

## Assessment of Wastewater Treatment Plant's Performance in Amol Industrial Park

<sup>1</sup>Maedeh Sadeghpour, <sup>2</sup>Bahar Hosseini and <sup>3</sup>Ghasem D. Najafpour

<sup>1</sup>Faculty of Engineering, Islamic Azad University of Qaemshahr, Iran

<sup>2</sup>Environmental Engineering, Faculty of Civil Engineering, Noshirvani University of Technology, Babol, Iran

<sup>3</sup>School of Chemical Engineering, Noshirvani University of Technology, Babol, Iran

**Abstract:** Amol's industrial wastewater treatment plant (WWTP) was monitored over a period of 8 months (July 2005 and February 2006). Also the operating conditions were optimized for 1 month to enhance the process efficiency. The problems associated with WWTP were chemical shock (strong acidic influent), bulking and rising of sludge, low ratio  $\frac{F}{M}$  and  $\frac{MLVSS}{MLSS}$  ratio, inadequate mixing in the equalization tank and inappropriate C/N/P ratio in anaerobic and aerobic tanks. Based on diagnosis of the anaerobic process, for the revival of anaerobic microbial consortium in the anaerobic digestion tank, fresh manure was added and  $\frac{F}{M}$  ratio was adjusted and then a 15% increase in removal efficiency was resulted. Addition of urea and phosphate into the aerobic tank has slightly improved on total removal efficiency (about 5%). The effluent COD concentration was reduced by 50%. Activated sludge and sludge volume indices were enhanced by 15% and 30%, respectively.

**Key words:** Industrial wastewater % Activated sludge % Biological treatment % Microbial consortium % Dissolved oxygen

**Abbreviations:** SVI = Sludge Volume Index MLVSS = Mixed Liquor Volatile Suspended Solids  
MLSS = Mixed Liquor Suspended Solids C/N/P = Carbon/Nitrogen/Phosphorous

### INTRODUCTION

It has been projected that in near future, the number of small-scale treatment plants such as the one presently operates in Amol (Iran), may gradually increase and a large demand for information on appropriate procedures and technologies has to develop. The technical alternatives ranging from mechanical and simple biological low rate systems such as ponds, sand filters and reed beds to complex high-rate suspended and fixed film biomass reactors have to be evaluated according to their plant size, operation safety, reliability, demand for skilled personnel, investment and operation costs [1].

Many small-scale municipal treatment plants are in operation in European communities but a great number of them are not working with high performance [2]. In general, process design should aim to optimize the reaction kinetics so that the desired reaction is completed with in minimum time. This often requires that the reaction

pH has to be maintained at a fixed value by addition of acid and alkali solutions. Precise control of the pH is then required, and for this purpose the use of an automated control system is essential [3].

Amol industrial zone collecting all the wastewater from several industrial plants such as poultry processing plant, meat and fruit juice processing plant, paperboard factory, dairy farm products, glass factory, tomato cannery and many more small plants which are located in 20 hectares of pasture land, generating a discharge flow rate of 350 to 400 m<sup>3</sup> per day.

The wastewater selected for the present research was obtained from Amol industrial-zone treatment plant. This plant is located at a distance of 10 km from Amol, Iran. Beside the plant, a small research lab was assigned to monitor the performance of the plant. This plant site was selected because of the short distance and also it was more convenient for sampling and analysis of samples.

**Corresponding Author:** Dr. Ghasem D. Najafpour, School of Chemical Engineering, Noshirvani University of Technology, Babol, Iran

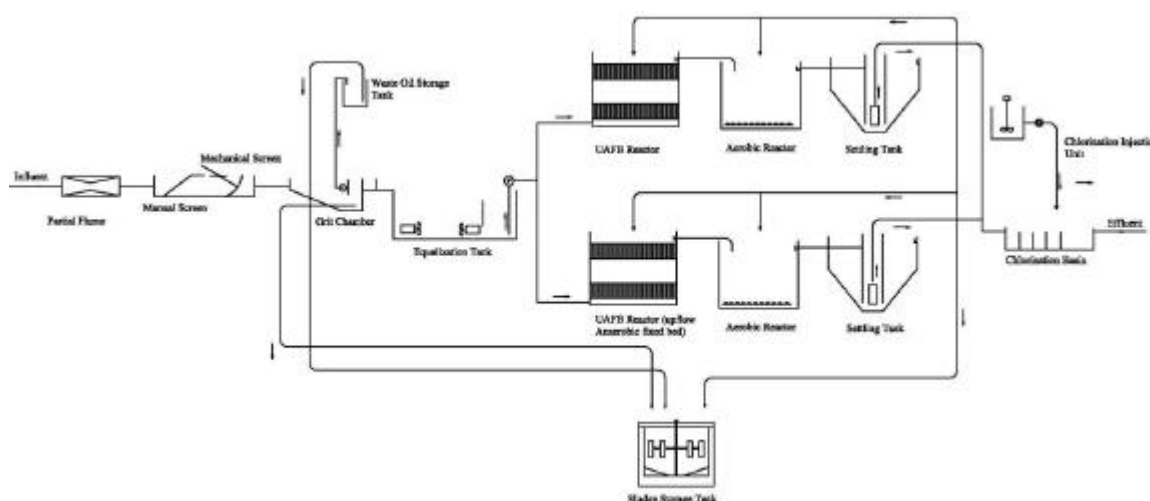


Fig. 1: Schematic diagram of Amol's wastewater treatment plant

Significant variations in the composition of the wastewater arising from a cluster of industries have created difficulties in ensuring the efficiency and effectiveness of the WWTP. Other factors that contribute in affecting the efficiency are temperature, flow of wastewater, PH and presence of different components [4]. The wastes consist of solid and liquid parts. The solids were removed from wastewater by screening and grit removal chamber. Wastewater was sent to degreasing unit to remove oil and grease and then pumped to an equalization tank to regulate the pH level of the wastewater. Then, wastewater was channeled to a biological unit operation. This unit consisted of two anaerobic tanks including plastic media and two aerobic tanks. Biofilm processes have proved to be reliable for organic carbon and nutrient removal and are without some of the problems associated with activated sludge processes [5].

The plant is using extended aeration system in aeration part. Conventional activated sludge and extended aeration had higher removal efficiencies for ammonia, TSS, COD and BOD<sub>5</sub> and produced good quality final effluents for ultimate disposal in accordance with the discharge standard [6]. After biological treatment, biological mixture is discharged to a sedimentation tank. Sludge is settled and the treated effluent is discharged to the chlorination tank and then to a branch of Haraz river near the plant. A simplified scheme of the plant is presented in Figure 1.

The present investigation was conducted in order to enhance the efficiency of the treatment plant. The purpose of this research was to achieve certain objectives

such as enhancing the process efficiency of the aerobic and anaerobic processes. The work was focused on operation of the activated sludge process for the removal of the pollutants from Amol industrial wastewater plant.

## MATERIALS AND METHODS

Industrial wastewater for the present research was selected from Amol industrial zone. The process parameters were dissolved oxygen (DO), chemical oxygen demand (COD), turbidity, optical cell density at a wavelength of 520 nm, total solids, total suspended solids (TSS), settle able solids, oil and grease, pH value, total alkalinity and total Kjeldahl nitrogen (TKN). All of the testing materials and methods used in this research is based on Standard Methods for the Examination of Water and Wastewater by APHA and AWWA unless is stated otherwise [6].

## RESULTS AND DISCUSSION

This plant was sometimes suffered from high organic load and chemical shocks. The mixers in equalization tank were not performed well. The pH for influent was varies, it was in the range of 4-8. The treatment plant's effluent normally had pH of 6.5. The pH of equalization tank was 5-7. In addition, there was no pH control, such as addition of basic material like NaOH to increase pH value if acid industrial influent was introduced as intake. Often, the inlet wastewater was almost acidic, even sometimes the pH value in the equalization tank was detected as low

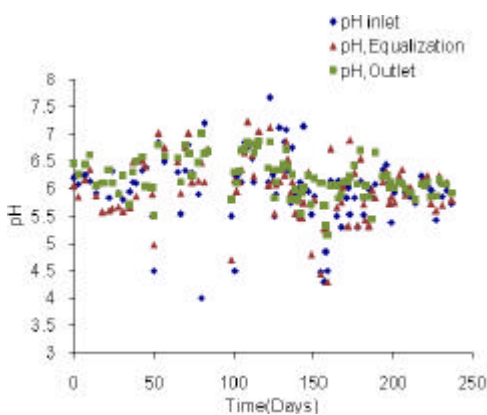


Fig. 2: Monitored pH values for the duration of 8 months

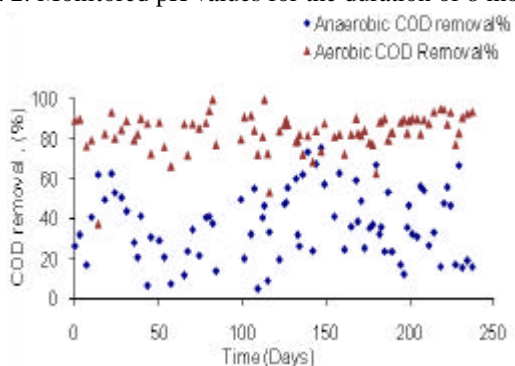


Fig. 3: Monitored COD removal for the duration of 8 months

as 4. Inlet equalization tank and outlet pH values for duration of 8 months are presented in Figure 2. That was due to anaerobic bacteria death and the microbial film was detached from the media. It should be understood that anaerobic bacteria activities decreased at low pH value (any pH lower than 6) [7, 8].

The C/N/P ratio in anaerobic processes should be held on 300-400/5/1. But measurements showed that the ratio was not sustained in Amol WWTP. Total Nitrogen in anaerobic inlet was about 1.7 mg/l and phosphorus amount was about 3 mg/l. The anaerobic removal efficiency of the plant was low, an averaged value of 40%. The removal efficiency for aerobic process was about 80%. The COD removal of aerobic and anaerobic processes is shown in Figure 3.

In the aerobic tank, the  $\frac{MLVSS}{MLSS}$  ratio was also low and it resembled that the microorganisms were not truly active, and also the cell retention time was high. The stability of  $\frac{MLVSS}{MLSS}$  ratio is shown in Figure 4. The ratio of active sludge in total sludge ( $\frac{MLVSS}{MLSS}$ ) had variation in the range of 0.2-0.7.

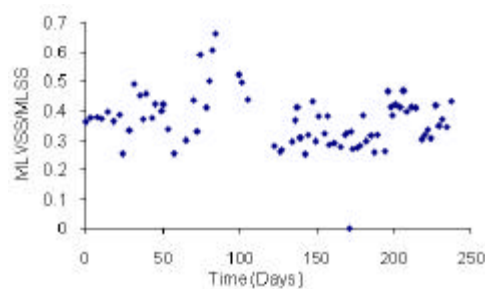


Fig. 4: The stability of the  $\frac{MLVSS}{MLSS}$  ratio for the duration of 8 months

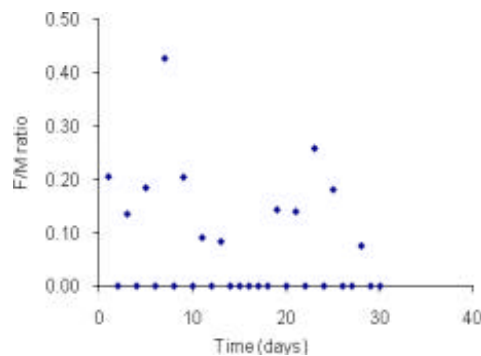


Fig. 5: The  $\frac{F}{M}$  ratio observation for the duration of 8 months

The high ratio of  $\frac{MLVSS}{MLSS}$  in activated sludge system may cause bulking. According to recommendation suggested by Arsiwala for wastewater treatment, at ambient conditions similar to Amol waste treatment plant, the  $\frac{F}{M}$  ratio should be in the range of 0.1 to 0.2 [9].

Figure 5 depicts that the food and microbe ratio at most of the time was lower than 0.1, even number of data points showed zero value. That means the system sometime suffered from limited amount food and the organisms have decayed. The SVI values which are shown in Figure 6 are in the range of 100-45. The SVI value above 150 ml/g is associated with bulking [10]. The average SVI was about 250. The SVI shows that at most of the time, the process was not efficiently operated.

Bulking is a wide phenomenon in activated sludge treatment plants. It is related to fats and oil content and operational aspects such as sludge retention time (sludge ages), low  $\frac{F}{M}$  ratio as well as dissolved oxygen. Bulking occurred seasonally and periodically, which bring serious operating problems and take a relating long time to restore [10, 11]. In Amol's treatment plant, the degreasing unit

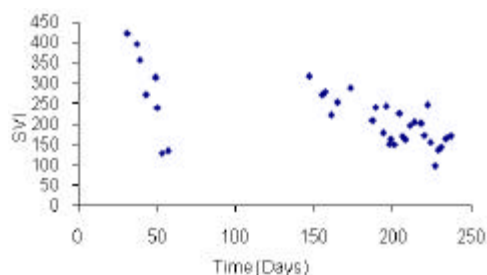


Fig. 6: The SVI values for the duration of 8 months

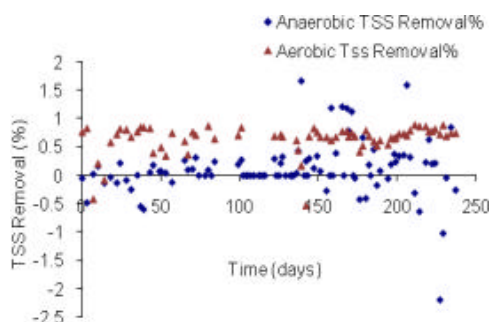


Fig. 7: Monitored TSS removal for the duration of 8 months

did not work well so oil and fats were conducted to the other units such as sedimentation tanks undesirably.

At the most of the time, aerobic inlet TSS value was higher than its value in the anaerobic inlet. Two of the most common reasons for this problem are: low pH values (less than 4) and high organic loading rates [12]. Because of the presence of hustle conditions, the microorganisms may die and detach from the surface of the media. Therefore, increasing in TSS value was also reported in the literatures [13, 14]. The percentages of TSS removal from Amol plant are presented in Figure 7. The average percentages of TSS removal for the anaerobic and aerobic processes were 25 and 75%, respectively.

There was an attempt for the full duration of one month to operate the plant at optimum condition. The processes were improved by addition of 10 kg/day manure into the anaerobic tank, urea and phosphate into the aerobic tank. Dosage of urea and phosphate was 10 kg/day and continued for the entire period of 30 days. The reformation was achieved. The data for COD removal in the anaerobic and aerobic tanks for one month of the treatment are presented in Figure 8. An increase in DO concentration in the effluent was a good indication of improvement in efficiency of COD and BOD<sub>5</sub> removal [3].

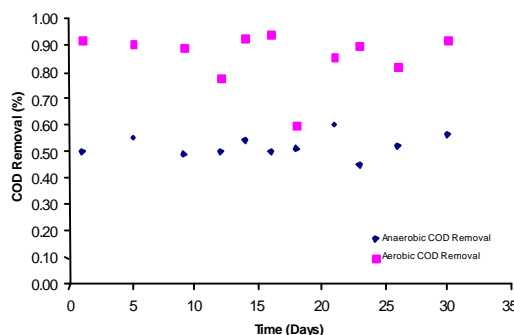


Fig. 8: Monitored COD removal for duration of 1 month

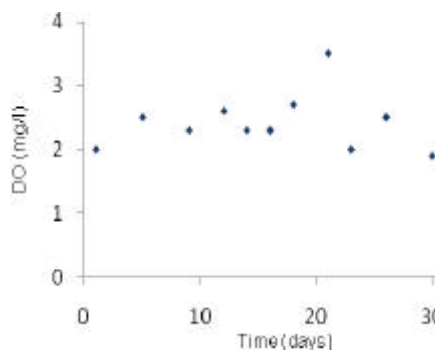


Fig. 9: DO concentration for duration of 1 month

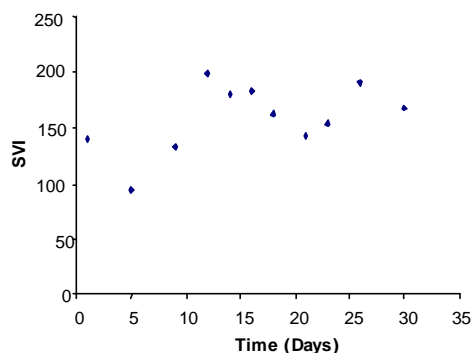


Fig. 10: Monitored SVI for duration of 1 month

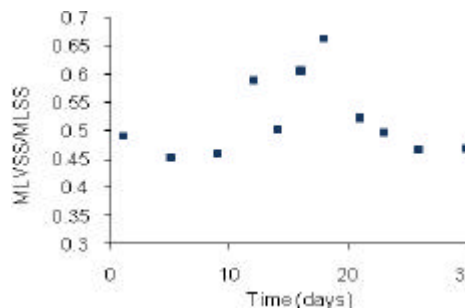


Fig. 11: The stability of the  $\frac{MLVSS}{MLSS}$  ratio for the duration of 1 month

DO levels always were kept constant (about 2 mg/l), the DO level is shown in Figure 9.

After process optimization, SVI values became more desirable. Values for SVI are presented in Figure 10. The activated part of the sludge the ratio of ( $\frac{MLVSS}{MLSS}$ ) has increased by 15%. The improvement of activated sludge ratio is shown in Figure 11. The average value of the active sludge to total sludge ratio is about 0.5.

### CONCLUSION

The biological treatment processes in Amol's industrial wastewater treatment plant were certainly improved. It was concluded that, by induction of microbial consortium of animal manure into anaerobic tank, there was a 15% increase in removal efficiency. Also by addition of urea and phosphate in to aerobic tank, there was a 5% increase in total removal efficiency. Effluent COD was decreased by 50%. Active sludge and sludge volume indices were increased by 15 and 30%, respectively.

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