MBBR Helps Seafood Manufacturer Meet Regulatory Requirements

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ABSTRACT

Seafood processor in Manta Ecuador has a high strength wastewater with TSS as high as 20,000 mg/l, FOG 700 mg/l, COD of 13,000 mg/l and BOD of 6,000 mg/l. Wastewater is discharged into Pacific Ocean across the street from the factory. Current treatment plant produces effluent with TSS of 150 mg/l, FOG of 80 mg/l, COD of 800 mg/l and BOD of 400 mg/l on average. New laws require that seafood processing streams that are discharged to the Ocean have TSS below 100 mg/l, FOG below 50 mg/l or better, COD below 500 mg/l and BOD below 250 mg/l. Plant has a very limited space to further treat their effluents. An MBBR System was designed, installed and is currently operated to help meet regulatory requirements. This manuscript describes design and operation of the MBBR System.

KEYWORDS: seafood processing wastewater, MBBR polishing, ocean discharge

INTRODUCTION

Seafood manufacturing produces high strength wastewater with high amounts of TSS, FOG, COD, BOD, TKN and often high TDS. Wastewater is usually treated by DAF to remove TSS, FOG and some COD/BOD. However, in some areas where water is discharged into the lagoon or Ocean, particularly in towns that depend on tourism, stricter regulation require further treatment, often with bioreactors to remove dissolved COD, BOD and TKN.

Current wastewater process at this plant is quite impressive but had few weak areas. The existing wastewater treatment process starts with blood removal treatment and then proceeds to grit removal and screening. DAF with aluminum sulfate and anionic flocculant is used to flocculate and float TSS and FOG. After that water is aerated and clarified for foam removal of some proteins. The effluent is then treated with zeolite/sand/anthracite filters. After that water is treated with ozone and discharged to the Ocean.

Water has very high conductivity of 30,000 microS. Therefore anionic flocculant used is less efficient and after the DAF TSS are over 250 mg/l and FOG around 150 mg/l. We

showed that if using a specialty anionic high conductivity flocculant A-190 K from KEMIRA (100% charge, sulfonate active groups) one can further reduce TSS below 100 mg/l, and FOG below 50 mg/l. Sludge can also be improved from 8% dry solids to 19% dry solids resulting in significant savings to the plant.
We also showed that if needed ozonization process can be enhanced by using ozone/hydrogen peroxide treatment. Up to 30% more BOD's can be removed that way. Finally, sometimes some blood appears in water after DAF. We showed that replacing aluminum with ferric sulfate as coagulant can improve on blood BOD removal, if it becomes necessary. Up to 15% more of BOD's can be removed that way.

Goals and Objectives

Design, test and implement polishing step that would bring the plant into compliance with the current regulations. Since final BOD can be 250 mg/l and available space is very limited we theorized that aerobic MBBR would be the best technology to bring the plant into compliance. At 50 GPM average flow, 75 GPM maximum flow, we had around 14 m - 12 m -7 m of available space to build MBBR, clarifier and sludge storage tanks. Many other companies suggested that it is impossible to build a polishing bioreactor within the available space.

The Pilot Study

MBBR laboratory pilot study showed that at available HRT we can indeed start with 400-500 mg/l of BOD and up to 50 mg/l of FOG and produce effluent with less than 250 mg/l of BOD and less than 10 mg/l of FOG (future requirement) and less than 500 mg/l of COD. Tanks will have to be filled 60% by volume with the high density polyethylene MBBR media with surface area of 650 m^2/m^3. Pilot study showed that if needed we can combine microbes growing on media with some suspended microbes up to 1,500 mg/l of MLSS ("home made IFAS").

FULL SCALE MBBR SYSTEM

System Design and Operation

Based on average wastewater contaminants levels from 2011 and 2012, the MBBR System was designed to treat an average of 50 GPM, with maximum flow of 75 GPM. Average influent COD's of 1,000 mg/l and BOD of 600 mg/l were considered. FOG of 10 mg/l and TSS around 100 mg/l were also used to design the System. The System was designed so that effluent with less than 250 mg/l of BOD and less than 500 mg/l of COD can be obtained. If possible, regulatory body also suggests that TSS in the effluent are below 150 mg/l and preferably around 50 mg/l.

To achieve that two concrete aeration tanks with effective volume of 144 m3 are needed. Tank dimensions are 8m - 6m - 3m. Coarse bubble aeration is to be used. Tanks are to be filled with 65 m3 of HDPE media, 836 m2/m3, 494 m2/m3 of protected surface. Three blowers with capacity of 2,200 m3/h will deliver needed air - oxygen .

Lamella tank tube clarifier (concrete tank with dimensions 8 m x 2 m x 3 m) and effective volume of 48 m3 is to be used for secondary clarification. AMIAD screen filter with 150 microns openings is to be used to polish clarifier effluent.

The System was built in 2012 and start up occurred in January 2013. Due to production increase at INEPACA plant it was immediately obvious that influent is loaded with significantly higher concentrations of all contaminants. For instance influent to the MBBR has on average 1,200 mg/l of COD, and values as high as 3,500 often occur. Sometimes values as high as 5,500 mg/l of COD occurred. FOG's as high as 150 mg/l occasionally enter the aeration tanks. Ammonia concentrations as high as 500 mg/l are common. BOD's as high as 800 occur.

Upon start up, good growth of microorganisms on the plastic media occurred. MLSS in suspension also increased from 20 to around 500 mg/l However, bulking toxic sludge often occurs in the clarifier. High amounts of ammonia and great efficiency of MBBR microbes in nitrification produce up to 150 mg/l of nitrates. During 90 minutes to 2 hours settling stage in the clarifier denitrifying organisms grow. This produces floating bulking sludge. To confront that problem oxygen concentration in the second aeration tank is kept high (over 3 mg/l whenever possible). Due to high TDS only coagulants are used (up to 500 mg/l of ferric chloride) but flocculants are not very efficient. SVI varies between 80 and 160, with average around 130. Dissolved oxygen in both aeration tanks is on average around 3 mg/l but varies between 1.2 and 5.9 mg/l, depending on the COD and BOD levels. F/M ratio between 0.15 and 0.30 is observed. Water temperature varies between 83 and 94 F. Conductivity as high as 32,000 microS/cm is observed.

After clarifier TSS vary between 20 and 550 mg/l, on average around 120 mg/l. FOG's in the effluent are mostly below 1 mg/l. BOD's vary between 80 and 250 mg/l, on average are 220 mg/l. COD in the effluent vary between 350 and 900 mg/l, on average 520 mg/l. AMIAD filter usually reduces TSS below 50 mg/l.

Figure 1. Aeration tank of the MBBR System

Figure 2. Second aeration tank of the MBBR System

TABLE 1. Variation of the dissolved oxygen in aeration tanks one and two at different days.

Tank 1 , DO/ppm	Tank 2, DO/ppm
3.6	2.9
5.2	4.1
3.4	3.0
1.5	1.2
3.7	4.3
0.4	0.2
1.1	1.1
7.5	7.2
5.7	5.5
1.5`	1.3

TABLE 2. Variation of TSS, COD and BOD in the secondary clarifier effluents at different days.

COD/ppm	TSS/ppm	BOD/ppm
380	75	260
330	70	190
630	170	255
150	150	195
410	120	227
200	77	222
430	128	215
250	171	185

CONCLUSIONS

Seafood manufacturer already had a wastewater primary and advanced oxidation treatment system. New regulations resulted in the need to polish wastewater further and remove dissolved BOD's more efficiently. MBBR System was installed to achieve this goal. In the meantime dissolved BOD's and COD's significantly increased. The System is meeting regulatory requirements in spite of much heavier loads of contaminants. Due to high amount of ammonia and denitrification in the clarifier bulking sludge occurs all the time. Increasing the concentration of oxygen in aeration tanks and shortening the time of settling partially alleviated this problem. Anionic flocculants used in the primary and secondary treatment are only somewhat efficient due to high TDS of the wastewater