



## Coordinators column

Willy van Tongeren—coordinator

**Cooperation** is an important factor of success within the European Research programmes. It is not without a reason that one of the programmes within FP7 is called Cooperation, the program within which also AquaFit4Use is carried out. Cooperation has different aspects. To carry out the programme all kind of parties - private and public, industries and RTD's, young researchers and experienced managers - have to work together to come to optimal achievements. Being involved in EU programmes leads to all types of cooperation between parties from all different countries in Europe, within projects but also in a broad area around this. Such networks is very useful for future cooperation



Cooperation is also very essential in AquaFit4Use. A team of over 100 persons of 35 partners work together to make the project successful. But also outside the project there is a lot of interaction between different stakeholders and all type of other parties interested. And often in this cooperation 1+1 is more than 2. We have seen this also in the latest large scale dissemination activity of the project in Valladolid where we had the opportunity to fill two complete sessions with results of AquaFit4Use in the IWA specialist's conference Water and Industry. More interested attendees, less expenses and efforts during the organization and a better program. Thanks to all persons involved, and a special gratitude to Dr. Raul Muñoz, chair of the Organisation Committee for the very pleasant cooperation.

## Introduction—Successful presentation of AquaFit4Use at IWA Water & Industry Congress Prof. Angeles Blanco

The IWA Specialist Conference 2011—Water & Industry was held between the 1st and 4th May in the Spanish city of Valladolid. The success achieved in combination with the AquaFit4Use Midterm Conference with the 7<sup>th</sup> International Congress of ANQUE, the project Board decided that the IWA Conference could also be a very good forum to present our project to the technical industrial audience. After a series of contacts the responsible representatives of AquaFit4use and the IWA conference organization agreed to have two sessions dedicated to AquaFit4Use Project results and a Demonstration Workshop. The sessions, entitled *Last Industry Initiatives on Sustainable Water Use*, comprised nine oral presentations in which our AquaFit4Use colleagues introduced the project latest results. In the Demonstration Workshop, the main features and operation of the AquaFit4Use Water Quality Management Tool were presented by Filip Claeys.



## Under the Water Specialists conferences

IWA Congress WATER & INDUSTRY was organised by the Department of Chemical Engineering and Environmental Technology of the University of Valladolid together with the International Water Association (IWA). This event involved the participation of 270 high level scientific and technical water professionals from 35 countries. During the Congress, 120 lectures were given and 130 posters presented. This significant exchange of information gave the opportunity to share knowledge and improve collaboration among researchers, administrations, public organizations and companies. Moreover, two large research initiatives - Aquafit4Use (EE-7th framework) and "Consolider-Novedar" (Spain-Ingenio 2010)- took the opportunity to show their results to a wide audience and presented their General Assemblies.

## participating partners



## Topics during the IWA conference

During the conference twelve different topics were considered in the congress: Advanced Oxidation Processes, Aerobic Wastewater Treatment-Nutrients Removal, Anaerobic Solid Treatment, Anaerobic Wastewater Treatment, Case Studies, Characterization & Management, Energy & Resource Recovery, Membranes Bioreactors, Microbiology, Physical-Chemical Processes, VOCs & Odour Treatment and AquaFit4Use-Industrial Initiatives in Sustainable Water Use.



## Keynote speakers

- **Michael Modell** introduced "Thermodynamics for supercritical water oxidation applications", discussing where and how thermodynamics may play a key role in the design process and the economics of full scale supercritical oxidation plants.
- **Juan Lema** presented "Rethinking the sewage treatment plant", through which he tackled the global impact of including novel technologies in the design of sewage treatment plants.
- **Benoit Guieysse** lectured on "Recent findings on the sustainability of algae-based wastewater treatment", putting special emphasis on the water-energy nexus.
- **Juan Luis Ramos** presented "Global approaches to solvent tolerance by microbes", explaining that for an effective use of microorganisms, a deep understanding of microbial diversity, microbial ecology and microbial communities are required.
- **Darren Sun** presentation was entitled "Is it possible to produce drinking water from wastewater with zero cost?". In it, he described the possibilities and problems of forward osmosis.
- **Bart Kraakman** spoke about "Trends in off-gas treatment of VOCs and VICs", presenting developments of vapour phase abatement technologies to control odour and VOC emissions, with a special focus on sustainability and reliability.

## Discussions

The discussions about advanced oxidation processes focussed on the synthesis of new catalysts like nanorod microspheres of  $\text{TiO}_2$  presented by Z.Y. Liu, or goethite-coated film for photo-Fenton process presented by Y. Segura. Several photocatalytic studies were presented including the use of  $\text{TiO}_2$  nanotube photocatalyst by D.D. Sun. Also solar photo-Fenton, catalytic ozonation and combination of advance oxidation processes with biological treatments were reported by some authors, e.g. S. Malato. Various presentations reported supercritical water oxidation or wet oxidation with catalysts, such as the study of the effects of Al/Fe-PILC preparation on wet peroxide oxidation, presented by L.A. Galeano.

A good number of presentations dealing with biological processes were presented, considering anaerobic, aerobic, membrane bioreactors, biological nutrients removal and microbiology. A comparison of semi-continuous-wet and batch-dry anaerobic treatment reactors was presented by D. Blanco; anaerobic processes to treat solid wastes were focussed on the combination of thermal hydrolysis and biological treatment, among them, the presentations performed by S.I. Pérez-Elvira or J. Abelleira. Regarding aerobic wastewater treatment studies, the reduction of the final effluent discharge cost of a European petrochemical site was presented by M. Vidal. Operational parameters and experiences in industrial MBR were reported by T. Wozniak or I. Rodríguez-Roda. MBR aspects such as operation modes, degradation kinetics or the influence of some compounds in the water were also tackled. Elimination of nitrates and phosphates by biological treatments were reported, including a new wastewater treatment technology: Bio-CAST, presented by C.N. Mulligan.

Several presentations involved studies about physical/chemical treatments. Among them, a comparison of coagulation conditions by Y. Wang or the use of Al<sub>13</sub> polymer to remove natural organic matters by B. Gao. VOC & odour treatment studies focussed on the use of biofilters to remove VOCs, including a comparison of technologies for odour treatment, which were performed by J.M. Estrada. Other treatments focussed low-cost resource-recovery processes such as treatments in wetlands or crystallization and precipitation. D. Traksel presented a case-study about water re-use and sustainable water cycle schemes within the food industry. Characterization and management issues were also presented; among others, G. Rodríguez-García offered a comparison of Atlantic and Mediterranean scenarios in relation to environmental and economic performance of wastewater treatment plants.

Finally, presentations of industrial initiatives in sustainable water use were made by the partners of the AquaFit4Use project.

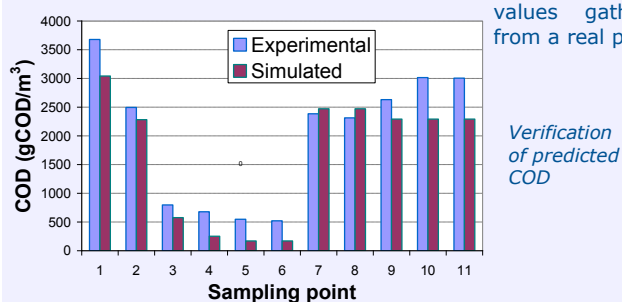




## Oral Sessions

### 1. NEW MATHEMATICAL MODEL LIBRARY FOR INDUSTRIAL WATER NETWORK OPTIMIZATION by CEIT

One of the core developments of AquaFit4USE is the Water Quality Management Tool, a software system conceived to manage information on typical water network constituents and to represent, simulate and optimization actual water networks. CEIT was in charge of creating a library of models representing the different water systems and operations one can find in an industrial plant. The results presented in the Conference by I. Lizarralde (CEIT) are concerned with the verification of the models by contrasting the simulated values obtained through them with actual values gathered from a real plant.



### 2. APPLICATION OF THE WQMT TO CHS CASE STUDY BY ATM

CHS is a food company producing a wide variety of products, mainly canned seasonal vegetables in different preparations. The characteristics of the wastewaters produced by the company therefore vary greatly around the year. M. de Gracia (ATM) presented the results obtained in the application of the WQMT to the CHS water system with a threefold objective:

- To verify the model library
- To contribute to the further development of the water quality management tool
- To find opportunities to reduce the water consumption at CHS



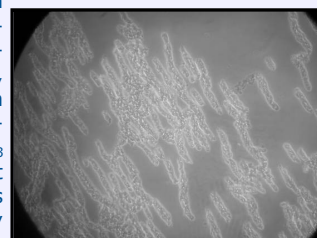
### 3. WATER QUALITY MONITORING: EVALUATION OF SENSORS by VEO

An area of AquaFit4USE is dealing with the evaluation and validation of sensors. In this oral presentation, Y. Ladegaillierie from VEO, described the research carried out to evaluate and select the most suitable sensors to measure the chemical oxygen demand (COD) of industrial wastewaters from a group of five preselected commercially available instruments. The devices were tested with lab and real wastewater and evaluated against a reference method applying several criteria. Only PeCOD P100 (AquaDiagnostic) was accurate independently from the water matrix. This and Uvas (Hach-Lange) were selected for future studies.



### 4. CHEMICAL PRECIPITATION APPLIED TO REDUCE SILICA CONTENT IN PAPER MILL EFFLUENTS by UCM

The paper industry have reached a high level of water reuse through the closure of internal water circuits. The reuse of the final effluent is possible after a treatment train involving a reverse osmosis step. The economical application of this treatment, however, is currently not possible due to the high concentration of silica in the effluent, which causes deposition and the subsequent clogging of the RO membranes. D. Hermosilla, of UCM, presented the results obtained in the studies of silica removal employing several coagulants,  $FeCl_3$  and various PACls, at different pHs. The best removal results were obtained at high basicity employing PACI5.



Coagula formed with PACIs at high basicity

### 5. MEMBRANE BIOREACTOR TECHNOLOGY COMPATIBILITY WITH CHEMICAL WASTEWATER by VITO

The application of membrane bioreactors (MBR) to treat the effluents of chemical plants often presents a series of constraints associated to the characteristics of the wastewaters generated, namely variability, presence of inhibitory species or interaction with the membrane material. H. de Wever presented the research carried out in the project to determine the application limits of MBRs and their feasibility of their implementation in a chemical WWT plant. The studies were carried out in four pilot systems in the facilities of two companies participating in the project, BASF and PERSTORP the first one producing a wide variety of products ranging from inorganics and intermediates to polymers, and the second one producing specialty chemicals. Sites.

- BASF: Two with flat sheets; one hollow fibres membranes
- PERSTORP: Hollow fibre membranes

The MBRs operated at BASF were operated in stable conditions for six months, although all the membranes underwent irreversible fouling, what may suggest that the membrane material employed is not completely adequate to the waters treated.

The MBR at Perstorp was operated reliably, with good recovery of the membranes after cleaning. The water treated with the MBR presented lower biogrowth potential than that treated with a conventional activated sludge system. The reuse of the treated water could be possible if the MBR is complemented with a reverse osmosis step.



MBR pilot at Perstorp





## Oral Sessions

### 6. INDUSTRIAL WASTEWATER RE-USE: APPLICATION OF 3FM® (NEW HIGH SPEED FILTRATION SYSTEM) AS PRE-TREATMENT by VEOLIA

S. Mauchauffee presented the results obtained in the application of the 3FM technology as a pretreatment in the pulp and paper industry. The 3FM® is a new filtration system able to achieve high filtration speed with a small footprint, constituting thus a very good replacement of sand filtration units. The 3FM® consists of a vertical steel column filled with fine polyamide fibers as porous filtration media. The 3FM® was tested in AquaFit4Use at laboratory and pilot scale in the facilities of a container-board mill. The system proved capable of reducing turbidity and TSS of the effluent coming from a clarifier by 8 and 10 times respectively. At pilot scale, the system was tested with pulp and paper raw wastewater reducing TSS 3 times and turbidity 2,5 times at a flux between 1.5 and 5 m<sup>3</sup>/h. Particulate COD was also reduced with the treatment. Backwash was carried out every 12 hours for 7 cycles with air followed by water. From the research it was concluded that the best removal performance is achieved at high concentration in feed. The removal could be increased with the use of coagulants (5 to 10 ppm).



Lab scale 3FM®

### 7. AQUAFIT4USE: REDUCING WATER FOOTPRINT OF COOLING TOWERS WITH CAPDI by VOLTEA

In this presentation, E. Driessen, from VOLTEA, gave a summary of the results obtained in the application of their Capacitive Deionization (CAPDI) technology to remove salts from a water stream used in cooling towers at the factory of Ben & Jerry's (UNILEVER) in The Netherlands. The capacitive deionization is based on the application of an electric field by means of two oppositely charged electrodes in combination with selective anionic and cationic membranes within a cell. The saline water flows through the cell and ions move towards the oppositely charged electrodes being retained in the selective membranes.



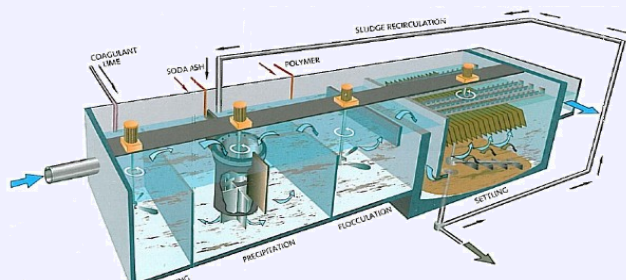
With the pilot at Ben & Jerry's, Voltea achieved an average salt removal of 60–70% from a cooling water stream having a pH of 8,4 a conductivity of 1277 µS/cm and a total hardness of 19,6 °G (degrees German). With the configuration CAPDI tested at B&J it is possible to save a good part

of the make-up water supplied to the cooling towers reducing, at the same time, the wastewater generated and the use of antiscalants. Further improvements in performance are expected with other configurations not yet tested and through the pretreatment of make-up water.

### 8. SOFTENING AND REMOVAL OF SCALING COMPOUNDS FOR INDUSTRIAL WASTE WATER RE-USE by VEOLIA

M.P. Denieul presented the studies carried out in AquaFit4Use concerning the application of softening to the effluent of a pulp and paper mill. The ultimate objective of this research was to fine-tune the water quality treated in the softening stage so as to prevent CaCO<sub>3</sub> scaling in a subsequent nano-filtration step. For such purpose, the VEO team employed the Multiflo® concept, a softening process characterised by its compactness. At bench removals of 67% of Ca and 60% of alkalinity were achieved when treating a simulated wastewater with no coagulant or flocculant addition. These values resulted in a **higher recovery** and **permeability** together with a **better permeate quality** in the

NF step. The pilot scale tests were carried out in the facilities of a paper mill that produces high quality coated and uncoated board



Multiflo® process scheme

from recycled paper. The Multiflo® softening pilot unit was operated at 150 L/h in combination with a 3FM® unit. Lime was used to reach pH of 9–9,5; a coagulant was used (FeCl<sub>3</sub>) as well as a polymeric flocculant. 96% of Ca and 66% of alkalinity removals were obtained with the system. These first results at pilot scale were evaluated as very promising and are to be confirmed at different influent water conditions. The impact on the subsequent NF process are also to be validated.

### 9. FINDING ECONOMICALLY THE MOST EFFICIENT OPERATING PARAMETERS OF UV/H<sub>2</sub>O<sub>2</sub> PROCESS: A CASE STUDY – DECOLORIZATION OF C.I. REACTIVE BLUE 268 SOLUTION by UMB

Studies on advanced oxidation processes are often focused on finding the optimal operating conditions. The presented work was aimed at establishing the most effective operating conditions from an economical approach. To achieve this aim a mathematical model of the UV/H<sub>2</sub>O<sub>2</sub> treatment process of the C.I. Reactive Blue 268 solution was developed by means of polynomial approximations. Two formulations were developed, one maximising the system response, and the other minimising total costs.

- The results indicate that the simultaneous optimization of operating parameters and costs, enables a significant improvement in economic efficiency of the treatment technology.
- For the case studied, the operating cost of the treatment process optimized solely with respect to the maximization of operating efficiency could be up to 5.5 times higher than those obtained using the proposed approach.

## general AquaFit4Use information



**Project title** AquaFit4use—Water in industry, Fit-for-use Sustainable Water Use in Chemical, Paper, Textile and Food Industry

**Acronym** AquaFit4use

**Participants** 34

**Start date** 1 June 2008

**Duration** 48 months

**Total budget** 14.800.000 euro

**Total EC funding** 9.650.000 euro

### VISIT OUR WEBSITE!

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The production of this newsletter is coordinated by UCM.