<br>-Apply sufficiently high coagulant doses to allow a reasonably wide optimum pH-window<br>-Optimise the coagulation step and avoid underdosing |
| Regrowth/Biofilm formation potential (BDOC) | -Control the CHA and NEU fraction concentrations by optimized and targeted treatment<br>-Control P or other nutrients – if limiting factors<br>-Apply sufficient disinfectant residuals in the network (according to national policy) |

**Further work**

The Bergen Case Study will continue to work to link water treatment and the corresponding water quality effects in the distribution network. The final results will be available from the TECHNEAU website towards the end of 2010.

**References**

1. Vreeburg, J. (2009). *Linking of water treatment optimisation to distribution system performance.* Presentation at Riga WA7 Workshop, 4-5 November 2009.

2. Eikebrokk, B. (2009). *Bergen Case Study: Overview and Highlights*. Presentation at Riga WA7 Workshop, 4-5 November 2009.

3. Hammes F., Berney M., Wang Y., Vital M., Koster O. and Egli T. (2008). *Flow-cytometric total bacterial cell counts as a descriptive microbiological parameter for drinking water treatment processes. Water Res.*, *42*(1-2), 269-277.

4. Vreeburg, J. (2007). *Discoloration in drinking water systems: A particular approach.* Gildeprint BV, Enschede.

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## Forthcoming Events

- **22-24 February 2010**

HiWATE Conference and Open Day: Health Impacts of Long-Term Exposure to Disinfection By-Products in Drinking Water
Organiser: Imperial College
Host: Imperial College, London, UK
Further information: www.hiwate.eu

- **19-25 June 2010**

Quantitative Microbial Risk Assessment Summer School
Organiser: KWR, TUD, RIVM, IRAS, CAMRA (US)
Host: Delft University of Technology, The Netherlands
Further information: Helena.sales.ortells@kwrwater.nl

- **19-24 September 2010**

IWA World Water Congress and Exhibition: Water - The Lifeblood of the World
Organisers: IWA, CWWA, CAWQ
Host: Montreal, Canada
Further information: www.iwa2010montreal.org

- **27-28 October 2010**

13th Aachener Membran Kolloquium
Organiser: AachenVerfahrentechnik, RWTH Aachen Universtiy
Host: VIVTA - Verein zur Förderung des Instituts für Verfahrenstechnik der RWTH Aachen
Further information: www.amk.rwth-aachen.de

## TECHNEAU Delivered!

The TECHNEAU project has been running for 4 years and the number of available publications continues to increase. Publications are issued on the TECHNEAU website (www.techneau.eu) and can be downloaded free-of-charge. Publications available up to December 2009 are listed below.

| Report Number | Title |
|---|---|
| **WA1 Rethink The System** | |
| D1.1.1 | Trend Report: Report on Trends in South Africa / Sub-Sahara Africa |

| | |
|---|---|
| D1.1.2 | Trend Report: Report on Trends in Water Stressed Regions |
| D1.1.3 | Trend Report: Report on Trends in Eastern European Countries (Baltic States) |
| D1.1.4 | Trend Report: Report on Trends in Southern European Countries (Portugal) |
| D1.1.5b | Trend Report: Report on Trends in Central Europe (Germany / Switzerland) |
| D1.1.6a/b | Spain - A TECHNEAU Case Study: Phases I & II - Climate Change |
| D1.1.6c | Long Term Effects of Climate Change on Europe's Water Resources (Romania) |
| D1.1.7 | Global Trends Affecting the Water Cycle: Winds of Change in the Water World |
| D1.1.9 | Trend Report: Report on Trends Regarding Future Risks |
| D1.1.11 | Organisation and Financing Models of the Drinking Water Sector: Review of Available Information on Trends and Changes |
| D1.1.12 | Report on Consumer Trends: Cross-cutting Issues Across Europe |
| D1.1.13 | Existing Foresight Studies: A Literature Review |
| D1.1.14 | Trend Report: The Netherlands |
| D1.2.1 | Adaptive Strategies: Integrated Approach and Flexibility under recognition of Local Conditions |
| D1.3.4 | Case Study Report Cyprus: Flexibility in Coping with Water Stress and Integration of Different Measures |
| **WA2 Treatment Technologies** | |
| D2.1.2 | State-of-the-Art Report on Reverse Osmosis Desalination |
| D2.1.2b | New Prototype Pre-Filter for Seawater Reverse Osmosis: Protocol for Bench-Scale Testing |
| D2.3.1.1 | A Semi-Quantitative Method for Prediction of the Rejection of Uncharged Organic Micropollutants with Nanofiltration |
| D2.3.1.2 | A Nanofiltration Retention Model for Trace Contaminants in Drinking Water Sources |
| D2.3.1.3 | Influence of Electrostatic Interactions on the Rejection with NF and Assessment of the Removal Efficiency during NF/GAC Treatment of Pharmaceutically Active Compounds from Surface Water |
| D2.3.2 | Coagulation Pre-Treatment for Microfiltration with Ceramic Membranes |
| D2.3.2.1 | Ceramic Microfiltration as the First Treatment Step in Surface Water Treatment |
| D2.3.2.2 | Removal of Particulate Matter by Ceramic Membranes during Surface Water Treatment: Interim Report |
| D2.3.2.3 | Superground PAC in Combination with Ceramic Microfiltration |
| D2.3.2.7 | Removal of Phages and Nanoparticles by Ceramic Membranes |
| D2.3.3.5a | Ceramic Membranes: Case-Related Protocol for Optimal Operational Conditions to Treat Filter Backwash Water |
| D2.3.3.5b | Ceramic Membrane Applications for Spent Filter Backwash Water Treatment |
| D2.4.1.1 | UV Disinfection and UV/$H_2O_2$ Oxidation: By-product Formation and Control |
| D2.4.1.2/3 | Fenton Process for Contaminant Control |
| D2.4.2.3 | Comparison of Ozonation and AOPs in Various Waters and Assessment of Oxidation Efficiency |
| D2.4.2.5 | Modelling Micropollutant Removal by Ozonation and Chlorination in Potable Water Treatment |
| D2.4.2.6 | Modelling of Micropollutant Removal by Ozonation and Chlorination in Potable Water Treatment |
| D2.5.3 | International Market Survey on Membrane-Based Products for Decentralised Water Supply |
| D2.5.4 | Decentralised Water Supply and Membrane Processes: Workshop |
| D2.5.5 | Preparation of the Demonstration Study of Compact Units for Decentralised Supply |
| D2.5.11 | Decentralised Water Supply: International Networks and TECHNEAU Activities - Workshop |
| **WA3 Monitoring And Control Technologies** | |
| D3.1.1/2 | Monitoring and Control of Drinking Water Quality: Selection of Key Parameters |
| D3.1.3 | Monitoring and Control of Drinking Water Quality: Inventory and Evaluation of Monitoring Technologies for Key Parameters |
| D3.2.1 | UV-Vis Monitoring Station for Calculating 'Integrated Parameters' |
| D3.2.4 | A Method for the Concentration of Microbes in Large Volumes of Water |
| D3.2.5 | Interim SOP for HPLC-based Analysis of New Algal Toxins (Dissolved State) in Natural Waters |
| D3.2.7 | Redesigned Monitoring Station based on UV/Vis Spectrometry |
| D3.3.1 | A Flow Cytometric Method for AOC Determination |
| D3.3.2 | Feasibility Report of a Quantitative Method for Rapid Assessment of Microbial Population Composition in Drinking Water using Flow Cytometry combined with FISH |
| D3.3.4 | Development of a Toolbox for Identifying and Quantifying Membrane Biofouling in Drinking Water Treatment |
| D3.3.5 | Assessing the Feasibility of Total Virus Detection with Flow Cytometry in Drinking Water |
| D3.3.7 | A Protocol for the Determination of Total Cell Concentration of Natural Microbial Communities in Drinking Water with FCM |
| D3.3.8 | Cultivation-Independent Assessment of Viability with Flow Cytometry |
| D3.3.9 | A Report on the Growth of Pathogenic Bacteria on Natural Assimilable Organic Carbon |
| D3.3.10 | A Comparison of AOC Methods used by the Different TECHNEAU Partners |
| D3.3.12 | Development of a Toolbox for Identifying and Quantifying Membrane Biofouling in Drinking Water Treatment |
| D3.3.13 | Characterisation of Biofouling on Hollow Fibre Membranes using Confocal Laser Scanning Microscopy and Image Analysis |
| D3.4.6 | Odour and Flavour Tests: Human Panel and Electronic Testing Compared |
| D3.4.12 | Monitoring of Toxins in Drinking Water by the ToxProtect64 Fish Monitor |
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| D3.5.2 | UV-Vis Monitoring Station for Calculating 'Integrated Parameters' |
| D3.5.3 | Detection of Number and Viability of *E. coli* and *A. hydrophila* with the FISH Technique |
| D3.5.4 | Integrated UV-Vis Parameters for Distribution Network Monitoring |
| D3.5.5 | Portable Monitoring Station |
| D3.6.3.4 | Monitoring of Toxins in Drinking Water by the ToxProtect64 Fish Monitor: Training Material for End Users |
| D3.6.8.1 | Survival of *E. coli* in Drinking Water Biofilm: The Application of the FISH Technique |
| D3.6.8.2 | Fate of *E. coli* in Biofilm of Water Treatment Plant and Distribution Networks: The Application of the FISH Technique |
| **WA4 Risk Assessment And Risk Management** | |
| D4.1.1/2 | Identification and Description of Hazards for Water Supply Systems: A Catalogue of Today's Hazards and Possible Future Hazards |
| D4.1.3 / D4.2.1/2/ 3 | Generic Framework and Methods for Integrated Risk Management in Water Safety Plans |
| D4.1.5a | Risk Assessment Case Study: Goteborg, Sweden |
| D4.1.5b | Risk Assessment Case Study: Bergen, Norway |
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| **WA5 Operation And Maintenance** | |
| D5.1.2 | Framework for Operational Cost Benefit Analysis in Water Supply |
| D5.2.1 | Results of Background Work and Data Integration of MAR Systems for an Integrated Water Resources Management |
| D5.2.2 | Inorganic Substances and Physiochemical Parameters listed in Indian and German Drinking Water Standards: Preliminary Report |
| D5.2.3 | Analysis of the Vulnerability of Bank Filtration Systems to Climate Change |
| D5.2.5 | Bank Filtration Simulator: Manual |
| D5.2.6 | Occurrence and Fate of Microbial Pathogens and Organic Trace Compounds at RBF Sites in Delhi, India |
| D5.3.1a | Water Treatment by Enhanced Coagulation: Operational Status and Optimization Issues |
| D5.3.1b | Ozonation and Biofiltration in Water Treatment: Operational Status and Optimization Issues |
| D5.3.2 | Water Treatment by Enhanced Coagulation and Ozonation-Biofiltration: Intermediate Report on Operation Optimisation Procedures and Trials |
| D5.3.4a | Ultrafiltration with Pre-Coagulation in Drinking Water Production: Literature Review |
| D5.3.4b | Nanofiltration in Drinking Water Treatment: Literature Review |
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| D5.3.6a | Ultra- and Nanofiltration in Water Treatment: Workshop |
| D5.3.6b | Nanofiltration as a Treatment Barrier Against Pathogens |
| D5.3.7a | Input for Process Simulator |
| D5.3.8 | Impact of Chlorination on the Formation of Odour Compounds and their Precursors in Treatment of Drinking Water |
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| D5.5.4 | Methodology of Modelling Bacterial Growth in Drinking Water Systems |
| D5.5.5 | Review and Selection of Monitoring Parameters and Methods |
| D5.5.9 | Modelling Planktonic and Biofilm Growth of a Monoculture (*P. fluorescens*) in Drinking Water |
| D5.6.1 / D5.6.2 | Report on Operational Methods and Maintenance Schemes: Applied in Praxis and Compared to Best Practice |
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An Integrated Project Funded by the European Commission under the Sustainable Development, Global Change and Ecosystems Thematic Priority Area.

Contract Number: 018320
Project Coordinator: Dr. Theo van den Hoven KWR
Project Duration: 1st January 2006 to 31st December 2010