



## Coordinators Column

I am very pleased to present you the second newsletter of AquaFit4Use. A little later then planned, because drawing up the first 1,5 year-report of a project with 35 partners showed to be more time consuming than expected. A new and useful experience. A positive thing of drafting such a report with the input of most of the partners is that you get a good overview of the progress of our initiative on a more detailed level. And I have to say that I am very impressed about the achievements so far.

As mentioned earlier, the involvement of the industry in AquaFit4Use is very important. For this reason, I am happy to announce that we can present already some results of the pilot work that has been carried out at two factories; Holmen Paper in Spain and the Chemical plant of Perstorp in Sweden. Very good examples of successful cooperation between different parties.

It is also a pleasure to present the Scientific Panel of AquaFit4Use. A group of high level people that will support the AquaFit4Use team and guide them at the scientific level. The first meeting with them in November 2009 was very fruitful and we already received a lot of useful advice. The members of the Scientific Panel are introduced in this newsletter.

Finally, I want to mention the Mid-term meeting of AquaFit4Use that will be organised in cooperation with the ANQUE Congress 'Integral Water Cycle: Present and Future - Shared Commitment' in Oviedo from 13-16 June 2010. Results of almost all the work packages will be presented at this conference. I hope to welcome most of you there. More information will be provided in the next newsletter.

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## When water is a critical issue: re-use, recycle or re-claim? The case of Holmen Paper Madrid

Water consumption is becoming increasingly important for all industries, mostly in those sectors considered "large consumers", such as paper, food, textile and chemical industries.

Holmen Paper Madrid S.L. is a 100% recycled newsprint and magazine paper mill located in the South of Madrid, Spain. Due to the water scarcity situation in Spain, water consumption has always been of high concern for the mill. When Mrs. A. Blanco, the leader of the Cellulose and Paper Research Group of the Chemical Engineering Department of the Complutense University of Madrid, invited Holmen Paper to collaborate in the AquaFit4Use initiative, the decision to participate was easily made.

Holmen Paper Madrid in collaboration with the research group from the Complutense University of Madrid has been investigating the closure of its water circuits to reduce fresh water consumption for the last 10 years, what has resulted in a water consumption of around 8 m<sup>3</sup>/Tn of produced paper, which is **2 m<sup>3</sup>/Tn lower** than the optimum expected for this kind of process according to the BREF.

As established in AquaFit4Use, further circuit closure without exhaustive treatment of the process water is not feasible. This is because higher levels of organic and inorganic contaminants in the process lead, on one hand, to scaling, fouling and corrosion problems and, on the other, to quality problems in the final product. Therefore, the aim within AquaFit4Use to further reduce the fresh water consumption is to find ways to directly replace the fresh water currently used in the high pressure showers of the paper machine. These are the most water-consuming elements in the mill nowadays.

The first step was to find the water quality requirements for this operation which are considerably high (total absence of solids and pathogens, and low conductivity). This implies the need for advanced treatments, considered normally as emerging technologies, such as membrane filtration or the combination of biological and membrane treatments. At this point, the company together with UCM have studied two approaches towards the replacement of fresh water based on two different water sources: on one hand, within AquaFit4Use, the effluent produced by the company and, on the other, reclaimed municipal wastewater.

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Figure 1. Pilot anaerobic treatment





**Figure 2.** Main uses of fresh water in Holmen Paper Madrid

Finally, the comparison of the results from the pilot plants of the two alternatives have been also compared in AquaFit4Use.

During the last 18 months Holmen along with the Complutense University of Madrid has evaluated, the feasibility of re-using its effluent as fresh water. This has been done through the operation of several pilot plants including anaerobic treatment (to reduce COD, BOD and sulfates at the same time that biogas is generated), aerobic treatment (Through Membrane Bio-Reactor or Moving Bed Bio-Reactor), and final membrane treatment (Ultrafiltration + Reverse Osmosis). So far, the results of the research have shown that the use of the effluent to replace fresh water presents several limitations that reduce the economical feasibility of this approach. The main findings are the following:

- The reject from the reverse osmosis must always fulfill the **legal restrictions** over the effluent of the mill. In Spain these limits are set as contaminant concentration, leading to a limitation in the maximum recovery that can be achieved in the reverse osmosis plant. Therefore, the research continues at laboratory scale for the treatment of RO concentrates.
- A **high amount of silica** is present in the paper mill effluent, due to the use of silica-containing compounds for the de-inking of recovered paper. Therefore, there is a high scaling potential for the reverse osmosis, which limits the recovery. This result has opened a new research line that is being studied within AquaFit4Use to try to solve this important bottleneck. At the moment studies are focused on advance flocculation of silica at laboratory scale.
- The trials have shown the **high potential of anaerobic treatment** of the effluent of Holmen, showing a considerable robustness and economical benefits through the generation of biogas what can lead to a reduction in the current aerobic treatment costs. Research continues at Holmen

On the other hand, since 2007, Holmen and the Complutense University of Madrid have been carrying out pilot plant trials with the effluent from a municipal waste water treatment plant, adding a membrane treatment through UF + RO and final disinfection to the current tertiary treatment. During 4 months, three different treatment lines were compared in parallel. The main conclusion was that the treatment is feasible and profitable enough (less than 5 years payback).

During the last months, results from the pilot plants of the two alternatives for fresh water reduction have been compared. Although the re-use of mill effluent, at least partially, seems to be the best alternative, results have shown that there are severe technical bottlenecks that need to be solved before this alternative is feasible. This comparison carried out within AquaFit4Use has allowed Holmen to decide that at this moment the best alternative is the use of reclaimed water as fresh water. Therefore, a reclamation plant will be constructed by the water supplier of the Madrid Community. It is scheduled that in 2011 Holmen will become the first paper mill in Europe producing 100% recycled paper with 100% reclaimed water.

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## Upcoming events

**13-16 June 2010**  
**AQUAFIT4USE Midterm Conference**  
**AQUAFIT4USE General Assembly**  
 In collaboration with "The Integral Water Cycle: Present and Future", 7th International Congress of ANQUE  
 Oviedo, Spain  
[www.anque2010.org](http://www.anque2010.org)

**28-30 March 2010**  
 2nd IWA/WEF wastewater treatment modelling seminar  
 Mont-Sainte-Anne, Canada  
[www.modeleau.org/WWTmod2010](http://www.modeleau.org/WWTmod2010)

**11-14 April 2010**  
 The water research conference: challenges in organic and bioorganic chemistry  
 Lisbon, Portugal  
[www.waterresearchconference.com](http://www.waterresearchconference.com)

**2-4 June 2010**  
 7th leading-edge conference on water and wastewater technologies  
 Phoenix, Arizona, US  
[www.let2010.org](http://www.let2010.org)

**9-11 June 2010**  
 Austria national Young Water Professionals Conference (IWA)  
 Vienna, Austria  
[gaul@oewav.at](mailto:gaul@oewav.at)

**16-18 June 2010**  
 Spain National Young Water Professionals Conference (IWA)  
 Barcelona, Spain  
[www.fundacionagbar.org/ywp.spain](http://www.fundacionagbar.org/ywp.spain)

**23-24 June 2010**  
 The 1st International Water Quality Conference.  
 The University of Leeds, Leeds, UK.  
<http://www.wateratleeds.org/>

**27-30 June 2010**  
 Membranes in drinking and industrial water treatment (AQUAFIT4USE contribution)  
 Trondheim, Norway  
[www.mdiw2010.no](http://www.mdiw2010.no)

**28 June - 2 July 2010**  
 Singapore International Week Singapore  
<http://www.siww.com.sg/water-convention>

**15-18 August 2010**  
 Biofilm reactor technology  
 Portland (Oregon), USA  
[www.wef.org](http://www.wef.org)

## Denutritor®: biofouling reduction in water systems

Denutritor is a biofilter, which reduces the biofouling potential of water. In Denutritor, microbial populations are grown in biofilms on a filler of polyurethane foams. The microorganisms in these biofilms degrade organic substrates, which are dissolved in the water. So doing, the source of biofouling is removed, and the potential for re-use of the treated water is enhanced. In AquaFit4USE, laboratory and pilot scale Denutritor biofilters are being tested for the treatment of effluents from the chemical and food industries. Effluents from the paper and textile industry will be tested subsequently.



Figure 3. Picture of the Denutritor pilot

### Perstorp Specialty Chemicals

Perstorp Specialty Chemicals aims to re-use effluent from their wastewater treatment plant (WWTP) for cooling or other industrial processes. With laboratory-scale Denutritor set-ups, the reduction of biofouling potential was studied with "synthetic" effluent from the wastewater treatment plant at Perstorp. The biofouling reduction potential was determined by measuring the difference between the protein formation of microbial biofilms, growing on polyethylene (PE) tubes exposed to the influent or effluent water of Denutritor. Under stable operating conditions, a maximum reduction of biofouling potential of 86% was obtained. Additionally, a pilot Denutritor was installed on site at Perstorp in June 2009 (Figure 3). The pilot consists of three 50-litre columns, placed in series and filled with polyurethane foams. Water from the wastewater treatment plant is pumped through the columns at a flow rate of 0.3–0.5 m<sup>3</sup> per hour. For five months, the Denutritor was operated on effluent from Perstorp's WWTP, when it was switched to effluent from a pilot membrane bioreactor (MBR) installed by Logisticon for the treatment of Perstorp wastewater. Protein analyses of the biofouling monitors show a reduction of biofouling potential of the treated Perstorp WWTP water ranging from 71% to 92% (Figure 4). In samples from filler of Denutritor it was observed that the bacterial biofilms were grazed by many protozoa and metazoa. A major fraction of the biofilm consisted of ammonia oxidising bacteria and nitrite oxidising bacteria, revealing an active nitrifying population. Pathogenic bacteria were not detected. WWTP water at Perstorp has a high BOD (biological oxygen demand) and contained

many particles and paper fibres. This caused problems with clogging of the fillers in the columns. This clogging is much less a problem since Denutritor is running on MBR effluent. Next research will focus on further testing Denutritor with MBR effluent.

Test run	Biofouling potential (mg protein/m <sup>2</sup> /day)				Reduction Biofouling Potential (%)
	Influent	Effluent Filter 1	Effluent Filter 2	Effluent Filter 3	
1 (1 day)	45	19	12	9	80
2 (19 days)	5.0	2.4	2.4	0.4	92
3 (12 days)	5.3	3.0	3.3	1.5	71
4 (13 days)	5.8	4.4	3.3	0.7	88
5 (6 days)	8.4	2.9	1.4	1.1	87
6 (14 days)	4.7	2.4	2.1	0.6	87

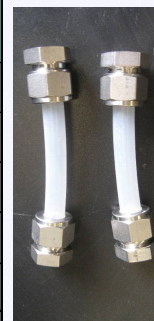


Figure 4. Reduction of biofouling potential of Perstorp WWTP water on biofouling monitors

### Unilever's Ben & Jerry's

Unilever's Ben & Jerry's factory in the Netherlands, is aiming to re-use collected rainwater for cleaning purposes. The use of Denutritor to reduce microbial growth and biofilm formation in rainwater is evaluated. Laboratory experiments were started with collected rainwater, which is recirculated in a buffer tank via Denutritor. An identical system, but without Denutritor, is used as reference. The flow rate, hydraulic residence time, and dimension of the laboratory systems are adapted to the situation at the Ben&Jerry's factory. In both test systems, the chemical and microbiological quality of the rain water is monitored. The concentration of bacteria, including pathogenic micro-organisms, is monitored by cultivation on agar plates and molecular techniques (qPCR and FISH), in collaboration with Vermicon. After one month of operation, of six monitored pathogenic bacteria, none were detected in Denutritor-treated water. In contrast, *Pseudomonas Aeruginosa* was found at low concentration in water from the reference system. In summer 2010, Denutritor pilot tests will be started at Unilever, Ben&Jerry's factory, to test the treatment of rainwater for cleaning purposes.

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## AquaFit4Use Scientific Panel

The Scientific Panel of AquaFit4Use was introduced to the project during a General Assembly meeting in November 2009. This Panel will act as an Advisory Body for the project and will provide input to the project at two levels: one concerning the general progress of our initiative and the other dealing with more specific aspects. In terms of generic progress, the Scientific Panel will give advice in issues related to the overall direction of the project in view of its innovative perspective. The specific input of the Panel will focus on concrete scientific issues as well as on the relation of the AquaFit4Use research lines with other projects. The members of the AquaFit4Use Scientific Panel are:



### Prof. Peter Wilderer

**TUM Professor Emeritus of Excellence**  
 Institute of Advanced Study of the TUM-IAS  
 Member of the Board of Trustees and of the Advisory Council  
**Academic Positions**  
 Univ. of Karlsruhe, Germany, 1967 – 1982  
 Techn Univ of Hamburg, 1982 – 1990  
 Techn. Univ. of Munich, 1991 – present

#### Major Areas of Research Interests

Earth system engineering  
 Water science and technology  
 Fundamentals of water quality management  
 Bio-Engineering and Bio-Technology  
 Decentralized sanitation and reuse technologies



### Dr. Antonio López

**Current Position**  
 Chief researcher/ Head Department of Bari of the Water Research Institute (IRSA) of the Italian National Research Council (CNR)  
**Academic Positions**  
 From 1976-1982: Professor of Chemistry at the Faculty of Engineering of the University of Naples

#### Major Areas of Research Interests

Professional activities: (waste)water treatment  
 Physicochemical treatments of municipal and industrial wastewater:  
 Advanced oxidation processes Biodegradability enhancement  
 Integrated processes for treating industrial wastewater and minimizing sludge production.



### Prof. Thomas Wintgens

**Background**  
 Thomas Wintgens graduated as an Environmental Engineer from RWTH Aachen University/Germany in 1999 after studies in Aachen, Delft, Exeter and Helsinki.  
**Academic Positions**  
 Since September 2008 Thomas is Professor in Environmental Technology at the Institute for Ecopreneurship of the University of Applied Sciences Northwestern Switzerland

#### Major Areas of Research Interests

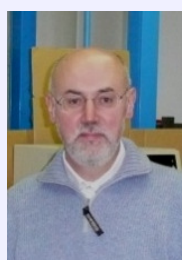
As he has a major interest in the field of water and process engineering he joined the Membrane and Environmental Technologies Research Group at the Chemical Engineering Department at RWTH Aachen University in 2000 which is lead by Prof. Thomas Melin.



### Mr. Jan-Erik Levlín

**Background**  
 MSc degree in physics, chemistry and mathematics from the University of Helsinki in 1962  
**Career**  
 Joined KCL, the Finnish Pulp and Paper Research Institute in 1963 Number of positions starting from a researcher via different managerial positions up to the position of Research Director and

Executive Vice President.  
 Involved with all aspects of papemaking technology, including the use of water. He retired at the end of 2003.  
 During the later parts of his career deeply involved with questions related to research strategies and international research cooperation. In this context he was also involved with the EU research programs, including COST (Chairman of COST Action E48 The limits of paper recycling 2009.  
 Member of the TC Forest and Forestry Products for circa 10 years.



### Prof. Gian Maria Colonna

**Current Position**  
 Stazione Sperimentale per la Seta – Textile Research Centre (Milano – Como)  
 Chief of the research unit in Como:  
 Environment, dyes and colour measurements  
**Background**  
 1981: degree in chemistry  
 since 1993 responsible of the research unit of Stazione Sperimentale per la Seta (Como)

Since 2003 contract professor at Insubria University of Como for Laboratory of chemistry and technology of coloured materials. He has been responsible for research projects, mainly dealing with environmental problems of processes in the textile industry.



### Prof. Peter Vanrolleghem

**Academic Career**  
 MSc Bioengineering ('87), PhD Environmental Technology ('94). From March 1995 staff member of Ghent University, Department of Applied Mathematics, Biometrics and Process Control of the Faculty of Applied Biological Sciences, from 1997 on as associate professor. From February 2006, full professor holding the Canada Research Chair in Water Quality Modelling at the Département de génie civil at Université Laval in Québec.

#### Expertise

Water quality modeling. Modelling methodologies and software (calibration, sensitivity analysis, experimental design, ...). Sensor development and data quality assessment. Process optimization (fault detection & real-time control).

## 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** 32  
**Start date** 1 June 2008  
**Duration** 48 months  
**Total budget** 14.800.000 euro  
**Total EC funding** 9.650.000 euro

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[www.aquafit4use.eu](http://www.aquafit4use.eu)

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