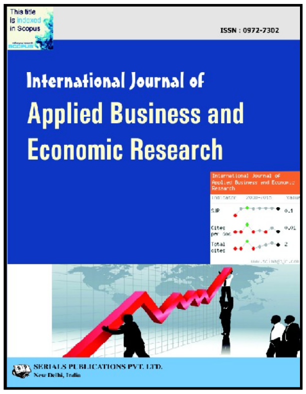

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Impact of High Oil & Grease in the Sewage Affecting the Performance of Advanced Treatment system of Membrane Bioreactor (MBR)

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Abstract: Sewage treatment plant established by Govt. Agencies (Name & Location Confidential) to treat sewage from various sources. The plant is being operated from 2010. During the initial stages all the inlet parameters were under control and treated water quantity and quality achieved continuously through Membrane Bio Reactor (MBR). The plant treatment capacity is started to slide down and various technical trouble shooting done viz. chemical cleaning of the membrane and checking other parameters. It was observed that Oil & Grease level is slowly increased to beyond the design level (18 ppm) and found other parameters are within control. Hence, it is established fact that increased level of Oil & Grease (O&G) is main cause of the reduction of flux and further controlling of the O&G from source or by treatment is only way to increase the output quantity.

Key Words: Environment, Sewage treatment, Plant hygiene, Treatment capacity

1. INTRODUCTION

This study focus on how increased level of oil & grease decrease the treatment efficiency of the sewage treatment in the Membrane Bio Reactor (MBR) system during entry of high Oil contaminated inlet sewage. The membrane is provide to physically separate the biologically treated water from the mixed liquor. The physical separation of the membrane is getting affected due to various pollutant level and other factors, which is more than designed limit of the plant. The plant normally takes 10% extra of any pollutant and produce the reusable type of treated wastewater.

Oil & Grease is normally coming from the canteen / households and other edible oil used in the eatery area (ABASS O. ALADE A. T., 2011). The design value limit is given tender and the plant designed by Construction Company. While operating stage, it is observed some of the key parameters are increased.

The oil & grease is measured by taking regular samples from inlet / equalization tank. The regular daily analyses carried out in in-house built laboratory to regularly monitor the plant. A year analysed report collected and studied the reasons for less flow from MBR.

AWWA / APHA (Standard methods for the examination of water and wastewater, 2005) method is followed for analyses the O&G and other parameters.

2. PLANT DESIGN DETAILS

2.1. Design Parameters

Table 1

Parameters	*Unit*	*Inlet to STP*	*Treated Water*
pH		**7 - 7.6**	**6.8 – 8.5**
Temperature		**Atmospheric**	**Atmospheric**
TSS	mg/l	**195-544**	**< 1.0**
BOD	mg/l	**116-263**	**< 2.0**
Oil & Grease	mg/l	**18**	**BDL**

2.2. Actual O&G Concentration inlet (in ppm) (Nupur, 2014 - 2015)

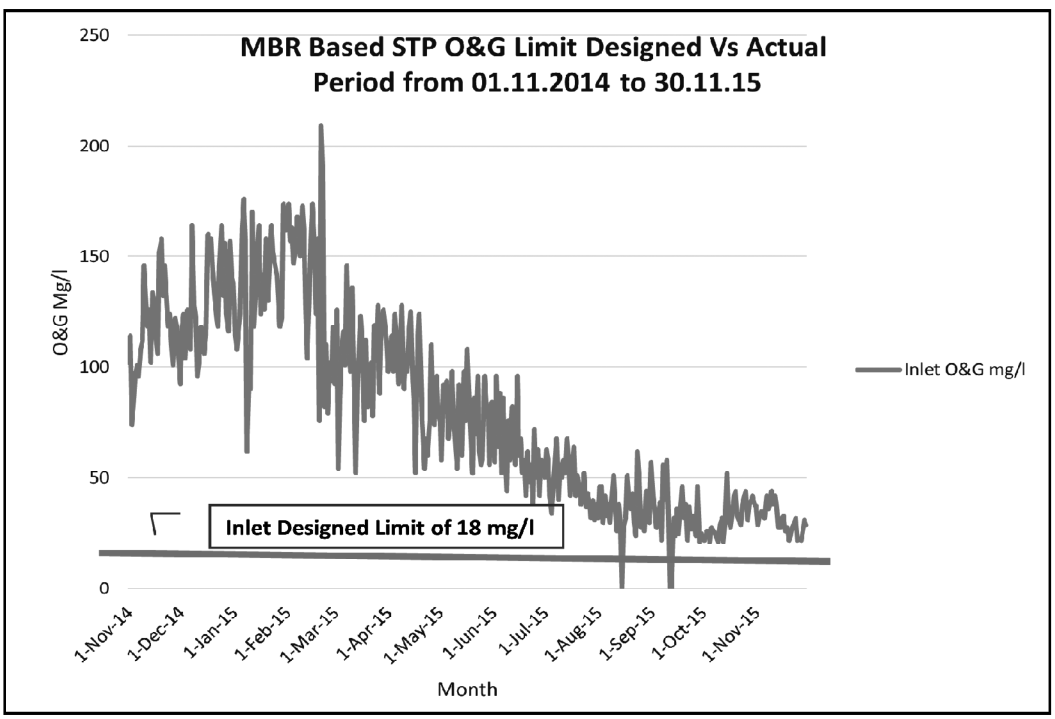
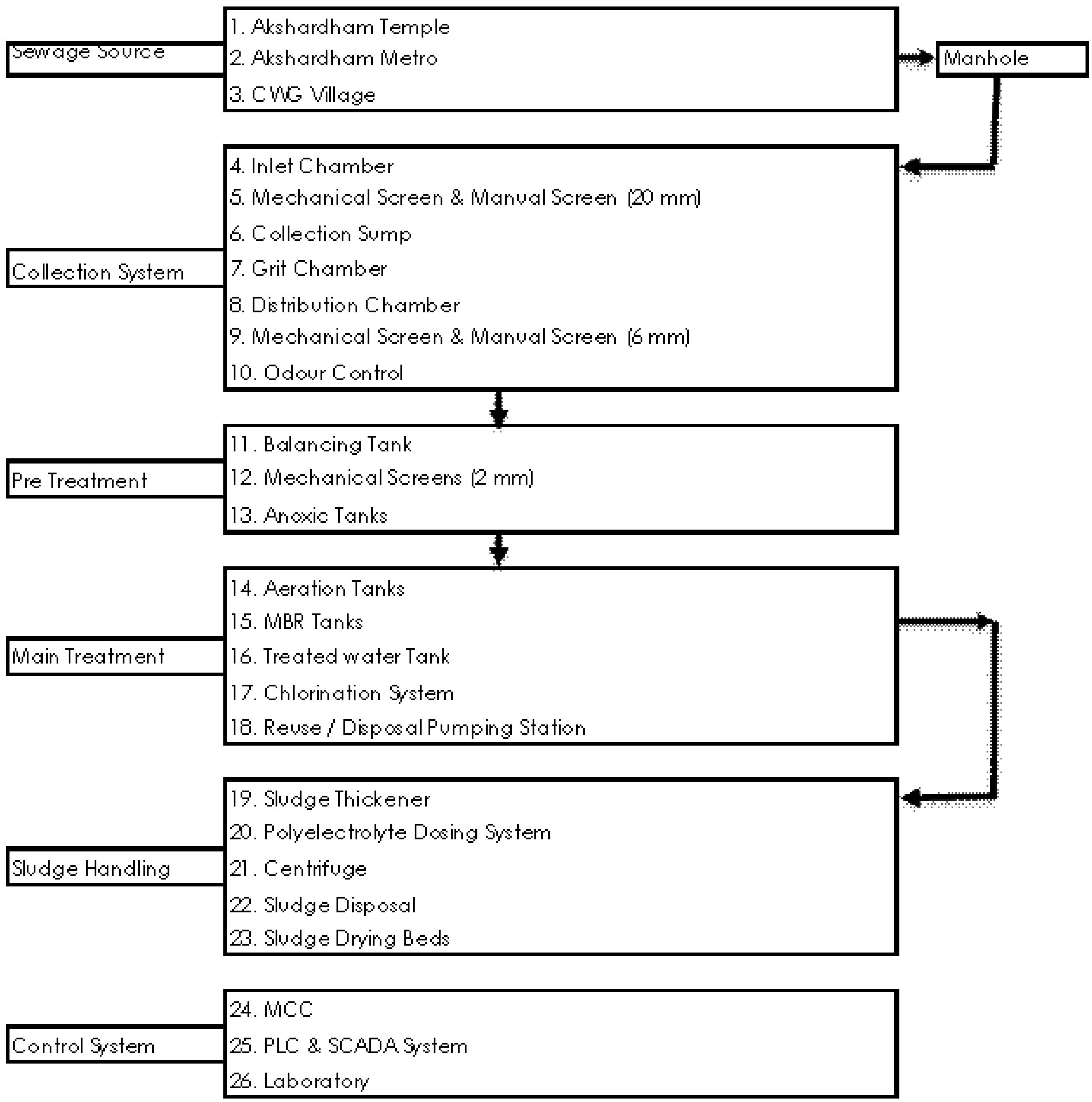


Figure 1

3. TREATMENT PROCESS & MEMBRANE CONDITIONS

3.1. MBR Process

The sewage treatment is designed to treat the sewage sources. Major Treatment systems as under:



The oil in the wastewater normally get degraded in the biological process when the concentration is below 20 ppm. Thus separate oil and grease trap is not provided in the treatment scheme. When the high concentration of the oil is observed in the influent during the weekend. It mainly from the canteen of the nearby temple area. Now, enough retention time is not provided degraded the oil.

3.2. New Membrane during Installation

Figure 2

The membrane system is provided to separate the biological solids from the treated sewage. The air scour cleaning system is provided at the bottom of submerged membrane unit to continuously clean the membrane surface to avoid biological solid fouling. The membrane system is monitored and used for controlling membrane performance through Trans Membrane Pressure (TMP). Monitoring within typical operating ranges, permeability changes linearly with flux or TMP.

When TMP reaches beyond set number then Clean – In – Place (CIP) is to be done. This is also called maintenance cleaning. CIP takes about 2-3 hours to conduct and is done in-situ. CIP is normally required twice in a year where typical STP only under operations. CIP is being done with 0.5 % Sodium Hypochlorite (Hypo) and 1.0 % Oxalic Acid.

3.3. High Oil Deposited Membrane

Figure 3

During the said operating period, it was observed that TMP was increased rapidly and membrane cleaning demand increased substantially. It was almost demanding every month. The operating flux declined and chemical cost increased due to frequent cleaning. The membrane was under submergence hence physical observation was not done. Finally it was decided to take shutdown of the plant to see the membrane conditions. It was observed that sludge accumulation and black spots are observed on the cassettes. When the incoming oily was measured and it was more than designed concentrations (Oil 18 ppm Max.). Elimination of the oil at source was discussed to meet the design criteria and it was implemented.

3.4. After Cleaning of Membrane with Detergents and HYPO

Figure 4

Cleaning of the MBR

To clean the membranes (Ovivo, 2011), MBR tank MLSS transferred to nearby standby tank. The following sequence followed to clean the membranes.

Materials used for Cleaning:

a) 12.5% Sodium Hypo 150 L

b) 100 % Soap solution 17000 L

c) One pump to transfer 0.15 % Soap solution from one basin to another basin after treatment

d) Arrangement for filling clean water into the basin

e) Clean water 250 m3 (Approximately)

Cleaning Procedure:

Day – 1: Filled with clean water. 0.25 % Sodium Hypochlorite (Hypo) solution is prepared in the tank and put it for a day.

Day – 2: Drain the water from the MBR tank and kept it for dry.

Day – 3: Continued the drying of the MBR membrane

Day – 4: Filled the tank with 0.15% soap solution (Nirma Detergent Powder) and kept for 2 hours. Started MBR air blower for 15 Minutes. Drain the soap solution water.

Finally, it get cleaned and membrane ready for further operations.

Oil & Grease Test Method In Wastewater (For Extraction)

3.5. Sampling Method

Composite Samples: Composite samples are used to indicate the character of the sewage over a period of time.

For composite samples (Standard methods for the examination of water and wastewater, 2005), individual grab samples (called aliquots) of sewage are collected at regular and specified time periods, each sample taken in proportion to the amount of flow at that time. These individual aliquots are mixed (or composited) together to form one large volume which is used for testing. Usually, composite samples are collected on an 8 hour, 12 hour, or 24 hour basis. The frequency will depend on the test requirements, size of the treatment plant, permit requirements and the purpose of the sampling activity.

Using composite samples for many test procedures is often important to eliminate the effects of changes in strength and other characteristics of the flow over a period of time. This helps to gain an overall picture of the total effects receiving water. Those tests which are performed on composite samples, such as Biochemical Oxygen Demand and Suspended Solids, are not affected by the chemical reactions which take place between individual samples as they are mixed together.

When taking composite samples (either by hand or using an automatic sampler), aliquots should always be kept at 4°C until the final composite is mixed and prepared for analysis. EPA holding times begin when composite sample is complete, however the sample "age" begins when the first aliquot is collected, you should add any necessary chemical preservatives when this first aliquot is collected provided the preservative is compatible with all tests to be performed on the composite sample.

3.6. Sample Volumes

One of the most important aspects of a composite sample is that each individual sample must be proportional to the amount of flow at the time the sample is collected. Flow proportioning can be based either on time or volume.

3.7. Testing Method and Procedures

Oil & Grease Analyses Method

S.No	*Method*	*Instrument used*			*Chemicals Used*			
1	413.2	Spectro-photometer	HCL	Flurocarbon 133 (B.P 48 C)	Sodium sulphate anhydrous crystal	n-hexa decane	isooctane	chloro benzene
2	CT 06484	Spectro-photometer	H2S O4	Tetrachloroet hylene	Sodium sulphate anhydrous crystal	octanic acid	isooctane	
3	5520 C	Spectro-photometer	HCL	Trichlorotri fluroethane (47 c)	Sodium sulphate anhydrous crystal	n-hexa decane	isooctane	chloroben zene
4	D 7066-04	Spectro-photometer	HCL	Carbon Tetra Chloride	Sodium sulphate anhydrous crystal	n-hexa decane	isooctane	chloro benzene

The test procedures used to measure the concentrations of oil and grease in typical oily wastewater target only conglomerate of oily substances that are extractable by specific solvents (ABASS O. ALADE A. T., 2011). The American Public Health Association (APHA)'s Methods for the Examination of Water and Wastewater (Standard methods for the examination of water and wastewater, 2005) suggested the use of the Partition-Gravimetric Method (503A) which involves the extraction of dissolved and emulsified oil and grease using trichlorotrifluoroethane. Other provisions are the Partition-Infrared Method (503B) which uses an extraction process identical to the 503A method together with Infrared Detection Methods and the Soxhlet Extraction Method (503C) which is based on an acidification of the sample, separating the oils from the liquid through filtration and extraction using trichlorotrifluoroethane. The Environmental Protection Agency (EPA), similarly favours 503A method under the General Pretreatment Regulations, 40 CFR 403.12(b) (5) (vi) for wastewater sampling and analyses.

A New ASTM Method D7066-04 is currently recommended as quick and easy field analysis method for determining oil and grease concentrations particularly for offshore oil platforms, soil remediation sites and industrial wastewater measurement. This development is due to the Montreal Protocol in 1995 banned on the use of Freon 113, which is widely employed in the ASTM method (D3921) for analyzing wastewater. The new ASTM Method D 7066–04, Standard Test Method for dimmer/trimmer of chlorotrifluoroethylene (S-316) under Recoverable Oil and Grease and Nonpolar Material by Infrared Determination, uses a similar extraction procedure with a more ozone friendly solvent called S-316. A variety of infrared instruments such as the full spectrum Fourier Transform Infrared (FTIR) spectrometers as well as portable and relatively inexpensive fixed filter infrared analyzers such as the Wilks InfraCal TOG/TPH Analyzer can be used with ASTM Method D7066-04.

4. SYSTEM REVIEW WITH O&G ISSUE

- Inlet given O&G value of 10 – 18 mg/l can be easily treated with aerobic biological process (UEM, 2010).
- When the high O&G introduced into system, which may not degraded in the designed STP units. Free Oil should not be entered into system (FS - 13, 2013).
- Membrane are physical separation of the biological solids and treated water but presence oil, microbes sticking into membrane surface
- Cleaning of the membrane is recommended by Original Equipment Manufacturer (OEM) (MBR Membranes)is six months only but due to sticky oil on the surface increasing the chemical enhanced Back wash (CEB) (MBR Membrane Cleaning Procedures) to every two months.
- Guaranteed life of membrane reduced to 2- 3 against normal membrane life of 5 years and more.
- Increase of downturn ratio is affecting the productivity.
- Chemical Consumption is increased for cleaning and affecting the sludge quality.

5. RECOMMENDATIONS

- Construction of Oil Traps at the sources
- Provision of oil removal by using belt oil skimmer / Pipe Oil Skimmer at the inlet of the STP with suitable disposal arrangements.
- Increase the retention time in the aeration tank to reduce the oily content through biological treatment process.
- Increase / maintain the water level in the MBR tank high so that oily on the top will remain same and contact with membrane can be reduced.

REFERENCES

Abass O. Alade, A. T. (2011), Removal of Oil And Grease As Emerging . *IIUM Engineering Journal,* Vol. 12, No. 4 : Special Issue on Biotechnology Alade *et al.*

Abass O. Alade, A. T. (2011), Removal of Oil and Grease as Emerging Pollutants of Concern (Epc) in Wastewater. *IIUM Engineering Journal*, 162 - 163.

FS - 13. (2013, December). Retrieved from *www.amtaorg.com: www.amtaorg.com*

MBR Membrane Cleaning Procedures. (n.d.). Japan: Kubota Corp.

MBR Membranes. (n.d.). Japan: Kubota Membrane Manufacturer.

Nupur. (2014 - 2015, Nov - 2014 to Dec- 2015). Daily Analyses Report . Delhi, Delhi, India.

Ovivo. (2011). *MBR Cleaning Procedure*. Mumbai.

Standard methods for the examination of water and wastewater. (2005), In *16th Edn. American* . New York: AWWA.

UEM. (2010). Operating Manual . New Delhi, India: UEM India (P) ltd.

M. Cheryan, and N. Rajagopalan, Membrane processing of oily streams, wastewater treatment and waste reduction, *Journal of Membrane Science,* vol. 151, pp.13-28, 1998.

W.U. Lan, G.E. Gang, and W.A.N. Jinbao (2009), Biodegradation of oil wastewater by free and immobilized Yarrowia lipolytica W29, *Journal of Environmental Sciences*, vol. 21, pp. 237– 242.

K. Hanaki, T. Matsuo, and M. Nagase (1981), Mechanism of inhibition caused by long-chain fatty acids in anaerobic digestion process. Biotechnol. Bioeng., vol. 23, pp.1591–1610.

A. L. Ahmad, S. Bhatia, N. Ibrahim, and S. Sumathi (2005), Adsorption of Residual Oil from Palm Oil Mill Effluent Using Rubber Powder. *Brazilian Journal of Chemical Engineering,* vol. 22, No. 3, pp. 371-379.

G. B. Techobanglous, and L. Franklin (1995), Wastewater Engineering, 3rd edition, Metcalf and Eddy Inc..

E. Friedler (2004), Quality of individual domestic greywater streams and its implication for on-site treatment and reuse possibilities. *Environ Technol.,* vol. 25, pp.997–1008.

A.G. Stams, and E.S.J. Oude (1997), Understanding and advancing wastewater treatment. *Current Opinion in Biotechnology,* vol. 8, pp. 328–334.

M. Abid Baig, M. Mir, Z. I. Bhatti, and M A. Baig (2003), Removal of oil and grease from industrial effluents. EJEAFChe, vol. 2, No 5, pp.577-585.

S. Rintoul, New ASTM Test Method Offers Quick and Easy Oil and Grease Measurement for Water and Soil Samples. Wilks Enterprise, Inc., www.WilksIR.com, pp. 1-3, 2010. 167.

L. K. Wang, Y. T. Hung, H. H. Lo, and C. Yapijakis (2004), (Eds) Handbook of Industrial and Hazardous Wastes Treatment, Second Edition, 2004, Marcel Dekker, New York.

K. Karakulski, A. Kozhiwski, and A. W. Morawski (1995), Purification of oily wastewater by ultrafiltration, Separation Technology, vol. 5, pp. 197-205.

J. Rubio, M. L. Souza, and R. W. Smith (2002), Overview of flotation as a wastewater treatment technique, *Minerals Engineering,* vol. 15, pp. 139–155.

K. Takeno, Y. Yamaoka, and K. Sasaki (2005), Treatment of oil-containing sewage wastewater using immobilized photosynthetic Bacteria. *World Journal of Microbiology & Biotechnology*, vol. 21, pp.1385–1391.

U. Daiminger, W. Nitsch, P. Plucinski, and S. Hoffmann (1995), Novel techniques for oil/water separation, *Journal of Membrane Science,* vol. 99, pp.197-203.

J. Kong, and K. Li (1999), Oil removal from oil-in-water emulsions using PVDF membranes. Sep. Purif. Technol., vol. 16, pp. 83–93.

M., Gryta, K. Karakulski, and A. W. Morawski (2001), Purification of Oily Wastewater by Hybrid UF/MD, Water Res., vol. 35, No.17, pp. 3665–3669.

T.-H. Bae, S.-S. Han and T.-M. Tak (2003), Membrane sequencing batch reactor system for the treatment of dairy industry wastewater. Process Biochem. Vol. 39, pp. 221–231.

S.B. Lee, Y. Aurelle, and H. Roques (1984), Concentration polarization, membrane fouling and cleaning in ultrafiltration of soluble oil. *J. Membrane Sci.*, vol. 19, No1, pp. 23–38.

M. Nyström (1991), Ultrafiltration of O/W emulsions stabilized by limiting amounts of tall oil, Colloids and Surfaces, vol. 57, pp. 99-114.

B. Tansel, J. Regula, and R. Shalewitz (1995), Treatment of fuel oil and crude oil contaminated waters by ultrafiltration membranes, Desalination, vol. 102, pp. 301-311.

S. Panpanit, and C. Visvanathan (2001), The role of bentonite addition in UF flux enhancement mechanisms for oil/water emulsion, *Journal of Membrane Science,* vol. 184, pp. 59-68.

C. G. Klatt, and T. M. LaPara (2003), Aerobic biological treatment of synthetic municipal wastewater in membrane-coupled bioreactors, *Biotechnology and Bioengineering,* Vol. 82, No.3, pp. 313-319.

Kurian, and G. Nakhla (2006), Performance of Aerobic MBR Treating High Strength Oily Wastewater at Mesophilic – Thermophilic Transitional Temperatures. Water Environment Foundation, Ontario Canada.

Howell, J.A.; Chua, H.C.; Arnot, T.C. (2004), In situ manipulation of critical flux in a submerged membrane bioreactor using variable aeration rates, and effects of membrane history. *J. Membr. Sci.*, 242, 13–19.

Stone, M.; Livingstone, D. Flat plate MBR energy consumption—Village of Dundee, MI. In Proceedings of Membrane technology 2008 Conference of the Water Environment Federation, Alexandria (VA), Egypt, 27–30 January 2008.

Guo, W.S.; Vigneswaran, S.; Ngo, H.H.; Kandasamy, J.; Yoon, S. The role of a membrane performance enhancer in a membrane bioreactor: A comparison with other submerged membrane hybrid systems. Desalination 2008, 231, 305–313.

Tay, J.H.; Yang, P.; Zhuang, W.Q.; Tay, S.T.L.; Pan, Z.H. Reactor performance and membrane filtration in aerobic granular sludge membrane bioreactor. *J. Membr. Sci.* 2007, 304, 24–31.

Holbrook, R.D.; Higgins, M.J.; Murthy, S.N.; Fonseca, A.D.; Fleischer, E.J.; Daigger, G.T.; Grizzard, T.J.; Love, N.G.; Novak, J.T. Effect of alum addition on the performance of submerged membranes for wastewater treatment. Water Environ. Res. 2004, 76, 2699–2702.

Frechen, F.-B.; Schier, W.; Linden, C. Pre-treatment of municipal MBR applications. In Proceedings of the Fourth IWE International Membranes Conference for Water and Wastewater Treatment, Harrogate, UK, 15–17 May 2007.