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The Effect of MLSS Values on Removal of COD and Phosphorus Using Control Method of Return Activated Sludge Concentration

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Abstract: The process of biodegradation by activated sludge for wastewater treatment plants in operation is a common matter, especially when the appropriate conditions are available. Such conditions can include the process of sludge transportation and ease of sludge transfer; The addition of the sludgeis also easy to control. Herein we present one example where in sludge was brought to Mahram Aisha treatment plant in Iraq from another plant during the beginning of its operation. In this case, sludge was brought from another plant due to the increased velocity of the MLSS concentration. Indeed, on the 1st and 2nd days, during the addition of 20 m^3 of the wet sludge, the sludge concentration ratios reached 550 mg. This method of adding the sludge is the best efficient method in terms of the speed of getting to the required determinants after controlling DO concentrations in the aeration basin. These concentrations were 2 mg/L during the periods of operation and the temperature remained at 25°C. After the stability of the return sludge, the concentrations of MLSS were compared with COD, phosphorus, froth and SVI by controlling the returning sludge while taking into account the influence of the returning sludge on the COD concentration, phosphorus and on the indicator of SVI and froth where the phosphorus removal efficiency is 50% without the EBPR system. At the same quantity, 95% of COD was removed. The quantity of SVI is 60 mL/g and there was a 99% reduction in the froth quantity.

Key words: Activated sludge return, mixed liqueur suspended solid, phosphorus removal, start-up, froth removal, COD

INTRODUCTION

The process of the reciprocal start-up can be defined as bringing amounts of sludge from another WWTP and adding it to aeration basins this is done because of the increase of the biomass adjustment and its ability to remove organic materials and nutrients (Otgraard *et al*., 1997).

The process of disconnected fertilization in the treatment plants has been the most reliable (Daigger and Nolasco, 1995) as it is easy to bring the sludge due to the nearby location of the treatment plant. Additionally, the plant is not that large, meaning it does not require great amounts of sludge during its operation where bringing the sludge in order to reach the amount of MLSS = 500 mg/L which is available according to the procedure of EPA (APHA, 1989). Due to the reasons mentioned above, the disconnected method was applied along with the addition of amounts of sludge to the aeration basin and since, the Aisha treatment plant discharges into the Euphrates River and because of strict laws, water leaving the plant must be free from organic materials and nutrients. This is because nutrients allow algae to grow and because these materials (Kuba *et al*., 1997). Phosphorus causes the phenomenon of Eutrophicationin rivers and lakes. The phosphorus is removed by using many methods: there are both chemical and the biological methods for achieving this. The biological method is conducted according to asystem of enhanced biological phosphorous removal, known as EBPR. Part of the phosphorus can be removed in the formed biomass in this system (which do not contain the system EBPR as removing phosphor is preferable in Winter, rather than in Summer) (Li and Wang, 2002).

The aim of the present study is to reduce the largest possible quantity of pollutants that are disposed into the Euphrates because the system of processes in this plant is the conventional extended aeration which does not contain systems for removing nutrients represented by the anaerobic/anoxictank. This is done by controlling the ideal MLSS through the sludge recession amount and forming the biomass which works on the depletion of BOD and the nutrients as well; the overflow of organic materials like COD and BOD into the rivers and estuaries will cause the depletion of dissolved oxygen in the river, leading to anaerobic conditions (AL-Degs *et al*.,

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2000). Such anaerobic conditions in rivers and will create decay because of the eruption of hydrogen sulphide gas which leads to disturbance in the biological activity in rivers (Paul *et al*., 1998), therefore, it is important to have the Dissolved Oxygen (DO), especially in the aeration basin where it has an essential impact on the behaviour and activity of the microorganisms in the processing plant. Do can also be used in different processes like nitrogen and phosphorus and BOD removal.

MATERIALS AND METHODS

The Mahram Aisha plant was designed according to the domestic waste water source with a flow rate of 12000 m^3/d and the characteristics of waste water are shown in Table 1.

Waste water treatment plant location: The plant is located in Alhindiya, district of Karbala, Iraq. It is located South of both Karbala and Baghdad. It is 20 km from the Karbala border and about 90 km from Baghdad city centre. It is located on the bank of Euphrates River as shown in Fig. 1 and it was designed to serve 50000 persons with a designated flow rate of 12000 m^3/d.

Waste water treatment process: The process in this plant uses extended aeration activated sludge as shown in Fig. 2.

Start-up: Temperature is one of the main factors that influences the growth of microorganisms. Luckily, during the start-up, the temperature was between 20-27°C and some experiments demonstrated that DNA and the growth of bacteria reaches its highest level at 20°C (Paul *et al*., 1998). The same thing can be said about nutrients and the dissolved oxygen and floc-forming bacteria.

Table 1: Characteristics of wastewater quality in mahram aisha WWTP

Parameters (mg/L)	Concentration (mean)
COD	600
BOD5	350
TSS	380
TN	20
TP	5

Fig. 1: Image of Maharam Aisha WWTP

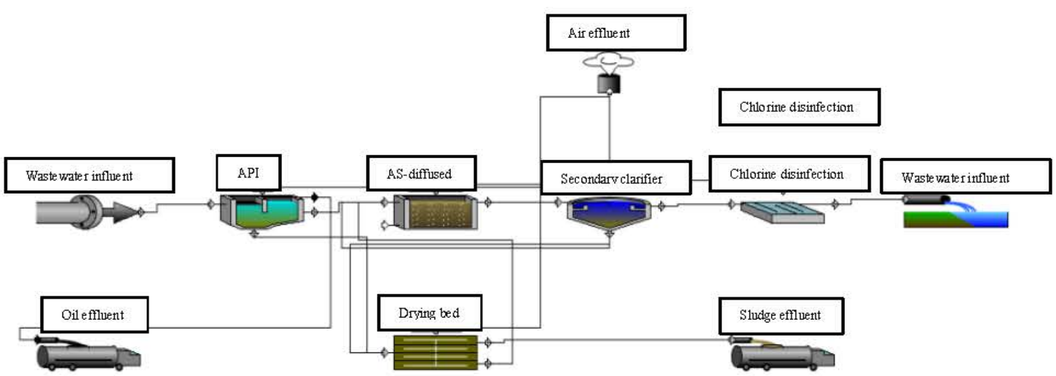

Fig. 2: Plant process system

During the start-up, 10% of the designated flow of waste water goes into the aeration basin, therefore, it was decided to bring another seed of biomass from another processing plant and add it to the aeration basin, mixing it with the waste water flowing into the aeration basin.

On the first day, 10% of the wet sludge was placed and the MLSS was measured; the outcome was 300 mg/L. On the next day and after the flow of 10% of the designing flow, 10 m^3 of wet sludge was added, bringing the MLSS to 550 mg which is considered sufficient in the start-up as it will individually grow. The 10% of the designated water will continually flow into the aeration basin until the basin is full. In this regard, the DO quantity from the first day until the filling of the basin averages 2 mg/L. After filling the deposition basin, 100% of the sludge returned to the aeration basin.

Analytical methods: During the start-up, factors like DO, TSS, MLSS, SVI and COD concentrations were checked daily and the methods of measurement concerning COD, BOD, MLSS, TP and TN concentrations were used according to the standard methods of examination.

RESULTS AND DISCUSSION

MLSS increase during the start-up: During the start-up, there is a great concern pertaining to the growth of the biomass in the biological system. MLSS and SVI concentration were measured separately during the start-up as shown in Fig. 3 and 4, respectively. During the first 2 days and because of the addition of sludge from another plant, the concentration of MLSS increased. However, the increment, somehow, turned out to be slower (Fig. 3) the quantity of SVI which can hardly be noticed is very little Fig. 4. Moreover, part of the organic material and some of the biomass flowed into the wastewater in the final sedimentation tank.

After the first week, it can be noted that there is an increase of MLSS concentration as a result of the availability of sufficient nutrients and the floc-forming bacteria in the biomass. About 37 days later, the concentration of MLSS reached 3800 mL/g and the value of SVI was 60 mL/g.

The influence of the increase of MLSS on phosphors removal: Iraqi laws have indicated that the effluent phosphors which have been disposed from waste water should be ≤ to 4 mg/L. Therefore, it is possible and through the increase of biomass concentration in the aeration basin which works through bio degradation, these concentrations fall within the allowable limits by the

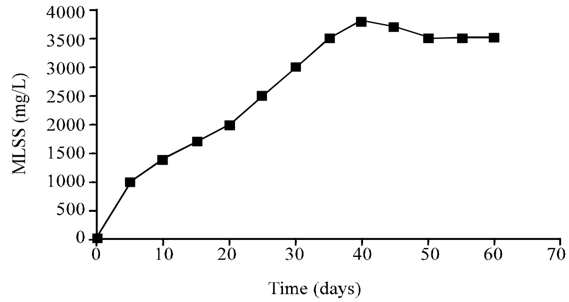

Fig. 3: MLSS variation during system start-up

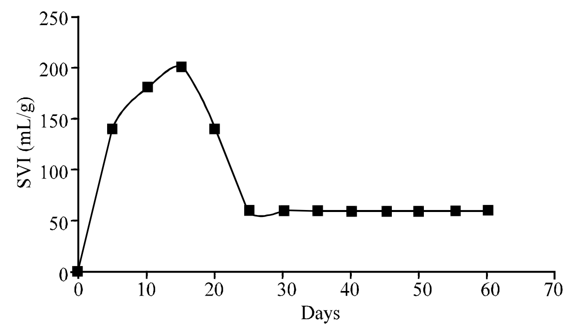

Fig. 4: SVI variation during system start-up

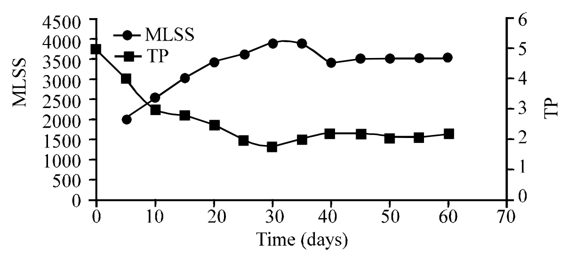

Fig. 5: Relationship between MLSS and TP

process of increasing MLSS concentration. Results show agradual increase in MLSS concentration and the removal of phosphors (Fig. 5).

The effect of increasing of MLSS concentration on the removal of COD concentrationat 100% RAS: The 16 days after filling the basin while the water flows from the aeration basin to the final sedimentation basin, 100% of the sludge has been returned back where the MLSS quantity in the aeration basin has become 2000 mg/L of sludge and the quantity of SVI is 200 mL/g while the quantity of sludge concentration in the return pipe was about 4000 mg/L and the temperature was 26°C, the COD concentration was 82 mg/L and the DO concentration was 2 mg/L.

The effect of increasing of MLSS concentration on the removal of COD concentration at 75% RAS: After more than 22 days, 75% of the quantity of sludge was returned and the quantity of MLSS was measured.The concentration of MLSS was 3400 mg/L, the SVI concentration was 70 mL/g, sludge concentration in the returning flow was about 8000 mg/L and the temperature was 25°C. The COD concentration was 20 mg/L for seven days where the DO concentration was approximately 2 mg/L.

The effect of increasing of MLSS concentration on the removal of COD concentrationat 60% RAS: After more than 29 days, 60% of the sludge was returned and the MLSS concentration was measured. MLSS concentration was 3600 mg/L and the SVI quantity was 62 mL/g, the sludge concentration in the returning flow was 800 g/L. The temperature is 27°C, the COD concentration over a 7 days periodwas 70 mg/L and the DO quantity was approximately 1.9 mg.

The effect of increasing of MLSS concentration on the removal of COD concentration at 50% RAS: After more than 37 days, 50% of the sludge was returned and the MLSS concentration in the aeration basin was measured. MLSS concentration was 3850 mg/L and the SVI quantity was 60 mL/g; The concentration of the returning sludge was12000 mg/L and the temperature was 27°C. The COD concentration over a seven-day periodrose to 80 mg/L and the DO quantity was 2 mg.

Selection of MLSS and the quantity of the return activated sludge: Through consideration ofthe COD increase, the MLSS quantity wasagain been chosen at 3500 mg/L and 75% of the returning quantity by controlling the concentration needed for the system of the sludge treatment line. It was noticed that the COD decreased to avalue of 25 mg/L in the 5th week after filling the basin where the DO concertation was 2 mg. The temperature is 27°C. Figure 6 shows the relationship between the quantities of COD and MLSS.

In comparison with published papers, especially, those similar to this study which are compared with the following two papers, bringing sludge requires costs to prepare and luckily, the availability of a nearby plant providedus with appropriate conditions and reducedthe cost required to bring the sludge during the start-up. As for comparison with 9 which adopted the extended method it is important to note that in the present study the MLSS concentration was quite suitable and this guarantees the treatment process as the MLSS reached 550 mg/L at the end of the second day. In comparison with 9 which lasted for more than 10 days, to get MLSS having the same value for the first two days. In the present study it was possible to obtain a more suitable

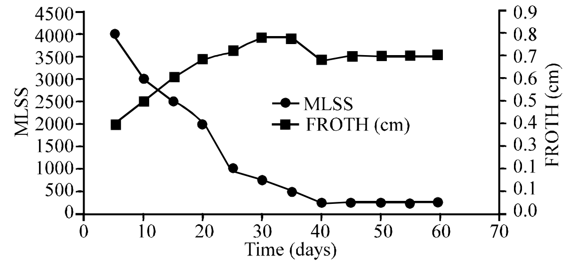

Fig. 6: Relationship between MLSS and froth

quantity of MLSS and in terms of the comparison with phosphors removal, a suitable and large quantity of phosphors removal was found even in the absence ofnon-aerial conditions. In comparison with 10 which depended on the quantity of HRT and controlling it throughout the study, we worked on fixing the HRT quantity and controlling the quantity of the returning sludge. For this reason, the percent findings showed that the level of COD removal washigher than those in the forementioned papers.

CONCLUSION

Through the results above it is clear that the process of the activated sludge proved quite efficient and it was possible to find environmentally acceptable limits. It was also found that increasing the sludge concentration MLSS in these systems has a great influence. Moreover, controlling the quantity of the returning sludge contributes in the sludge required quantity. This sludge required quantity to remove the pollutants in the waste water as the increasein the quantity of sludge led to an increase in the concentrations of pollutants. However, excessive increase leads also to a decrease in the efficiency of the process. This decrease is attributed to the rise of ratios of TSS and Nocardia foamin the effluent. It can also be attributed to the rise in the COD concentration unless the appropriate returning quantity is determined as well. Therefore, it was shown that the best removal for COD concertation is at 3500 mg/L MLSS and the returning quantity is about 75%. Considerable quantities of phosphors can be removed by increasing the MLSS concertation. The COD efficiency is 95% when the MLSS is 3500 mg/L and the returning quantity is about 75%. At the same quantity, the phosphor concentration quantity in the effluent has become 2 mg/L and the froth quantity has been reduced from 0.75-0 m, a quantity which can easily be noticed.

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