MBR-Network

Final MBR-Network workshop

"Salient outcomes of the European R&D projects on MBR technology"

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Workshop report

European projects on MBR technology delivered
A report on the final MBR-Network workshop

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Presentation of the key project outcomes in the final MBR-Network workshop

On behalf of MBR-Network, the coalition of research projects dedicated to MBR technology and financed by the European Commission, the Berlin Centre of Competence for Water organised the final project workshop “Salient outcomes of the European R&D projects on MBR technology” on 31 March and 1 April 2009 during the Trade Fair Wasser Berlin. This event was kindly endorsed by the International Water Association, sponsored by Veolia Water, and supported by the European Membrane Society, the European Membrane House and the European Desalination Society.

MBR-Network is a coalition of four major research projects financed by the European Commission, all entirely dedicated to further development of the MBR technology, the membrane based process for advanced wastewater treatment. These projects engaged about 50 European and international companies and institutions and will be completed by the end of the year 2009 after more than 3 years of intensive activity. Significant technological breakthroughs have been generated and key know-how which has further improved the competitiveness and acceptance of this innovative wastewater treatment process.

Results of fundamental and applied research were unveiled by the project partners and international delegates in about 40 oral presentations and in many posters. In addition, other groups and companies versed in the MBR field presented their projects, outcomes and products in posters. All aspects of the MBR technology covered by the European projects were reported during the workshop sessions: membrane fouling characterisation and monitoring, membrane fouling control and cleaning, process modelling and control, novel European MBR technologies, process integration and new processes, full-scale implementations, including economics and market trends.

Opening session with international key-note speakers

After a short welcome message addressed by Boris Lesjean of Berlin Centre of Competence for Water, Germany, the workshop started with a session of key-note lectures held by international speakers. Prof. Roger Ben-Aim, Chairman of IWA Specialist Group "Membrane Technologies" gave the opening addresses highlighting key facts on the European projects, in particular the significant investment efforts of the European Commission on the MBR technology through the MBR-Network projects. He introduced the very tight program of the workshop and reminded that each presentation on average is the results of 3 years of full-time work from one engineer or a PhD degree. Michel Schouppe, representative of the European Commission, Research Directorate, presented the EC activities and strategy on membrane R&D, highlighting the numerous projects funded by the Commission on water technologies in the 6th and 7th Framework Programmes and the objectives of the European Commission to support the European industry of environmental technologies. Prof. Nazim Cicek, University of Manitoba, Canada provided an overview of the American MBR market and of the international R&D efforts on MBR technology. Prof. Tony Fane, Singapore Membrane Technology Centre held an inspiring lecture on the well known “TMP jump” and disclosed a working hypothesis that also in low pressure membrane systems, the polarisation layer of organic substances could explain the “self accelerating fouling phenomena”. Finally Prof. Chung-Hak Lee, Seoul National University, South Korea, held a convincing talk on a

novel microbiological approach to control fouling while reducing the biofilm formation through quorum quenching enzyme acylase immobilized on magnetic particles.

Audience with key-note speaker M. Schouppe (European Commission)

Session "Membrane fouling characterisation and monitoring"

The first session presenting the outcomes of the European projects was chaired by Prof. Joao Crespo of the New University of Lisboa, Portugal. The first talk was held by Renata Mehrez, Technische Universität Berlin, Germany, who described the successful development of a sensor for on-line monitoring of proteins and polysaccharides, potential fouling compounds. The two next speakers, Prof. Jaap van der Graaf, Delft University of Technology, The Netherlands, and Teresa de la Torre, Berlin Centre of Competence for Water, Germany, presented results of similar investigations aiming at identifying chemical or chemical indicators of MBR sludge filterability. Similar conclusions could be drawn on the fact that today, no single chemical parameter can be used as unequivocal indicator of sludge filterability. However, standard filtration methods can provide a reliable indication of the fouling propensity. In addition, both pointed at the flocculation status of the mixed liquor as a key parameter impacting the sludge filterability. Prof. Joao Crespo of the New University of Lisboa, Portugal, presented the potential of applying novel techniques, such as 2D-fluorescence and molecular tools to characterise and monitor MBRs. 2D-fluorescence is a promising on-line monitoring technique that can accelerate decision taking as response to deterioration of MBR performance. Prof. Alain Grasmick, University of Montpellier, France, presented the work performed in the project by the team of the University of Technology, Sydney, Australia. Studying the effect of support media in membrane fouling, while using kaolin clay suspension at different aeration rates, they could demonstrate that the presence of support media helped not only to reduce the fouling propensity by scouring the membrane surface, but also changed the particle layer formation pattern on the membrane surface and increased the porosity. Finally, Prof. Gary Amy of the UNESCO-IHE Institute for Water Education, Delft, The Netherlands presented a study looking at characterising foulants in MBR treatment and optimising cleaning, highlighting the impact of the water type used to prepare the cleaning solution (permeate, tap water or demineralised water).

Session "Membrane fouling control and cleaning"

Under the chair of Prof. Corinne Cabassud, INSA Toulouse, France, the session "membrane fouling control and cleaning was introduced by Prof. Alain Grasmick of the University of Montpellier, France. This study could demonstrate at lab scale that appropriate aeration conditions could control the deposition of suspended solids on the membrane, but also partly the presence of the biofilm, therefore minimising the membrane fouling on long terms. The following work presented by Prof. Corinne Cabassud of INSA Toulouse, France, provided complementary insights on membrane fouling. This study highlighted the impact on module design on fouling phenomenon, particularly the compactness of the system, but demonstrated also that too much air scouring could be contraproductive and lead to additional membrane fouling. They also demonstrated that the addition of fine particles (500 nm) could improve rejection and flux recovery by backwash. When adsorption mechanisms occurred between the particles and the organic matter of the effluent, the long term fouling of the system was reduced. Dr. Giuseppe Guglielmi of the University of Trento, Italy, presented a 2-year study on the dewaterability, filterability and settleability of MBR excess sludge in relation with characterisation parameters. They key result was that the MBR excess sludge can be dewatered with typical dewatering facilities used for CAS plants, although due to the high content of organic matter in the liquid phase, a proper conditioning step would be needed. Vera Iversen, Technische Universität Berlin, Germany, presented a comprehensive study were 30 additives were assessed against their impact on enhanced filtration flux. The results at pilot scale showed that cationic polymers were able to slow down the fouling rate while acting on the floc structure of the mixed liquor. Aurélie Grelot of Anjou Recherche, France, showed that cleaning chemicals other than chlorine could be considered to remove organic fouling from the membrane, such as hydrogen peroxide or enzyme-based surfactants. However, increased concentration and soaking time would be required. As last speaker of the session, Enrico Fatarella presented a promising development using nonwoven textile cloths coated with elctrospun nanofibers. Similar surface characteristics and pore sizes comparable to conventional microfiltration membranes could be achieved, with a critical flux twice as high (i.e. > 200 L/h.m²) when determined in filtration test cells.

Session "Process modelling and control"

Prof. Jaap Van der Graaf, Delft University of Technology, The Netherlands, chaired this session dedicated to process modelling and control of the MBR technologies. Prof. Ingmar Nopens, BIOMATH, Ghent University, Belgium, presented the outcomes of a review performed by a collective of seven partners of the MBR-Network on the experience of biological modelling of the MBR process with conventional activated sludge models (ASM), and the specificities bound to the membrane process. Julie Jimenez of Anjou Recherche, France, provided further details on the impact of sludge age and primary sedimentation on the parameters of ASM-based biological models. Chris Thoeye of Aquafin, Belgium, presented an application where a biological model was successfully implemented to optimise the operation of the full scale hybrid MBR plant of Schilde. In parallel, the operational algorithms of a patented hybrid DUAL MBR system were demonstrated on pilot scale. Heleen De Wever of VITO, Belgium, highlighted another control concept based on on-line fouling sensor measurement and a fuzzy logic processor to optimise the filtration step. Based on first pilot results, about 20% of energy saving could be achieved compared with a more conventional approach. The session was completed by two presentations dealing with the hydrodynamics of MBR systems using computer fluid dynamic (CFD) softwares. Jan Saalbach, of the company FlowConcept, Germany, demonstrated how CFD analysis could help optimise the design of MBR plants, using examples of large full-scale MBR plants such as the very well known Nordkanal WWTP. On behalf of the Autralian partner of the University of New South-Wales, Steffen Buetehorn, RWTH-Aachen, Germany, resumed the demonstration of the applicability and usefulness of CFD softwares by showing some CFD studies performed on MBR units of various scales (from pilot up to full scale). The CFD models could be well calibrated using tracing experiments with lithium chloride.

Poster session
The last session of the first day was a dedicated poster session. About 50 posters were presented from MBR-Network partners but also from other companies and institutions, among which 25 posters competed in the "Best Student Poster Contest". The international jury composed by the international key-note speakers and chaired by TorOve Leiknes, NTNU, Norway, was impressed by the high quality of the posters presented by the students, both in terms content and presentation. The jury finally decided to award the three MBR-Network prices of €1,000 to the following presenters and posters:

- C. Binz, EAWAG, Switzerland: Development Perspectives of on-site MBR treatment plants in the municipal wastewater sector of China
- P.G. Rathnasiri, University of Moratuwa, Sri Lanka: Effects of biofilm formation on oxygen transfer membranes in membrane micro-aerated anaerobic digesters
- N. Rios, BIOMATH, Ghent University, Belgium: Modeling hydrodynamics in MBR systems using Computational Fluid Dynamics

Poster award winners and international jury

Gala dinner "Berlin of the golden 20's"
At the end of the day, the participants of the MBR-Network workshop could join the gala dinner organised by the host Trade Fair "Wasser Berlin 2009". For the workshop attendees, the gala dinner was kindly sponsored by Veolia Water. The dinner literally plunged the participants into the atmosphere of the Berlin 20's with cabarets and jazz orchestra: a very pleasant excursion back to the golden times of Germany's capital.

Session "Novel European MBR technologies"
The second day started by a session chaired by Adriano Joss, EAWAG, Switzerland, and focused on the new MBR technologies developed in the MBR-Network projects. Steffen Buetehorn, RWTH-Aachen, Germany, presented some work dealing with the optimisation of surface modification of the Puron hollow fibre membranes to increase their filtration performances, and the first time use of Computer Tomography (CT) to scan the exact module

geometry and fibre distribution for hydraulic modelling. Olivier Lorain reviewed the progress achieved in the MBR-Network projects by the company Polymem, France, towards the development of a proprietary capillary fibre MBR system. Martin Heijnen presented a radically new MBR technology based on Fibre Sheet membranes, fully developed by the German company Inge GmbH during the Amedeus project. Ulrich Brüss of A3 Water Solutions, Germany, gave a review on the history and references of their flat-sheet MBR system and on the optimisation of the filtration and cleaning operation performed together with Anjou Recherche. Dirk Volmering, KMS, Germany, demonstrated the technological progress of the Puron MBR system in the recent years, and showed how the product became competitive to world leaders. Finally, Daniel Vilim and Petr Hlavinek of the company Envi-pur, Czech Republic, presented a new range of containerised turn-key MBR plants (50 to 500 inhabitants) and first case studies performed in Czech Republic to retrofit existing WWTPs.

Session "Process integration and new processes"

Prof. Petr Hlavinek, Brno University of Technology, Czech Republic, chaired this session looking at issues related to process design and operation of MBR systems. Adriano Joss, EAWAG, Switzerland, reported the results of a long term study with 3 large MBR pilot plants on the effect of organic peak loads on biofouling of MBR treating municipal wastewater. The study could not show a strong correlation between high organic peak loads (high F/M ratios) and membrane permeability. Heleen De Wever, VITO, Belgium, presented an analysis of the pros and cons of the two design configurations with the membrane modules set up inside or outside the biological reactor. She proposed a simplified decision tree to select the appropriate solution. Regina Gnirss, Berliner Wasser Betriebe, Germany, reported on the operation of an MBR demonstration plant designed for advanced nutrients removal. Up to 99% phosphorus and 95% nitrogen elimination could be achieved in 24h samples. Jan Willem Mulder, Water Authority of Hollandse Delta, The Netherlands, provided the experience acquired on the Heenvliet plant, conventional plant being retrofitted with an MBR unit set up "in series". Prof. TorOve Leiknes, NTNU, Norway, provided detailed results on pilot investigations carried out on the combination biofilm-MBR and highlighted both challenges but also potentials of this technology. Finally, Prof. Chris Buckley of UKZN, South Africa, showed the first results of a promising concept of an anaerobic membrane bioreactor based on baffled reactors for domestic wastewater treatment of small and remote communities.

Session "Full-scale implementations, economics and market"

Prof. TorOve Leiknes, NTNU, Norway, chaired the laste technical session of the workshop. Greet de Gueldre (Aquafin, Belgium) presented a study performed with European stakeholders on the market interest and technical potential of MBR standardisation in Europe. This initiative resulted in a formal procedure of standardisation (CEN Workshop Agreement N° 34 on Submerged Membrane Bioreactor Technology). The CEN working group was chaired by Prof. Franz-Bernd Frechen (University of Kassel, Germany), who presented the outcomes of the procedure. Bart Verrecht, on behalf of Cranfield Univerisity, United Kingdom, presented an aeration energy model for immersed membrane bioreactors calibrated to two full scale plants. The model can serve as a benchmarking tool for the energy requirement of MBR plants during the design or operation phases. Murad J. Bino and Shihab N. Al-Beiruti, of the Inter-Islamic Network on Water Resources Development and Management, Jordan, presented a study on the potential of MBR technology for municipal wastewater treatment applications in the Middle East and North African (MENA) Region, looking at the total life cost of one case study for decentralised sanitation. Lucas Maes, Aquafin, Belgium, presented a very comprehensive investigation looking at the economic potential of large scale plant retrofitting with a patented hybrid MBR concept in newly accessed countries of Europe. Through a detailed cost estimation of a real plant in Bulgaria it was concluded that the hybrid DUAL MBR technology could be a cost-beneficial alternative to conventional MBR schemes in situations where water reuse is required. Christoph Brepols, Erftverband, Germany, provided detailed insights in the economics of large-scale membrane bioreactors, using in particular the data accumulated since 2004 with the

operation of the Nordkanal MBR plant, one of the largest MBR units in Europe. Finally, Boris Lesjean, Berlin Centre of Competence for Water, Germany, presented a comprehensive market survey of the MBR process in Europe, highlighting the potential of the technology and current trends.

Closure session and awards

Prof. Roger Ben-Aim, Chairman of the IWA Specialist Group on Membrane Technologies, chaired the closing session of the workshop, and introduced a very special guest who kindly held the closing lecture of the workshop: Prof. Kazuo Yamamoto (University of Tokyo, Japan). Prof. Ben-Aim reminded that Prof. Yamamoto invented the submerged MBR technology some 20 years ago and that he can as such be considered as the spiritual father of MBR professionals attending the event. He also announced that Prof. Yamamoto will receive an honorary award from IWA for his outstanding contribution to the water sector at the upcoming IWA specialised conference on membrane technologies (1-3 September, Beijing, China). Prof. Yamamoto then presented, with very much humour and humbleness, his lecture "Submerged MBR technology: an unfinished international adventure of 20 years", which demonstrated the pitfalls of developing breakthrough technologies, but also the promises and new developments of the MBR process. The workshop was closed after an award ceremony where the three winners of the best student poster contest were given their prizes by the international jury.

Prof. Yamamoto (University of Tokyo, Japan), father of the immersed MBR process

Conclusion

More than 220 international participants attended the workshop, which took place in a very friendly but also studious atmosphere. The participants will certainly remember the workshop endorsed by IWA as one of the most successful and pleasant events dedicated to the MBR process in the history of this advanced treatment technology.

The proceedings and the presentations of the workshop, as well as the project reports, can be downloaded from the MBR-Network website:
www.mbr-network.eu/mbr-projects/downloads-common.php

www.mbr-network.de: web-platform dedicated to the international MBR community

The MBR-Network can be found online at www.mbr-network.eu. This website provides detailed information on the European projects devoted to MBR technology including all public reports. Additionally, it is intended and designed as a communication and exchange platform dedicated to the worldwide MBR community. **More than 1,200 international professionals** have already joined the MBR-Network platform.

The following free services are offered online:

- A database of about **150 companies and institutions** active in the MBR field;
- About **1,500 references** of articles, books and conference proceedings related to MBR with search engine and automatic alert per email;
- A **web-based discussion forum** between members of the MBR-community.

Companies, institutions or individuals interested by or active in the field of MBR technology are invited to register online and provide relevant news or information to the MBR community through this website.