First installation of a Membrane Aerated Biofilm Reactor plant in the Caribbean

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Introduction

Membrane Aerated Biofilm Reactors (MABR) isa new technology for biological wastewater treatment, already installed in a couple of sites in Israel and now also implemented in the Caribbean for the first time. These first installations are a result of many years of academic and commercial research and development.

The principle at the core of this new technology is self-respiring membranes that are submerged in the aeration tank. The membranes supply most of the oxygen to the biological treatment process, at about only 10% of the energy of conventional alternatives based on the activated sludge process. The membranes also support the development of a nitrifying biofilm operating simultaneously with the activated sludge in the tank. Thus nitrification and denitrification are performed effortlessly and optimally by two microbiological population performing two synchronous processes.

The main advantages of the process are:

- high effluent quality with low operator intervention
- low energy consumption translating to lower operating cost
- modularity for convenient gradual expansion when required
- less noise, odors and foaming due to passive, bubble-less aeration

80-90% Reduction in Aeration Energy

The main basis, cause and origin of the extremely lower energy consumption for aeration in MABR, is the lower pressure of air blown through the air side of the membrane. Whereas in any conventional diffused air aeration methods the blower discharge pressure is sufficiently higher than the immersion depth of the diffusers, in MABR the fan discharge pressure only needs to overcome pressure drop in flow through the membrane air side spacing, which is an order of magnitude lower than common water depth of aeration basins. MABR blowers' parameters, as a percent of conventional activated sludge (CAS) aeration blowers, are listed in table 1 below. Power is proportional to the product of discharge pressure, flowrate and duty (wherein duty is the fraction of time in operation).

	Pressure	Flowrate	Duty	Power
Mixing	60%	400%	2.5%	6.0%
Aeration	9.1%	80%	100%	7.2%
Total				13.2%

Table 1: MABR blower parameters as a percentage of CAS

Simultaneous Nitrification and Denitrification

The process principle exercised by Emefcy comprises holding MLSS in the presence of the biofilm, similarly to IFAS processes, as can be seen in the block diagram of Ha Yogev installation in Israel as an example in figure 1. However, in MABR this enables nitrification in the biofilm simultaneously with denitrification in the suspended biomass. This way a high nitrification rate is achieved, while BOD is also being removed by denitrification, using the nitrate as it is produced by the biofilm. Note that division into anoxic and aerobic zones and internal circulation are not required when nitrogen removal is performed through simultaneous nitrification and denitrification. Furthermore, addition of an external carbon source is either eliminated or decreased.

Process Optimization

It has been found to be advantageous to arrange the biological reactors in two stages in series, as also shown in figure 1. Staging enables operation at high removal rates in the first stage, and production of high quality in the second stage. Three stages are sometimes chosen, for especially low effluent total nitrogen requirements. The Emefcy MABR is a prefabricated modular product. The number of modules required to meet a given load is determined by an optimization calculation, considering the number of stages and how many modules are installed in each stage.

So besides energy saving, Emefcy MABR also simplifies and improves nitrogen removal, and provides process design flexibility.

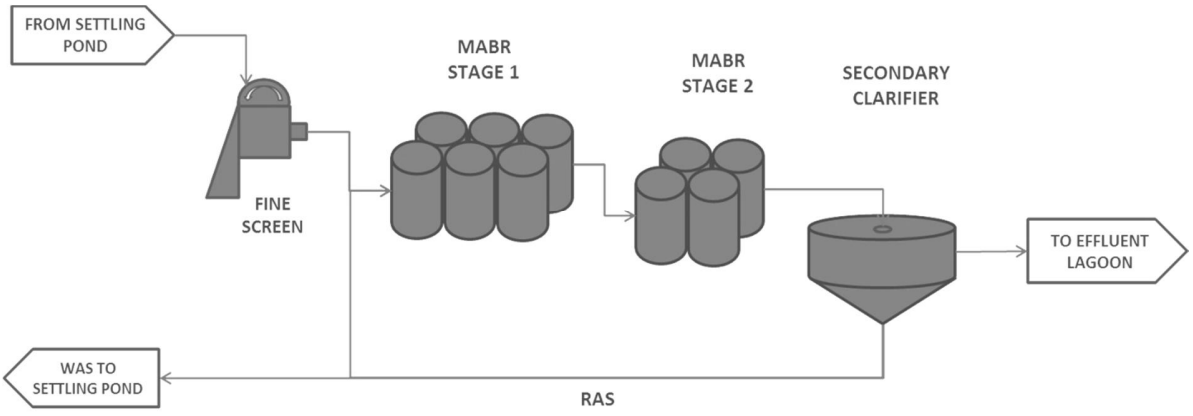

Figure 1: general process block diagram

Process performance

Third party sampling and analysis was performed in an Emefcy MABR sewage scalping (mining) demonstration plant. The demo plant produces 20 m3/d (5,300 gpd) of irrigation-quality effluent, as a small fraction of the sewage going through a pumping station. The water is meant to be used for landscaping irrigation and must comply with TSS/BOD/TN/TP of 10/10/15/5 respectively. In addition there is a requirement for fecal coliforms < 10 per 100 ml in monthly average. As a result of more than 3 months analysis, a permit for landscape irrigation was granted. Some of the results over time are shown in the charts of figure 2 below.

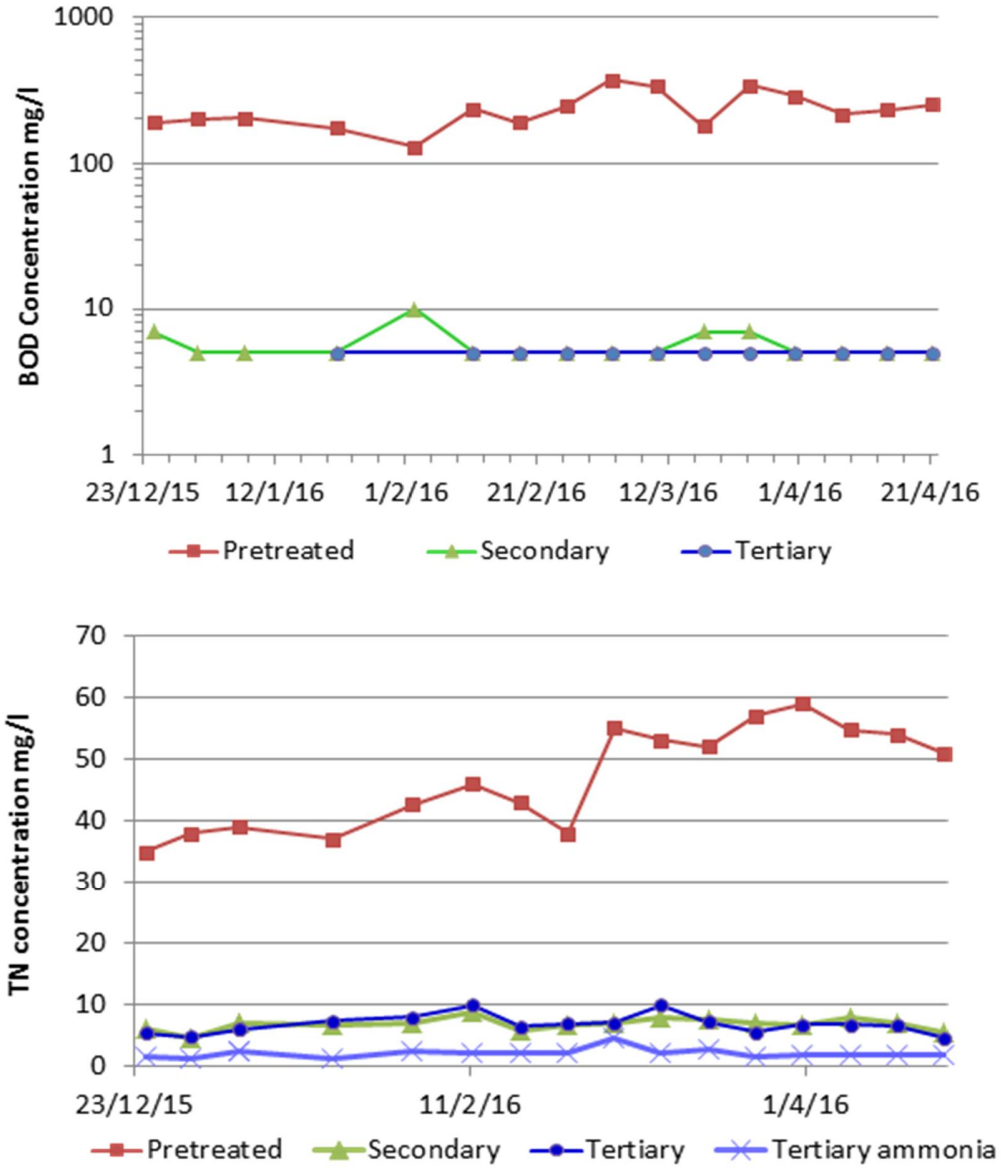

Figure 1: Third party analyses results over time

Case studies

1. Bordeaux, St, Thomas

A localized wastewater treatment plant project was recently awarded by the Virgin Islands Waste Management Authority to a MABR based process. The choice was mainly guided by requirements for high effluent quality, low energy consumption and low operator attention, matching the features and advantages of this new technology.

Plant construction has already started, and scheduled to start operating in November 2016, not much after the CWWA annual event. It will initially treat 95 m^3/d, and will be able to expand in the future up to double the initial capacity. Effluent quality requirements include total nitrogen

of less than 10 mg/l and phosphorous removal. As a future continuation of the project, water reuse for agriculture is considered.

2. Ha-Yogev, Israel

Ha-Yogev is eligible to be categorized as a water reuse facility (WRF) because all effluent is reused for irrigation in local agriculture. The principles of Emefcy MABR process design are demonstrated in this first commercial installation in Israel, treating 125 m3/d of combined sewage and dairy-farm wastewater. It is a 2-stage process, with RAS from a secondary clarifier circulated to hold a sufficient MLSS to meet conventional F/M criteria. A photo of the plant, located in the valley of Jezreel in Israel, is shown in figure 2 below.

Figure 2: Ha-Yogev MABR plant

Summary and Conclusions

- MABR have great promise in energy savings, but also offer improved nitrogen removal capability through simultaneous nitrification and denitrification.
- The advantages of MABR have just recently been demonstrated on full scale by Emefcy, and are ready for use in small wastewater treatment plants.
- Modular prefabricated MABR are part of an emerging market for decentralized and localized treatment and reuse, mainly due to their inherent nitrogen removal feature.