Monitoring, investigation and analysis of pathogens in MBR treated water at Hammarby Sjöstadsverk, Stockholm

IVL Report C 39

AQUA-Q
Online Water Control & Ozone Application

Ramnath Lakshmanan
Ulla Chowdhury
Sudhir Chowdhury

IVL Swedish Environmental Research Institute

Christian Baresel
Hugo Royen

Aqua-Q AB
Box 115
SE-123 22 Farsta
Sweden

IVL Swedish Environmental Research Institute
Box 210 60
SE-100 31 Stockholm
Sweden

Contact:
Ramnath Lakshmanan, ram@aqua-q.se, AQUA-Q
Sudhir Chowdhury, Sudhir@aqua-q.se, AQUA-Q
Christian Baresel, christian.baresel@ivl.se, IVL

Table of Contents

Summary

This report summarises the findings from operations with AQUA-Q's online real-time water quality monitoring system on the effluent from a pilot Membrane Bioreactor (MBR) within the co-financed VINNOVA-project entitled Tomorrows Sewage Treatment Plants – A Utility Production Facility (Morgondagens kommunala vattenrening – en produktionsanläggning för nyttigheter).

Significant progress has been made during recent years with regard to real-time water quality monitoring systems for monitoring and control of water quality and water treatment operation. This report provides an evaluation of the efficiency of the MBR process at the R&D-facility Hammarby Sjöstadsverk, Stockholm, Sweden. This includes the monitoring of larger contaminants (>0.2μm) in effluent water of the MBR process. Aqua-Q's early warning system, WQM-100, has monitored the water quality 24/7 during the spring 2014 and the particle/micro-contaminants removal efficiency of the MBR was evaluated.

Aqua-Q's real-time monitoring system detected that one of the membranes (membrane A) of the MBR-process had a constant leakage of micro-contaminants. Periodic variations in the measured micro-contaminants concentration could have been caused by an overload in MBR process and also by a potential filter breakthrough. However, during the test period no significant problems were observed in the MBR-process control.

For evaluation and verification of the indication from Aqua-Q's real-time monitoring system, complete microbiological analyses were performed with an alternative ISO standard method (Microbiological Survey, MBS) and by a certified environmental laboratory (Eurofins, Stockholm).

The results highlight the importance of real time quality monitoring of processes related to human sources of microbiological growth. Therefore, a better understanding and control of water qualities in water treatment processes is cost and resource effective, and reduces microbiological emissions to the environment.

Keywords

Membrane Bioreactor; water quality; Early warning system; microbiological analysis; micro-contaminants; pathogens.

Abbreviations

MBR	Membrane bioreactor
MBS	Microbiological survey
WQM-100	Water quality monitor
EWS	Early warning system
E.coli	*Escherichia coli*
TVC	Total viable count
TMP	Transmembrane pressure
Cluster 1	Possible bacterial contamination (>1µm)
Cluster 2	Possible parasite contamination (>2µm)
PVDF	Polyvinylidene fluoride
LMH	Litre/m^2/hr
INK	Incoming wastewater
TSS	Total suspended solids
DO	Dissolved Oxygen

1. Background

1.1 Waste water treatment

The human population is growing; nevertheless water demand is increasing even twice as fast as population growth. With that, potable water will be more valuable in the future, than we might ever imagine. The main purpose of wastewater treatment has been to protect the health and well-being of our communities. Among them operations include preventing disease, contamination of water supplies, maintaining clean water for survival of fish, bathing, recreation and conserving water quality for future use **[Bitton G., 2005]**. However, the paradigm has shifted, primarily because of new regulations that include protecting against excess nutrients (nitrogen and phosphorous) microbes, protozoan and virus by implementation of multiple barrier-approach in wastewater effluent **[Spellman R.F., 2008]**. The increasing demand for fresh water implies that water reuse will gain a great importance in the future. For this reason, the effluents from wastewater treatment plants (WWTP) will play a key role in the planning and sustainable management of water resources. This includes the conservation of resources and it will be advantageous for economic development. In addition, water reuse reduces the pressure on natural water resources **[Bernardes A.M, 2014]**.

The membrane separation process applied to water/waste water treatment can be applied in different ways. In the present study, membrane separation is used as the final step in a conventional physical, chemical, and biological wastewater treatment process.

1.2 Membrane separation process

Membrane Bioreactors (MBR) are based on conventional biological active sludge process where the final separation step, usually a sedimentation process, is replaced with membrane separation (Fig. 1). A commercial manufacturer of hollow sheet membranes that operates with an exceptionally low transmembrane pressure (TMP) is being used in this project. The membrane material consists of polyvinylidene fluoride (PVDF) that is highly resistant to acids, caustic and oxidation process. Moreover the pressure drop over the membrane is close to zero and has an average pore size of 0.2 µm. The extremely low TMP implies that the membranes are significantly less prone to fouling, have a longer lifetime, and can have extended operating periods between cleaning. Other characteristic ranges for MBR include pH (1-11), temperature (Max. 50°C), TMP (0.01-0.04 bar), liquid capacity (178 gallons) and flux (10-30 LMH).

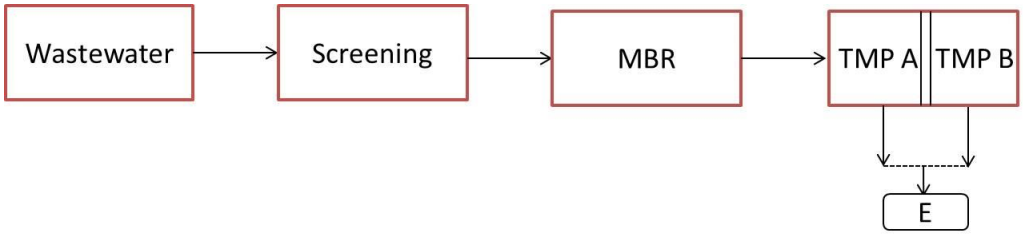

Fig 1. Overview of wastewater treatment process with MBR. [MBR – Membrane bioreactor; TMP – Transmembrane pressure of membranes A&B; E – effluent/treated water]

1.3 AQUA-Q WQM-100 - Online real-time water quality monitoring system

Aqua-Q's early warning system (WQM-100) for water is a Swedish innovation. It is in this project used to monitor the quality of effluent water from a MBR-process. The WQM-100 is a unique internet-based communication system that can quickly communicate with various key persons, e.g. agencies for water safety control and wastewater operational managers. The system operates 24 hours a day, 7 days a week. It has full automation and is robust and sensitive in detection of lower level contaminants (Fig. 2). The system consists of a chain of fast information transfers (every minute) with modern communication technology, sensors, detection, continuously refined evaluation and hygienic sampling of water when required with logging function. This warning system is intended to immediately detect any deviation in water quality that may or may not include pathogens but can indicate risk of biological growth (bacteria and/or parasites in the water system that can trigger outbreaks of disease).

Fig 2. AQUA-Q WQM-100 for monitoring and detection of contaminants.

The pathogens (Fig. 3) are of concern to humans as they cause diarrheal diseases and their origin mainly from treated/untreated wastewater and surface water.

E-coli **Giardia** **Cryptosporidium**

Fig 3. Examples of pathogens such as bacteria and parasites that are harmful to human health and environment.

One important feature of the WQM-100 system is that it automatically can capture water samples when there is a risk for microbiological contamination indicated by the system. The captured samples automatically goes into a clean cold storage and alarms are sent including information that water samples were collected.

1.4 Onsite microbiological analysis

Microbiological survey (MBS) (ISO 16140:2003) is an alternative innovative rapid colorimetric bacteria test kit with an incubator (Fig. 4) to perform microbiological test on food, water, and surfaces onsite. The main features of the MBS include high speed of analysis, ease of use, high sensitivity and selectivity, and lower analysis cost when compared to other existing methods.

Fig 4. MBS for rapid detection of microorganisms.

The MBS is an important alternative method to confirm or reject the existence of *E.coli* within a few hours, which is impossible with standard validated methods that require almost two weeks. Reducing the analyses time and obtaining primary information about potential contaminations is not only important for process control and optimization but also for precautionary measures that may be required in the case of contaminations. Furthermore, selectivity reagents of the system are dependent of specific microorganisms, such as total viable count, coliforms (total and *E.coli*), *enterobactereriaceaea*, *staphylococcus aureus*, *pseudomonas aeruginosa*, *salmonella spp*., *enterococcus faecalis* and yeasts (saccharomyces spp.). Both quantitative and qualitative results can thus be obtained. The MBS test kit is commercially available on the market.

1.5 Standard microbiological analysis

Eurofins is an independent certified environmental testing lab in Stockholm (SS-EN ISO 9001/14001) with a wide range of quality analysis including chemical, microbiological and ecotoxicity tests. Analyses of samples sent to the laboratory have been analysed according to the ISO standard. For further information of these standards see the analysis protocol from Eurofins in Appendix IV.

2. Aim of the study

This innovative study was mainly aimed to monitor the quality of the MBR effluent in real-time by using the WQM-100. More specifically this means to examine the biological contaminants in treated water both quantitatively and qualitatively. The size and concentration of contaminants that pass through the discharge can be related to possible bacteria and parasites growth as well as predict process variation and its consequences.

Furthermore, the study aimed to collect water samples on normal process conditions as well as abnormal conditions, and to analyze them for the presence of standard fecal indicators like *E.coli*, coliforms, total viable bacteria count, and parasites such as Cryptosporidium/Giardia.

Finally, the aim was to evaluate the usefulness of real-time water quality monitoring by WQM-100 for process optimization and fast access to information on variations in the process that may lead to negative and costly consequences for the process.

3. Methodology

3.1 Setup of sampling points and process design

The incoming wastewater undergoes a primary treatment process known as screening for elimination of larger particles. Further, nutrients such as organic matter, nitrogen, and phosphorous are eliminated from the wastewater with conventional pre-sedimentation, activated sludge process and integrated in the MBR as a final step. The separation consisted of two membrane units (Filter A and Filter B) with individual TMP measurements for comparison of effluent efficiency. The AQUA-Q WQM-100 was connected with the effluent of Filter A from March 10 to April 29 2014 and with the effluent of Filter B from April 29 to May 27. For the analysis of wastewater before membrane separation, samples were collected from the top of MBR tank. Samples of MBR effluent were collected before and after the AQUA-Q WQM-100 for the analyses of bacteria using MBS (Fig. 5).

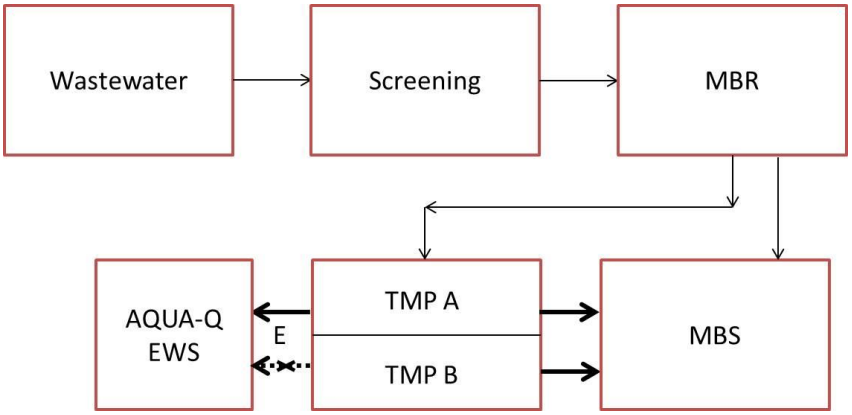

Fig 5. Process setup and sampling points for analysis. [MBR – Membrane bioreactor; MBS – Microbiological survey, TMP – Transmembrane pressure; EWS –WQM-100].

3.2 AQUA-Q WQM-100 analysis

The WQM-100 is optimized to measure micro-contaminants in a flow of water. A pre-filter with pore size of 60 µm is feed with continuous flow and is followed by the main sensor. The microprocessor of the WQM-100 transforms the contaminant counting into two clusters depending upon their size, concentration, and optical behavior, which is related to possible bacteria and parasite contamination. The processed values and results are presented in contaminants/ml or 100 ml over a time period and a threshold can be defined for various water qualities and depending on water fingerprint.

3.3 Onsite microbiological analysis

The MBS kit consists of zero sample and reaction vials for each sample of interest. In the present study, total viable count (TVC) was performed using MBS at 30° C and 37° C. The MBS kit provides both qualitative and quantitative information by color change and CFU/100 ml, respectively. The results are reported in Log CFU/100ml. In most cases, triplicate samples were performed for the determination of the standard deviation. However, the confirmatory samples collected on May 26 2014 were validated within a certified microbiological testing laboratory in Stockholm (Eurofins). In total six confirmatory samples were sent to Eurofins and parameters such as TVC, *E.coli* and coliforms were analyzed. Among them, TVC was studied at 21° C with 7 days incubation.

4. Results

4.1 Overview of MBR effluent water quality

The results indicate that the AQUA-Q WQM-100 observed a varying contamination in the effluent water from the MBR-process (Fig. 6). The variation in the concentration of micro-contaminants in cluster 1 (representing probable bacteria size 0.5 – 3µm) is much higher than compared to cluster 2 (representing probable parasite size 3 – 16µm) as shown in the diagram (Fig. 6). Cluster 1, which corresponds to possible micro-contaminants, can be associated with different types of bacteria specifically fecal contamination such as *E-coli* and coliforms. Whereas, the cluster 2 corresponds to possible micro-contaminants associated with parasites like Cryptosporidium and Giardia. The sources of these contaminants are often found in treated wastewater. The results also indicate that the MBR-process is performing much better in removing contaminants of larger size than smaller micro-contaminants.

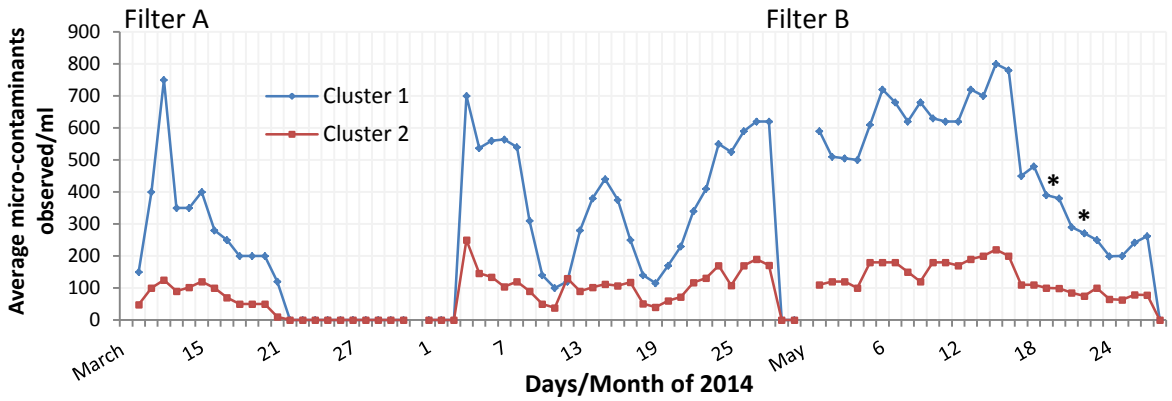

Fig 6. Overview of AQUA-Q WQM-100 monitoring on MBR effluent (March - May 2014). [Cluster 1 – detection above 1 µm and Cluster 2 – detection above 2 µm; March 10th to 29th April – Filter A connected to WQM-100 and 29th April to May 27th Filter B connected to WQM-100; * - Pre-filter cleaning time].

The contaminants in the effluent act as powerful carriers for microbiological populations as bacteria and parasites can attach to these contaminants and travel downstream. It is suspected that the contaminants/micro-contaminants might constitute undissolved substances from pharmaceutical and personal care products residues. More investigation is needed to verify this. In this project, only the target fecal indicator bacteria have been analyzed while no parasite analysis has been performed.

4.2 AQUA-Q WQM-100 and microbiological analysis on MBR filter B

As a first step, samples before and after MBR filter B were collected on May 26th at 9.00 and 14.00 hrs for the analysis of contaminants/particles, pathogens, TSS, DO and pH. The results from TSS, DO and pH for incoming wastewater were 6352 ± 241 mg/L, 0 mg/L and 6.7 ± 0.7, respectively. The treated wastewater samples were below the detection limit for TSS and DO that are in the range of 8.4 ± 1.2 mg/L for such samples. However, pH was 6.8 ± 0.3 and contaminants/micro-contaminants in cluster 1 were determined to about 200/ml and cluster 2 about 50/ml, respectively (Fig. 7). As mentioned in section 4.1, a similar variation or disturbance was observed in WQM-100 representing random high peaks within 24 hours of surveillance. The reason for the sudden increase in peaks may be due to unexpected increase of contaminants/micro-contaminants released from the MBR process during the relaxation time or pressure drop or any other process variations that were not specifically investigated.

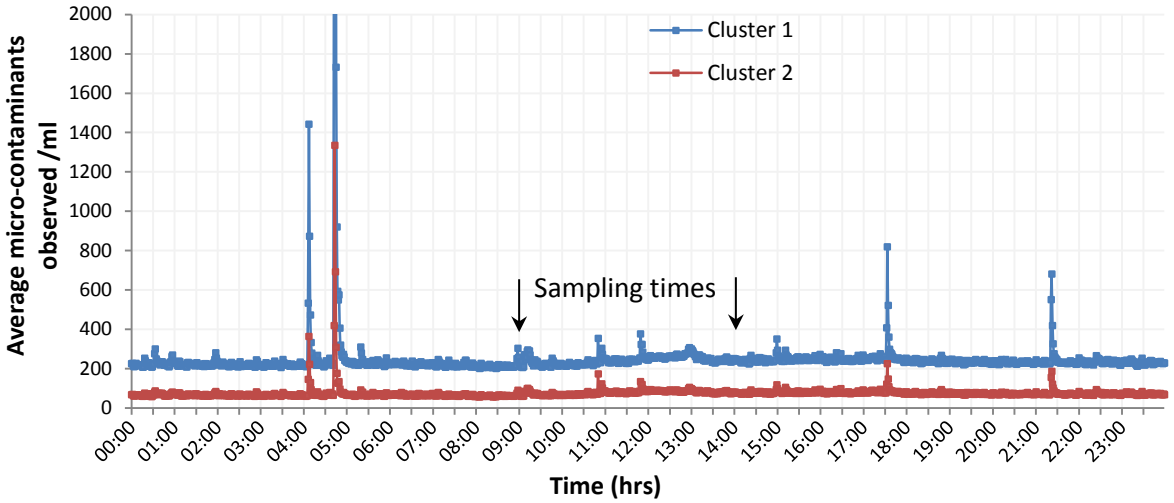

Fig 7. EWS data on effluent from MBR filter B. [c – Sampling points (Time – 09.00 and 14.00 hrs) for microbiological analysis on 26th may 2014; Channel 1 – detection above 1 µm and Channel 2 – detection above 2 µm].

On May 20, 10.45 hrs, it was observed that the MBR Filter A was leaking due to significant increase in TSS and the process was shut down after two hours. However, a loss in efficiency could already be detected three weeks earlier by using data from the AQUA-Q WQM-100. This is one of the examples where real-time monitoring of water quality can help to detect problems before any negative impacts to the process, humans, or the environment occur.

Furthermore, microbiological analysis results showed confirmation of contaminant concentrations when using the MBS and standard analyses (Eurofins; Table 1). The zero value found in TVC at 30°C could be due to improper signal from the sample vials to the MBS software. Unfortunately, a repetition of analysis was not possible due to lack of samples, time and instrumentation onsite.

Table 1. Data from microbiological analysis (All data represented in the table as CFU/100ml). [Ink – Incoming waste water; 9.00 and 14.00 hrs – sampling time points; 1 and 2 – duplicates; B represents MBR filter; TVC – Total viable count; Detail analysis report from Eurofins and other relevant information on initial experiments can be found in appendix].

Samples	TVC at 22°C	Slow growing	Coliforms	*E.coli*	TVC at 30°C
Ink 9.00 hrs	>5,000,000	>5,000,000	>2,400,000	1,100,000	493,900,000
1B effluent 9.00 hrs	43,000	170,000	40	10	1,660
2B effluent 9.00 hrs	94,000	240,000	40	10	0
Ink 14.00 hrs	>5,000,000	>5,000,000	>2,400,000	770,000	568,700,000
1B effluent 14.00 hrs	69,000	260,000	30	<10	196,300
2B effluent 14.00 hrs	79,000	2,000	59	<10	0

According to the microbiological analysis, microbial concentrations in the treated wastewater were 3 to 5 orders of magnitude lower than in the wastewater before membrane separation. Moreover, the total and slow growing microorganisms have dominated the concentration when compared to *E.coli* and coliforms. This may be put into relation by using an example in California, United States, were water reuse criteria states that, coliforms higher than 25 CFU/100ml are not suitable for irrigation or

for farm workers on recycled water. When the coliforms concentrations rise above 25 CFU/100ml, then recreation activities (i.e. swimming or full body exposure) are prohibited according to the goals described in protection for public health. As a consequence, higher concentrations affect the gastrointestinal tract in fish and children less than 11 years old are at greater risk from exposure (USEPA, 2012). In most of the countries *E.coli* is regarded as a cheap way to indicate the existence of parasites in water. In the present case, the MBR process is an efficient technology for secondary wastewater treatment considering the pore size (0.2µm) and removal efficiency of the present membrane filter; even so, it does not achieve 100% elimination of bacteria and parasites. It was further evident from the results that increase in number of contaminants/micro-contaminants observed by the AQUA-Q WQM-100 is directly proportional to microbial presence in treated wastewater.

5. Conclusions

This report highlights the advantages and significance of real-time water quality monitoring by the AQUA-Q WQM-100 for microbial contamination in treated wastewater. The monitoring on water quality was accomplished by measuring the increase in number of contaminants/micro-contaminants over a certain period on effluent from both MBR filter A and B. The microbiological investigation performed with both MBS and Eurofins analysis confirmed the presence of bacteria in MBR-treated wastewater. It is proposed that the MBR process would need further investigation on the efficient removal of bacteria with up to 100 % and continuous monitoring of the effluent water. The WQM-100 is recommended for water quality and process control.

Further, despite the short monitoring period after start-up of the system, the gradually deterioration and finally breakthrough of filter A could be concluded, which for the first time shows another potential useful application of the system for efficient process control. The knowledge of system deterioration can prevent process failures and downtimes of treatment processes can be avoided by sensitive real-time monitoring. Long-term monitoring to observe the seasonal variations is recommended for the next study phase. For now, the purpose assigned in this project has been fulfilled and AQUA-Q expects to be a part of an eventual continuation of this project.

6. Recommendations

To avoid operational problems in the future it is recommended to run long-term (>1 year period) observation using the WQM-100 for the overall efficiency of the MBR process. Unexpected leakage or inadequate process efficiency may then be detected and open for the possibility to be thoroughly understood. Finally, microbial (i.e. *E.coli*, Coliforms and total viable count) and parasites (i.e. Cryptosporidium and Giardia) analyses are crucial in regular basis to achieve high proficiency with the MBR process and contaminant-free water.

7. Acknowledgements

This report comprises one activity within the co-financed VINNOVA-project entitled *Tomorrows Sewage Treatment Plants – An Utility Production Facility* (Morgondagens kommunala vattenrening – en produktionsanläggning för nyttigheter). It is an open accessible report. When using parts of the report, a clear reference to the source must be provided.

The authors would like to thank the staff at the R&D-facility Hammarby Sjöstadsverket for all support. Special thanks to Staffan Filipsson that helped the project team throughout the whole project.

8. References

Bernardes M Andrea, 2014. General aspects of membrane separation. Electrodialysis and water resuse, D.O.I: 10.1007/978-3-642-40249-4_2, Springer, Berlin; Pp: 3-9.

Bitton Gabriel., 2005. Waste water microbiology. ISBN: 0-471-65071-4; Third edition, John Wiley & Sons.

Luca D.Giovanna, 2013. Removal of indicator bacteriophages from municipal waste water by a full-scale membrane bioreactor and a conventional activated sludge process: Implications to water reuse. Bioresource technology, 129: 526-531.

Spellman R.Frank, 2008. Hand book of water and waste water treatment plant operations. ISBN: 978-1-42007530-4; Second edition, CRC Press.

USEPA, September 2012. Guidelines for water reuse. EPA/600/R-12/618.

Appendix

I. Initial Screening

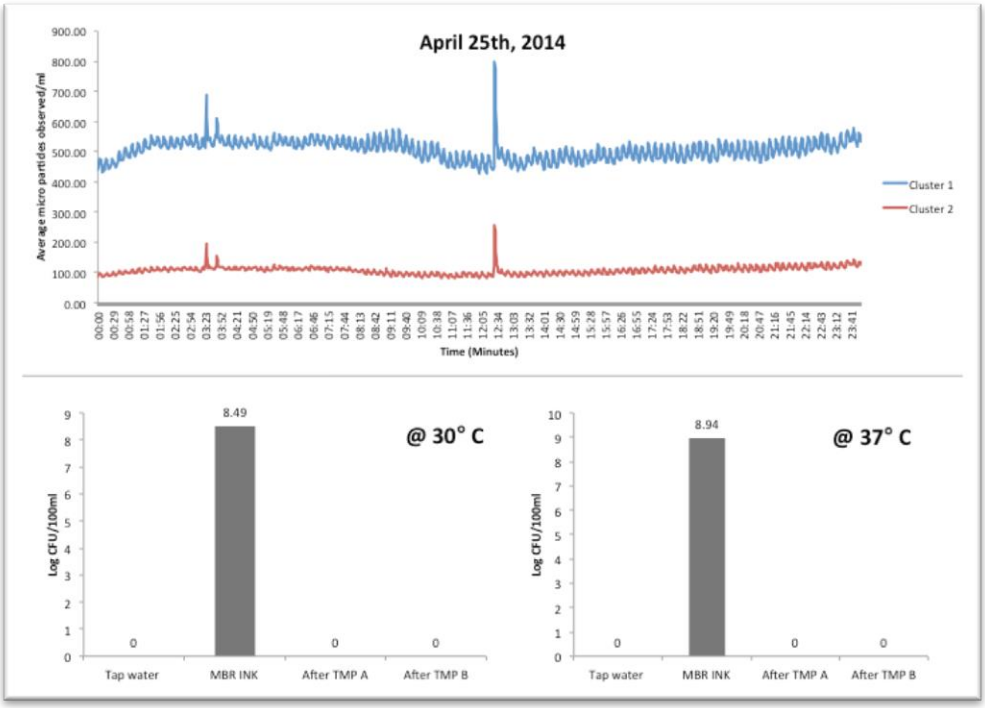

Fig A. Initial screening of effluent from MBR filter A and MBS optimization. Average contaminants/micro-contaminants detected over time points [MBS incubation period – 30° and 37° Celsius; Cluster 1 – detection of possible bacterial contamination and Cluster 2 – detection of possible parasite contamination].

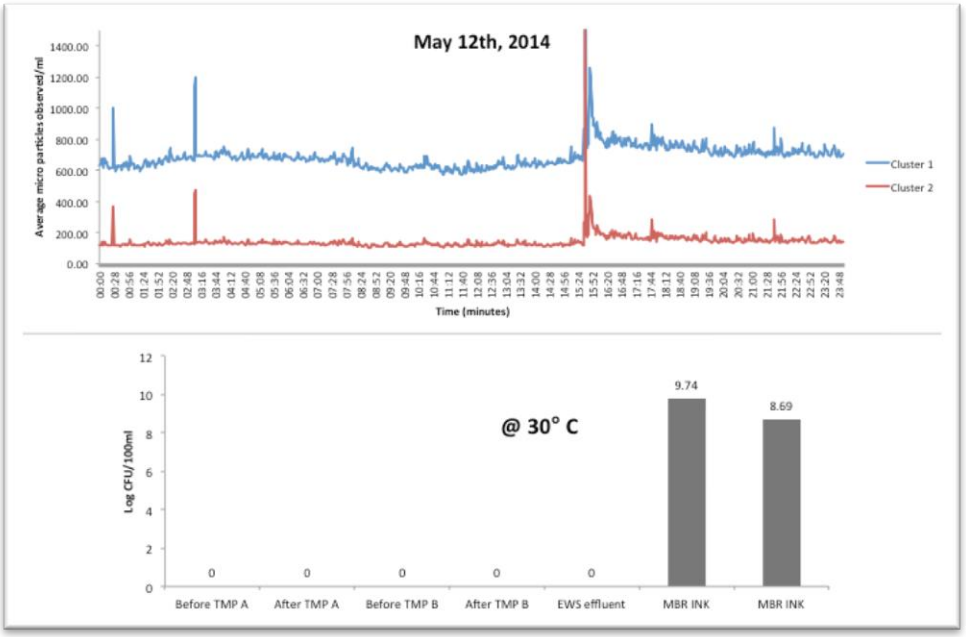

Fig B. Comparison of WQM-100 data on effluent filter B and testing of microbial growth at different sampling points. [A and B – MBR filter A & B; MBS incubation period – 30° Celsius; Cluster 1 – detection of possible bacterial contamination and Cluster 2 – detection of possible parasite contamination]; TMP – Transmembrane pressure; INK – Incoming waste water; EWS effluent – After WQM-100 observation].

II. Performance and importance of pre-filter in AQUA-Q – WQM-100

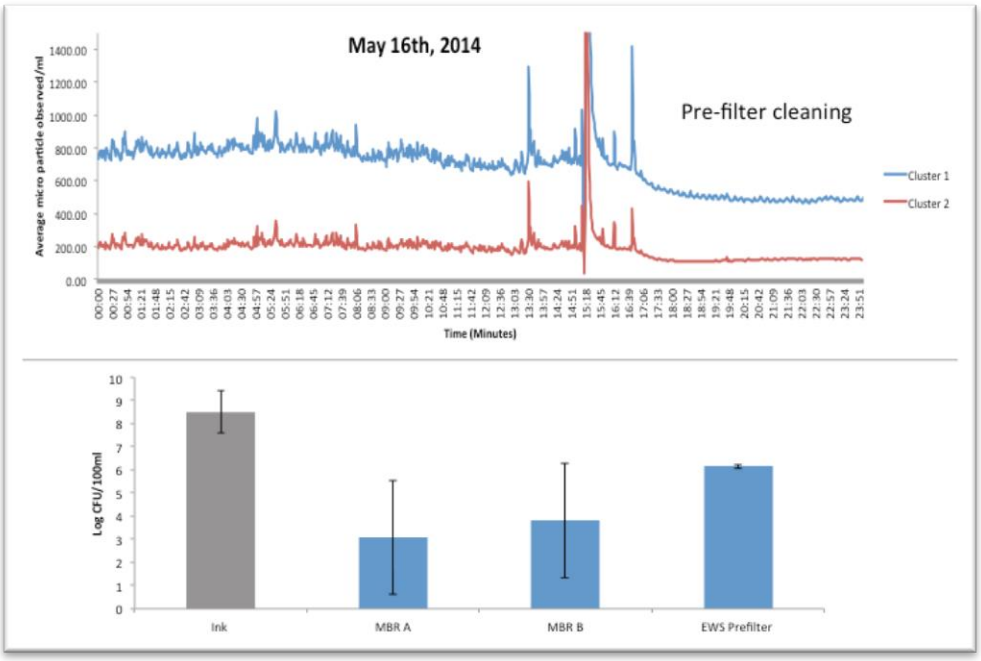

Fig C. Observation after pre-filter cleaning in WQM-100 and difference in microbial concentration. [Cluster 1 – detection of possible bacterial contamination and Cluster 2 – detection of possible parasite contamination; Pre-filter cleaning assists in stable peaks; INK – Incoming waste water; MBR filter A&B; EWS pre-filter – water between the filter was used for microbiological analysis].

III. Prefilter in WQM-100 and during the treatment efficiency drop (MBR A)

Fig D. Observation of used and new pre-filter attached in the WQM-100. [Left – clogged pre-filter in WQM-100; Right – New pre-filter before installation with MBR A effluent]. These clogged contaminants/micro-contaminants are normally not visible to the naked eye but can be observed in a filter.

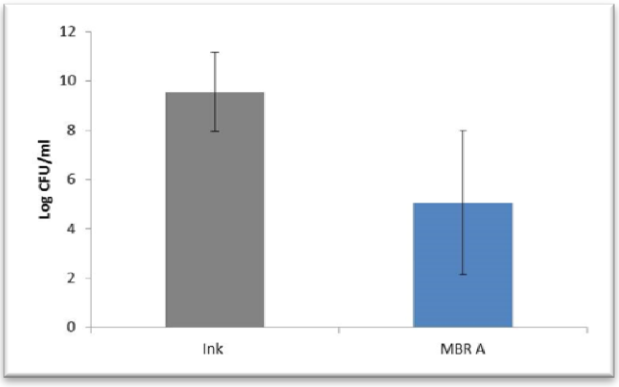

Fig E. Comparison of effluent on microbiological analysis from MBR filter A effluent at the time of damage detected. [INK – Incoming wastewater; MBR filter A treated water].

IV. Detailed report from Eurofins microbiological analysis

Eurofins Environment Testing Sweden (Stockholm)
Box 45185
Torsgatan 26
SE-10430 Stockholm

Tlf: +46 10 490 8110
Fax: +46 8 30 33 94

IVL Svenska Miljöinstitutet AB
Ramnath Lakshmanan
Hammarby Sjöstadsverk
Henriksdalsvägen 58
131 32 NACKA

AR-14-SS-007950-01

EUSEST-00042873

Kundnummer: SL8411815

Uppdragsmärkn.
Morgondagens kommunalavattenrenn.StaffanFillipsson

Analysrapport

Provnummer:	**177-2014-05270763**	Ankomsttemp °C	13
Provbeskrivning:		Provtagare	R.L.
Matris:	Avloppsvatten	Provtagningsdatum	2014-05-26 09:00
Provet ankom:	2014-05-26		
Utskriftsdatum:	2014-06-10		
Provmärkning:	MBR- 9:00 hrs (Ink.)		

Analys	Resultat	Enhet	Mäto.	Metod/ref	
Odlingsbara mikroorganismer 22°C	**> 50000**	cfu/ml		ISO 6222	a)
Långsamväxande bakterier	**> 50000**	cfu/ml		ISO 6222 mod	a)
Koliforma bakterier	**> 2400000**	/100 ml		IDEXX Colilert-18	a)
Escherichia coli	**1100000**	/100 ml		IDEXX Colilert-18	a)

Mikrobiologisk bedömning
Ej bedömt

Utförande laboratorium/underleverantör:
a) Eurofins Environment Testing Sweden (Stockholm), SWEDEN

Changwen Wang, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätosäkerheten, om inget annat anges, redovisas som utvidgad mätosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Sida 1 av 1

Eurofins Environment Testing Sweden (Stockholm)
Box 45185
Torsgatan 26
SE-10430 Stockholm

Tlf: +46 10 490 8110
Fax: +46 8 30 33 94

IVL Svenska Miljöinstitutet AB
Ramnath Lakshmanan
Hammarby Sjöstadsverk
Henriksdalsvägen 58
131 32 NACKA

AR-14-SS-007951-01
EUSEST-00042873
Kundnummer: SL8411815

Uppdragsmärkn.
Morgondagens kommunalavattenrenn.StaffanFillipsson

Analysrapport

Provnummer:	**177-2014-05270764**	Ankomsttemp °C	13
Provbeskrivning:		Provtagare	R.L.
Matris:	Avloppsvatten	Provtagningsdatum	2014-05-26 09:00
Provet ankom:	2014-05-26		
Utskriftsdatum:	2014-06-10		
Provmärkning:	1B- Effluent- 9:00 hrs		

Analys	Resultat	Enhet	Mäto.	Metod/ref	
Odlingsbara mikroorganismer 22°C	**430**	cfu/ml		ISO 6222	a)
Långsamväxande bakterier	**1700**	cfu/ml		ISO 6222 mod	a)
Koliforma bakterier	**40**	/100 ml		IDEXX Colilert-18	a)
Escherichia coli	**10**	/100 ml		IDEXX Colilert-18	a)

Mikrobiologisk bedömning
Ej bedömt

Utförande laboratorium/underleverantör:
a) Eurofins Environment Testing Sweden (Stockholm), SWEDEN

Changwen Wang, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätosäkerheten, om inget annat anges, redovisas som utvidgad mätosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Sida 1 av 1

Eurofins Environment Testing Sweden (Stockholm)
Box 45185
Torsgatan 26
SE-10430 Stockholm

Tlf: +46 10 490 8110
Fax: +46 8 30 33 94

IVL Svenska Miljöinstitutet AB
Ramnath Lakshmanan
Hammarby Sjöstadsverk
Henriksdalsvägen 58
131 32 NACKA

AR-14-SS-007952-01
EUSEST-00042873
Kundnummer: SL8411815

Uppdragsmärkn.
Morgondagens kommunalavattenrenn.StaffanFillipsson

Analysrapport

Provnummer:	**177-2014-05270765**	Ankomsttemp °C	13
Provbeskrivning:		Provtagare	R.L.
Matris:	Avloppsvatten	Provtagningsdatum	2014-05-26 09:00
Provet ankom:	2014-05-26		
Utskriftsdatum:	2014-06-10		
Provmärkning:	2B- Effluent- 9:00 hrs		

Analys	Resultat	Enhet	Mäto.	Metod/ref	
Odlingsbara mikroorganismer 22°C	**940**	cfu/ml		ISO 6222	a)
Långsamväxande bakterier	**2400**	cfu/ml		ISO 6222 mod	a)
Koliforma bakterier	**40**	/100 ml		IDEXX Colilert-18	a)
Escherichia coli	**10**	/100 ml		IDEXX Colilert-18	a)

Mikrobiologisk bedömning
Ej bedömt

Utförande laboratorium/underleverantör:
a) Eurofins Environment Testing Sweden (Stockholm), SWEDEN

Changwen Wang, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätosäkerheten, om inget annat anges, redovisas som utvidgad mätosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Sida 1 av 1

Eurofins Environment Testing Sweden (Stockholm)
Box 45185
Torsgatan 26
SE-10430 Stockholm

Tlf: +46 10 490 8110
Fax: +46 8 30 33 94

IVL Svenska Miljöinstitutet AB
Ramnath Lakshmanan
Hammarby Sjöstadsverk
Henriksdalsvägen 58
131 32 NACKA

AR-14-SS-007953-01
EUSEST-00042873
Kundnummer: SL8411815

Uppdragsmärkn.
Morgondagens kommunalavattenrenn.StaffanFillipsson

Analysrapport

Provnummer:	**177-2014-05270766**	Ankomsttemp °C	13
Provbeskrivning:		Provtagare	R.L.
Matris:	Avloppsvatten	Provtagningsdatum	2014-05-26 14:00
Provet ankom:	2014-05-26		
Utskriftsdatum:	2014-06-10		
Provmärkning:	MBR- Ink- 14:00 hrs		

Analys	Resultat	Enhet	Mäto.	Metod/ref	
Odlingsbara mikroorganismer 22°C	**> 50000**	cfu/ml		ISO 6222	a)
Långsamväxande bakterier	**> 50000**	cfu/ml		ISO 6222 mod	a)
Koliforma bakterier	**> 2400000**	/100 ml		IDEXX Colilert-18	a)
Escherichia coli	**770000**	/100 ml		IDEXX Colilert-18	a)

Mikrobiologisk bedömning
Ej bedömt

Utförande laboratorium/underleverantör:
a) Eurofins Environment Testing Sweden (Stockholm), SWEDEN

Changwen Wang, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätosäkerheten, om inget annat anges, redovisas som utvidgad mätosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Sida 1 av 1

Eurofins Environment Testing Sweden (Stockholm)
Box 45185
Torsgatan 26
SE-10430 Stockholm

Tlf: +46 10 490 8110
Fax: +46 8 30 33 94

IVL Svenska Miljöinstitutet AB
Ramnath Lakshmanan
Hammarby Sjöstadsverk
Henriksdalsvägen 58
131 32 NACKA

AR-14-SS-007954-01
EUSEST-00042873
Kundnummer: SL8411815

Uppdragsmärkn.
Morgondagens kommunalavattenrenn.StaffanFillipsson

Analysrapport

Provnummer:	**177-2014-05270767**	Ankomsttemp °C	13
Provbeskrivning:		Provtagare	R.L.
Matris:	Avloppsvatten	Provtagningsdatum	2014-05-26 14:00
Provet ankom:	2014-05-26		
Utskriftsdatum:	2014-06-10		
Provmärkning:	1B- Effluent- 14:00 hrs		

Analys	Resultat	Enhet	Mäto.	Metod/ref	
Odlingsbara mikroorganismer 22°C	**690**	cfu/ml		ISO 6222	a)
Långsamväxande bakterier	**2600**	cfu/ml		ISO 6222 mod	a)
Koliforma bakterier	**30**	/100 ml		IDEXX Colilert-18	a)
Escherichia coli	**< 10**	/100 ml		IDEXX Colilert-18	a)

Mikrobiologisk bedömning
Ej bedömt

Utförande laboratorium/underleverantör:
a) Eurofins Environment Testing Sweden (Stockholm), SWEDEN

Changwen Wang, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätosäkerheten, om inget annat anges, redovisas som utvidgad mätosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Sida 1 av 1

Eurofins Environment Testing Sweden (Stockholm)
Box 45185
Torsgatan 26
SE-10430 Stockholm

Tlf: +46 10 490 8110
Fax: +46 8 30 33 94

IVL Svenska Miljöinstitutet AB
Ramnath Lakshmanan
Hammarby Sjöstadsverk
Henriksdalsvägen 58
131 32 NACKA

AR-14-SS-007955-01
EUSEST-00042873
Kundnummer: SL8411815

Uppdragsmärkn.
Morgondagens kommunalavattenrenn.StaffanFillipsson

Analysrapport

Provnummer:	**177-2014-05270768**	Ankomsttemp °C	13
Provbeskrivning:		Provtagare	R.L.
Matris:	Avloppsvatten	Provtagningsdatum	2014-05-26 14:00
Provet ankom:	2014-05-26		
Utskriftsdatum:	2014-06-10		
Provmärkning:	2B- Effluent- 14:00 hrs		

Analys	Resultat	Enhet	Mäto.	Metod/ref	
Odlingsbara mikroorganismer 22°C	**790**	cfu/ml		ISO 6222	a)
Långsamväxande bakterier	**2000**	cfu/ml		ISO 6222 mod	a)
Koliforma bakterier	**59**	/100 ml		IDEXX Colilert-18	a)
Escherichia coli	**< 10**	/100 ml		IDEXX Colilert-18	a)

Mikrobiologisk bedömning
Ej bedömt

Utförande laboratorium/underleverantör:
a) Eurofins Environment Testing Sweden (Stockholm), SWEDEN

Changwen Wang, Rapportansvarig

Denna rapport är elektroniskt signerad.

Förklaringar AR-003v35

Laboratoriet/laboratorierna är ackrediterade av respektive lands ackrediteringsorgan. Ej ackrediterade analyser är markerade med *

Mätosäkerheten, om inget annat anges, redovisas som utvidgad mätosäkerhet med täckningsfaktor 2. Undantag relaterat till analyser utförda utanför Sverige kan förekomma. Ytterligare upplysningar samt mätosäkerhet och detektionsnivåer för mikrobiologiska analyser lämnas på begäran.

Denna rapport får endast återges i sin helhet, om inte utförande laboratorium i förväg skriftligen godkänt annat. Resultaten relaterar endast till det insända provet.

Sida 1 av 1