IMPROVING PARTICLES SEPARATION AFTER MOVING BED BIOFILM REACTOR (MBBR) SYSTEMS BY MEDIA CLARIFIER

Keren Nof[1], Nir Assulin[1], Yosi Galer[1] and Ramiro César Garza Carreón[1]

[1] Aqwise – Wise Water Technologies Ltd., 8 Hamenofim St., Herzliya, Israel
* keren@aqwise.com

ABSTRACT
Separation of biomass from pure Moving Bed Biofilm Reactor (MBBR) systems is more challenging, compare to conventional Activated Sludge or IFAS systems. Media Clarifier (MC) is a new patented clarifying technology, integrating clarifier and a plastic media layer, for MBBR effluent developed by Aqwise.

This paper presents results of one year full scale plant operation with Media Clarifier as separation system. The plant operation results show that the average suspended solids concentration is about 10 mg/l without the use of polymers or coagulation/flocculation units. These significant results indicate that the Media Clarifier can be a good solution for the clarification challenges typical to MBBR effluent.

Keywords: Media Clarifier (MC), Moving Bed Biofilm Reactor (MBBR), Solids separation, Clarification, Wastewater treatment

INTRODUCTION
The media clarifier (MC) is a unique patented clarifying technology, developed especially for MBBR effluent. It was developed in order to provide a specific solution to the sedimentation and clarification challenges typical to MBBR effluent.
The MBBR effluent characteristics, containing mainly the sloughed-off biomass from the carriers and the influent particulate matter, are different in particle size distribution and biomass morphology from that of activated sludge.

There are several conventional particles separation systems, such as: gravity sedimentation / clarification, flotation and membrane separation. Each of these systems has its merits and demerits. Settling tanks have high footprint requirements, while the flotation and membrane systems will have higher operation and maintenance costs. Further, these systems require coagulants and flocculants to increase floc sizes and enhance suspended solids (SS) separation, resulting in high operational costs.

On the other hand, the developed MC requires small footprint, relative to conventional clarifiers, and is simple to operate. In addition, it eliminates scum problems and reduces energy consumption.

Aqwise has already installed a number of Media clarifier systems world-wide. One of the first installations of the MC was at a wastewater treatment plant (WWTP) in the south of Israel. The WWTP is in operation since 2010, treating sanitary wastewater

containing also high strength wastewater from cowsheds. The biological process operates as an MBBR system followed by a Media Clarifier (MC).
The aim of this paper is to describe the Media Clarifier technology and to present results obtained from one WWTP in Israel and 15 plants in Mexico.

THE PROBLEM
Separation of biomass from pure MBBR systems is more challenging, compare to conventional Activated Sludge or IFAS systems. Since MBBR systems contain only excess biomass (as there is no sludge recycling) the effluent has only several hundred milligrams per liter of TSS, with two typical types of solids: particles that are easily-settled (in gravity systems) and those that are hardly settled. Both particle size distribution and biomass morphology effect the particle's separation. The particle size distributions in MBBR systems can be highly variable with more small size fractions at hydraulic retention times (HRTs) shorter than 2 hours [1].

Furthermore, the Extracellular polymeric substances (EPS) concentration in the MBBR systems is relatively low. The EPS, which are polysaccharides, proteins and lipids, accumulate on the surface of the bacterial cells and govern the aggregation of these cells.

Particle separation after MBBR systems is not favorable; therefore, a specific approach to particles separation is required.

THE SOLUTION
The Media Clarifier (MC) is a compact secondary biomass separation unit dealing with the typical sedimentation challenges of pure MBBR systems, by the integration of clarifier and a plastic media layer.
At the media layer, several parallel processes take place which results in maximal solids separation and clarification:

- Auto-flocculation: the turbulent micro-currents upon the carriers results in the adhesion of small particles to each other (floc formation).
- Entrapment of solids within the carrier layer, in the non-turbulent zones.
- Adsorption of the particles to the organic matter attached to the carriers due to its high surface area.

As will be discussed in this paper, the MC has several advantages:

- The unit is extremely compact. While a conventional clarifier is designed with hydraulic loads of about $0.5m^3/m^2/h$, the MC operates in much higher loads, and save about 65% of the footprint required for conventional clarifiers.
  During the MC development the hydraulic loads reached extreme values of up to $2.2m^3/m^2/h$ while reducing the SS to below 30 mg/l.
- The flat floor used, together with the fact that scarper arm and scum skimmer are not required, reduces the capital expenses relate to the unit construction.
- Results from more than twenty operating plants show that the MC reaches effluent SS below 30 mg/l - without polymer addition, thus reducing significantly the operational expenses.

OPERATION PRINCIPLE
Figure 1 demonstrates a general scheme of the MC system. Sedimentation and solids separation occurs in the same tank with an up-flow pattern. The incoming flow [1]

from the MBBR positioned at the bottom of the tank while the outlet [2] is at its upper part. The upper zone of the tank is separated from the lower zone by a coarse screen [4] (Figure 2) and filled with an immobile layer of carriers [3] (Figure 3), removing solids that didn't settle within the lower zone.

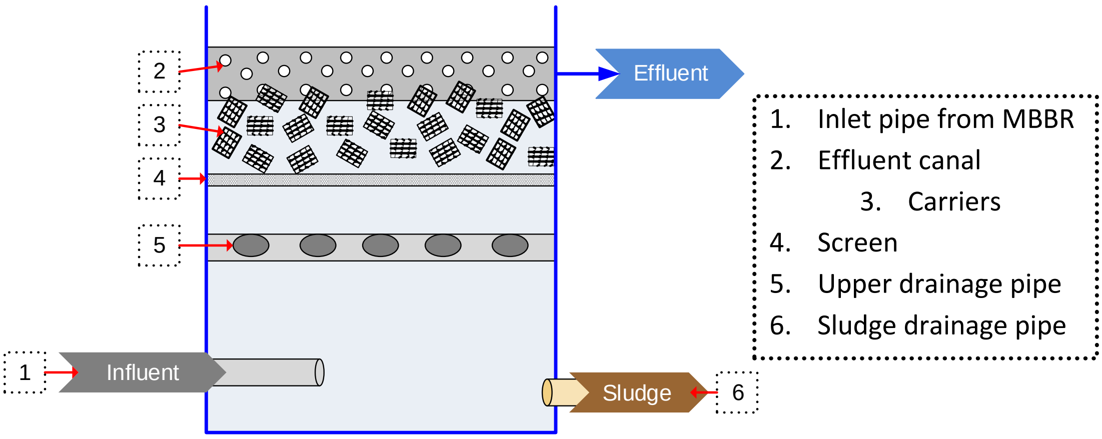

Figure 1: A schematic view of the MC

The carriers are kept in the tank by means of perforated effluent weir, located at the water surface, as can be seen in Figure 3.
The up flow velocity within the MC unit enables the easily-settled solids to accumulate at the bottom of the MC to a concentration of 1-2%. The liquid (containing remaining solids) continues to flow through the media layer at the upper zone of the MC.

The coarse solids settled at the lower zone are removed by a drainage valve [6] which operates intermediately, to prevent excess sludge accumulation.
The fine solids, entrapped within the carriers, removed periodically in order to prevent uncontrolled accumulation upon the carriers. The upper media level is drained periodically to remove the accumulated solids from the carriers' surface and allow for the next cycle of operation. , The drained liquid is recycled upstream to the WWTP inlet.

Figure 2: Coarse screen supporting the carriers layer

Figure 3: Static layer of carriers and effluent weirs

RESULTS AND DISCUSSION

A WWTP positioned in the south of Israel is treated according to the scheme presented in figure 4. The wastewater is a combination of sanitary wastewater from two villages and wastewater from two big cowsheds (ca. 200 cows).

The design daily flow to the plant is 600 m^3/d with TSS concentration of 117 mg/l.

The monitoring regime for the past two years included the following: COD, BOD, TSS, TKN, NH_4-N, NO_3-N and TP. Samples were taken from the WWTP influent, each of the MBBR stages (1 anoxic stage and two aerobic stages, as presented in Figure 4) and the MC effluent.

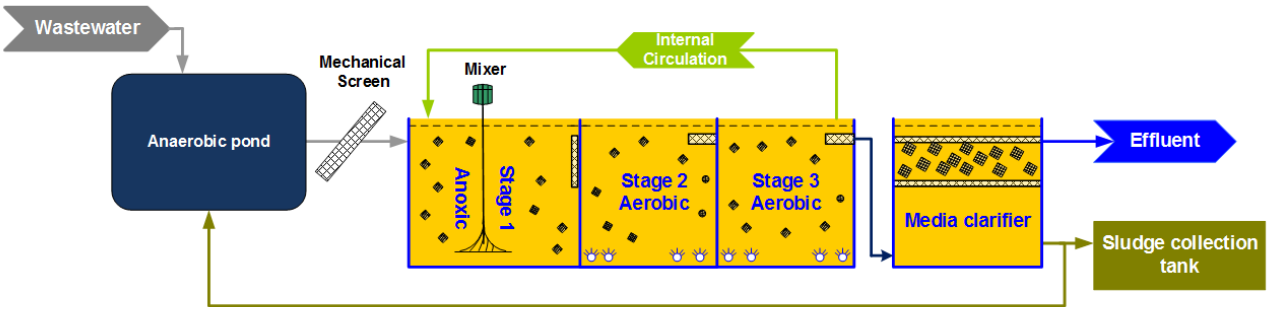

Figure 4: Schematic diagram of the MBBR process followed by MC

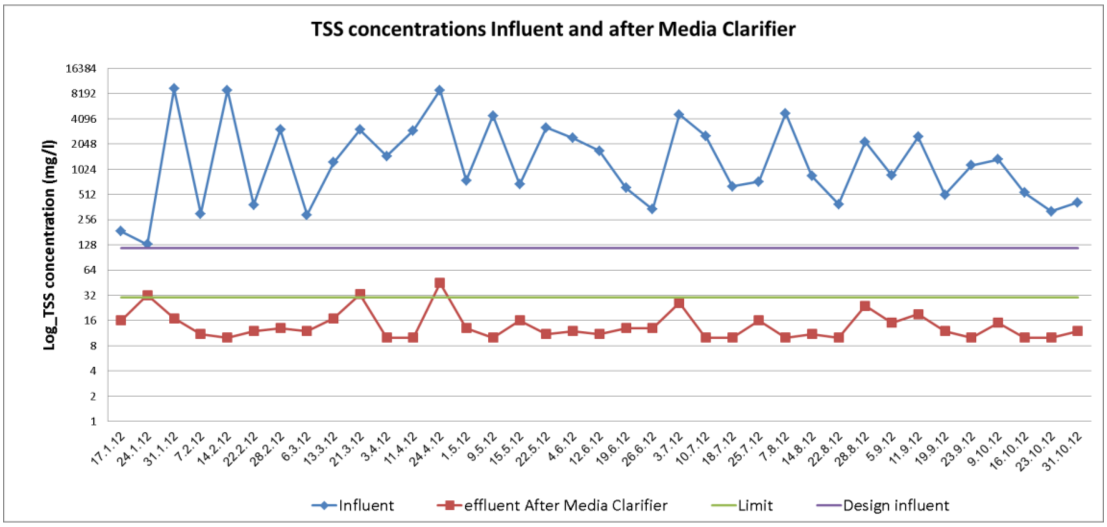

Figure 5: TSS results - Influent and Effluent (after MC) in the Israeli WWTP (2012)

Figure 5 presents the inlet and effluent suspended solids (SS) concentrations from January to October 2012. Due to the absence of primary treatment for the cowshed's WW, the plant received higher concentrations of suspended solids than expected and designed. As can be seen in the Figure, although the influent SS concentrations are much higher than the designed values (the purple line), the average effluent SS concentration is about 10 mg/l. These superior, and stable, results were achieved without the use of polymers or coagulation/flocculation units.

Another 14 WWTPs using MC, have also been monitored for the past two years, between 2010 and 2011

Figure 6 presents the inlet and effluent suspended solids (SS) concentrations for those particular plants. As can be seen, the average effluent SS concentration is about 15.5 mg/l, without the use of polymers or coagulation/flocculation units.

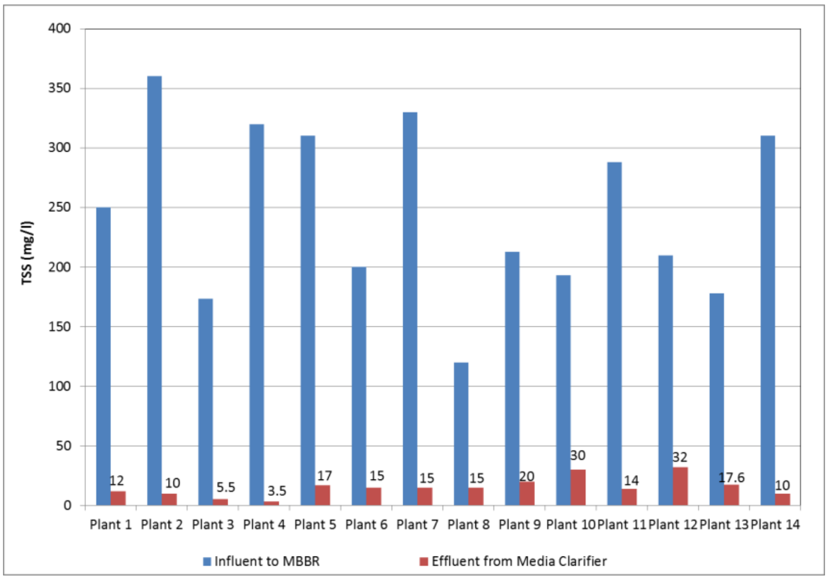

Figure 6: TSS results - Influent and Effluent (after MC) in WWTPs (2010-2011)

To summarize, it has been demonstrated that the MC may favorably be able to replace traditional settling units. These results are significant in providing answers to the particle separation challenges after MBBRs, with low footprint requirements and elimination of the need for use of coagulation/flocculation chemicals.

REFERENCE

1. Ødegaard, H., Cimbritz, M., Christensson M. and Dahl,C.P. (2010) Separation of biomass from moving bed biofilm reactors (MBBRs). WEF/IWA Biofilm reactor technology conference