Improvements to a Water Treatment Plant in a Dairy Company in Aguadilla, Puerto Rico

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Abstract *—A dairy company has made a 40-million-dollar investment these past years in a new production line to offer new products. One of the problems that needs to be solved is what to do with the new amount of processed water that goes to the water treatment plant. A solution that includes installation of equipment for the facility is necessary to comply with local and federal agency guidelines and to increase efficiency so that the plant can treat more than 120,000 gpd of wastewater and lower cost in haulage. After taking into consideration all the possibilities to improve the water treatment plant and after the design analysis, a sequencing batch reactor tank and a dissolved air flotation unit are the best options to respond to the problem, which will result in a net savings of $103,000.*

Key Terms *— dissolved air flotation, overhauling, sequencing batch reactor, water treatment plant*

INTRODUCTION

A dairy company has made a 40-million-dollar investment these past years in a new production line to offer new products, including UHT (ultra-high temperature) milk and juices. Besides the increase in production, this new production line resulted in a rise in expenses in facilities, maintenance, utilities and the water treatment plant. One of the problems that needs to be solved is what to do with the new amount of processed water that goes to the water treatment plant. The plant is already at its peak complying with the permits before this new production line. The purpose of this project is to improve/find a way to treat the processed water that is overcharging the water treatment plant.

PROBLEM STATEMENT

The purpose of this project is to design an expansion for an increase in manufacturing production in the wastewater treatment plant of the company. After the expansion, the processed wastewater characteristics and quantity changed. The objective is to design the necessary improvements to eliminate the necessity to haul wastewater and comply with current permit limitations. Previously, the existing pre-treatment plant treated around 40,000 gpd (50,000 gpd peak) on average and then discharged the effluent to the Puerto Rico Aqueduct and Sewer Authority (PRASA) system. Production lines were expanded, increasing wastewater discharges to 120,000 peak gpd. The treatment plant does not have the capacity to treat this large volume, resulting in high transportation costs and the potential for state and federal compliance violations. In addition, the existing condition of the plant must be repaired to ensure long-term operation of the system and minimize interruptions in production.

Project Description

This project is about helping the manufacturing industries to understand what amount of production equipment and which maintenance utility areas are affecting their maintenance cost in their water treatment plant or in transportation cost.

Project Objectives

The objective for this project is to add the facilities necessary to comply with local and federal agency guidelines and to increase efficiency so that the plant can treat more than 120,000 gpd of wastewater and lower cost in haulage.

Project Contributions

Comply with federal and local agencies and avoid penalties that will affect cost. Also, this would bring environmental and health benefits for the industry and nearby communities. This will also bring savings to the company by lowering the haulage.

BACKGROUND REVIEW

In 2016, a dairy company made an expansion of their production line to produce UHT products. The increase of the production line also made an increase in the processed water that entered their water treatment plant. The original base production part of the plant has an effluent of 40,000 gpd (50,000 gpd peak) and is transferred to the water treatment plant by two pumps. The expansion part of the plant called "Vida" (figure 1) has an effluent of 70,000 gallons per day. Both areas run 5 days per week and have a total effluent of 120,000 gallons per day. The processed water reaches two equalization tanks of 35,000 gallons. Equalization tank 1 was part of the plant before the expansion. A second equalization tank was added for the increase in processed water that was going to enter the plant. The equalization tank 1 is the only one with screen bars and has influent from the "base" plant and equalization tank 2, while the equalization tank 2 has only influent from "Vida" plant with 70,000 gallons per day. There is a flow meter before equalization tank 1. The processed water then passes through an SBR tank. The SBR tank has a capacity of 170,000 gallons per day. After the SBR tank, it passes through a deaerator tank, which holds 35,000 gallons. Before arriving to the sludge drying beds, it passes through a mixer. The discharge permit is 80,000 gallons per day and the excess water (~ 40,000 gallons) is hauled. This hauling has only been permitted for one year and the cost per gallon is $0.05.

Figure 1
Before "Vida" Plant Expansion Water Treatment Plant

In the month of July, 365 gallons were hauled, and the cost was $18,290, while in August 709,044 gallons were also hauled with a total cost of $35,452, and in September 691,200 gallons were hauled for a total of $34,560, for a total amount of $88,302 for three months. If we estimate that for a year, it would be a cost of $350,000. This is money that is being lost for not having a plant with the necessary improvements to manage those 120,000 gallons per day.

METHODOLOGY

The improvements that will be made to the water treatment plant in Aguadilla are to add a DAF (dissolved air flotation) unit system and another SBR system. Also, the plant will need to seek permission from the Puerto Rico Aqueduct and Sewer Authority (PRASA) in order to increase the discharge permit from 80,000 gallons per day to 120,000 gallons per day. Although making this change will allow the company to comply with the permits of discharge, improvements to the plant need to be made in order to handle that amount of discharge. Dissolved air flotation is used in certain treatment plants to separate solids, oils and greases. Typical removal efficiencies are 70%-98% of total suspended solids (TSS), 40%-60% of biochemical oxygen demand (BOD), 80%-95% of oils and grease and 70%-95% of metals. Because of this, the dissolved air flotation system will lower 4,000 gallons per day of water that will go to the sequencing batch reactor because of all the typical removal efficiencies or wastes. A new SBR system will help treat the amount of water that goes into the plant to be treated. Doubling the size of the equipment will help to treat all the amount required to treat those 120,000 gallons per day. A comparison will be made to compare the cost of having another SBR tank operation and a DAF unit system to compare with the expenses of hauling the excess of water. Below are the formulas used for the design of the DAF and SBR system equipment.

Design Inputs for SBR Tank [1]

- Aeration Time, tA= 3 hr.
- Settling Time, tS=2 hr.
- Sludge Blanket Depth dL/dSL=1.2
- Decant Time t0=1 hr
- Idle Time ti=0 hr
- Aerated Fraction of Fill Time=0.5

Input Values SBR Design

tF=tA+ tS+tD+tl $\boldsymbol{t_f = t_a + t_s + t_s + t_d + t_l \times t_f}$ (1)

Fill Time, tf= 6 hr

No. of Cycles/day, Nc = N (No. of Cycles/tank/day) (2)

No. of Cycles/day, Nc=2 Cycles/day

Fill Volume per Cycle, $V_c = Q_{ww} \frac{10^6 gal}{MG} \div \frac{7.48\ gal}{1\ ft^3} Cycle\ per\ day$ (3)

Fill Volume/Cycle, Vc= 2674 m3/cycle

Total Cycle Time $t_c = t_A + t_S + t_d + t_i + t_f$ (4)

Total Cycle Time, tc=12 hr.

No. of Cycles/tank/day = $\frac{24\ hr}{day} \Big/ t_c$ (5)

No. of Cycles per Tank per Day= 2

Maximum Allowable Fill Fraction per Cycle

MLSS in settled sludge, $X_s = \frac{10^6}{SVI}$ (6)

MLSS in settled sludge, Xs=6667 mg/L

Settled vol. fraction, $\frac{V_S}{V_T}$ (7)

Settled Vol. Fraction, Vs/Vt=0.63

Maximum Fill Fraction$\frac{V_F}{V_T} = 1 - Settled\ Vol\ Fraction,$ (8)

Max Fill Fraction, Vf/Vt=0.37

Tank Volume and Dimensions [2]

Tank freeboard (must be higher than 18") = 2 ft. (9)

Tank Liquid Volume, VT = (Fill Volume/Cycle)/Fill Fraction (10)

$V_T = \frac{V_c}{Fill\ Fraction}$ (11)

Tank Liquid Volume Vt=2228.2 ft^3

Tank Depth = Liquid Depth + Freeboard

D tank = d + Freeboard (12)

Tank Depth, D tank= 22 ft.

For a circular tank: $D = \sqrt{\frac{4V_T}{(pd)}}$ (13)

Tank Diameter 23.8 ft

Solids inventory/tank = $V_t \times \frac{7.48\ gal}{ft^3} \times MLSS \times (8.34 \frac{lb}{MG} \div \frac{mg}{L}) \div \frac{10^6 gal}{MG}$ (14)

Calculate the Solids Retention Time (SRT) = 8.5 days

Solids Inventory/Tank= 1946 lb

Solids Inventory Tank= 486.5 lb (Using the alternate equation for solids inv./tank

Difference= 1459.5 lb

kd at WW Temperature = (kd_20)Theta_kdTww_C – 20 (Tww_C is WW Temp in oC) (15)

Kd at WW temperature= 0.103 lb VSS/d/lb VSS

kdn at WW Temperature = (kdn_20)Theta_kdnTww_C - 20 (Tww_C is WW Temp in oC) (16)

Kdh at WW temperature= 0.069 lb VSS/d/lb VSS

Aeration Time for Nitrification

VSS wasted/day/tank = $(\frac{Q_{ww}}{N} \times Y \times bCOD_0 \times (\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}) \times SRT)/1 - k_d \times SRT$
$+(\frac{Q_{ww}}{N}) \times nbVSS_0 \times (8.34(\frac{lb}{MG})/(\frac{mg}{L}) \times SRT$
$+ \frac{Q_{ww}}{N} \times Y_n \times NO_x Fraction \times TKN_0 \times (8.34 \frac{lb}{MG} \frac{mg}{L}) \times SRT/(1 - k_{dn} \times SRT)$
$+f_d \times k_d \left(\frac{Q_{ww}}{N}\right) Y \times bCOD_0 \times 8.34 \frac{lb}{MG} \frac{mg}{L} \times SRT^2/(1 - k_{dn} \times SRT)$ (17)

VSS Wasted/day/tank= 389.7 lb/d

MLVSS conc. = $\frac{VSS\frac{wasted}{day}/tank}{V_t} \times (7.48 \frac{gal}{ft^3}) \div \frac{10^6 gal/MG}{8.34\ (\frac{lb}{MG})(\frac{mg}{L})}$ (18)

MLVSS Concentration=701 mg/L

MLVSS Fraction = $\frac{MLVSS}{MLSS}$ (19)

MLVSS fraction=0.20

Biol. Solids Prod. Rate/tank =

$$P_{xbio}=(\frac{Q_{ww}}{N}\times Y\times bCOD_0\times(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}})\times SRT)/1-k_d\times SRT + \frac{Q_{ww}}{N}\times Y_n\times NO_x Fraction$$

$$TKN_0\times(8.34\frac{lb}{MG}\frac{mg}{L})\times SRT/(1-k_{dn}\times SRT) + f_d\times k_d\left(\frac{Q_{ww}}{N}\right)Y\times bCOD_0\times 8.34\frac{lb}{MG}\frac{mg}{L}\times\frac{SRT^2}{(1-k_{dn}\times SRT)} \quad (20)$$

Biol. Solids Prod. Rate, Px,bio= 26.42 lb/d/tank

$$NO_x \text{ generated} = TKN_0-((NH4N)_e - Y\times(P_{xbio})/(\frac{Q_{ww}}{N})/\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}) \quad (21)$$

NOxgenerated=25 mg/l

$$NH_4N \text{ before fill} = NH_4N_E\times\left(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}\right)\times(V_T - V_C)\times\frac{7.48\frac{GAL}{FT^3}}{10^6\frac{GAL}{MG}} \quad (22)$$

NH4N before fill= 0.195 lb/tank

$$\text{Oxidizable } NH_4N \text{ added/fill} = FILL\ VOLUME\times\frac{7.48\frac{GAL}{FT^3}}{10^6\frac{GAL}{MG}}\times NO_X\times\left(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}\right) \quad (23)$$

Oxidizable NH4N added/fill=1.04 lb/fill

Init oxidizable N,

$$N_o=\frac{\text{oxidizable NH4N/fill + NH4N before fill}}{V_T\times\frac{7.48\frac{GAL}{FT^3}}{10^6\frac{GAL}{MG}}\times\left(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}\right)} \quad (24)$$

Init. Oxidizable N, No= 7.85 mg/L

Nitrifier conc.,

$$X_n=\frac{Q_{ww}}{N}\times Y_n\times NO_x Fraction\times TKN_0\times(8.34\frac{lb}{MG}\frac{mg}{L})\times SRT/(1+k_{dn}\times SRT)\times V_T\times\frac{7.48\frac{GAL}{FT^3}}{10^6\frac{GAL}{MG}}\times\left(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}\right) \quad (25)$$

Nitrifier Concentration, Xn=9.7 mg/L

K_n at WW Temperature = (K_n at 20°C)q^{T-20}

(T is WW Temp in °C) (26)

Kn at WW temp.= 0.605 mg/L

m_{mn} at WW Temperature = (m_{mn} at 20°C)q^{T-20}

(T is WW Temp in °C) (27)

µmm at WW temperature=0.576 lb VSS/lb VSS

$$\text{Req Aer Time for nitrif., } t_{nit}=24\frac{hr}{day}\times(K_n\times ln\left(\frac{N_o}{N_e}\right)+(N_o-N_e))/(X_n\times\frac{m_{mn}}{Y_n})\times\frac{DO}{K_o-DO} \quad (28)$$

Req. Aeration Time, t Nit= 5.81 hr.

Current Total Aeration Time/Cycle hr= 6 hr.

Calculating Operational Parameters

Decant Pumping Rate =

$$\frac{\text{Decant Volume}}{\text{Decant Time}}\times\frac{\text{Fill Volume}}{t_D}=\frac{V_F}{t_D}\times 60\frac{min}{hr} \quad (29)$$

Decant Pumping Rate= 44.563 ft3/min

Sludge (TSS)Prod. Rat e=

$$VT\times N\times\frac{7.48\frac{GAL}{FT^3}}{10^6\frac{GAL}{MG}}\times\left(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}\right) \quad (30)$$

Sludge (TSS)Production Rate= 227.8 lb/day

$$bCOD \text{ removal rate}=Q_{ww}\times bCOD_0\times(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}})$$

(31)

bCOD Removal Rate= 106.8 lb/day

BOD removal rate =

(bCOD removal rate)/(bCOD/(BOD ratio)). (32)

BOD Removal Rate= 66.7 lb/day

$$\frac{TSS}{BOD\ Observed\ Yield}=\frac{TSS\ Sludge\ Prod\ Rate}{BOD\ Removal\ Rate}$$

$$\frac{VSS}{BOD\ Observed\ Yield}=\frac{TSS\ Observed\ Yield\times MLVSS}{MLSS}$$

(33)

TSS/bCOD Observed Yield=2.13 lb/lb

$$Sludge\ Wasting\ Rate=\frac{Sludge\ Prod.Rate}{Sludge\ Conc.In\ Wasted\ Sludge}$$

(34)

Sludge Wasting Rate= 7803 gal/day-
From MLSS Conc.

Sludge Wasting Rate= 4097 gal/day- From Settle Sludge

$$\frac{F}{M}Ratio = \frac{Q_{ww}}{N} \times BOD_0 \Big/ V_t \times MLVSS \quad (35)$$

F/M (g BOD/d/g MLVSS)= 0.171

$$Overall\ Hydraulic\ Retention\ Time, t = V_T \times \frac{7.48\frac{GAL}{FT^3}}{10^6\frac{GAL}{MG}} \times 24\frac{hr}{day} \times \frac{N}{Q_{ww}}$$

(34)

Overall Hydraulic Retention Time, t= 40hr

Calculating the Required Alkalinity Addition

$$All\ Alkalinity\ concentrations\ below\ are\ \frac{mg}{L}\ as\ CaCO_3$$

Alklinity used for nitrif. =(g $\frac{\text{Alk}}{\text{g}}$ NH_3-N rem)×

(TKN_o-$NH4N_e$) (37)

Alkalinity used for nitrif. =246 mg/L

$$Alkalinity\ to\ be\ added = Target\ Effl\ Alk + Alk\ Used\ for\ nitrif - Prim.Effl\ Alk \quad (38)$$

Alkalinity to be added= 106 mg/L

$$Daily\ Alkalinity\ Req'mt = Q_{ww} \times ALK\ to\ be\ added \times \left(\frac{8.34\frac{lb}{MG}}{\frac{mg}{L}}\right)$$

Daily Alkalinity Req'mt=35.5 lb/day

$$Daily\ NaHCO_3 Req'mt = (Daily\ Alk\ Reqmt)\ (Equiv\ Wt\ of\ \frac{NaHCO_3}{Equiv\ Wt\ of\ CaCO_3} \quad (40)$$

Daily NAHCO3 Req'mt= 59.6 lb/day

$$NaHCO_3\ to\ be\ added\ per\ fill = Daily\ NaHCO_3 \frac{reqmt}{cycles\ per\ day} \quad (41)$$

NAHCO to be added/fill= 29.80 to NAHCO3/fill

Calculating Oxygen/Air/Blower Requirements

Oxygen needed per Tank= $\left(\frac{Q_{ww}}{N} \times bCOD_0 \times (8.34\frac{lb}{MG} \div \frac{mg}{L}\right) - \frac{1.42(P_{xbio})}{N} + .33(\frac{Q_{ww}}{N}) \times NO_x \times 8.34\frac{lb}{MG} \div \frac{mg}{L}$ (42)

Oxygen needed per tank 105.4 lb/d/tank

$$Ave.O_2\ Transf.\frac{Rate}{tank} = O_2 \frac{needed\ in\frac{kg}{d}/tank}{24\ hr/day} \quad (43)$$

Aver. O2 Transf, Rate/tank 4.39 lb/hr/tank

Required Ave. Actual Oxygen Transfer Rate during Aerated Periods:

$$AOTR = O_2 needed \frac{in\frac{kg}{hr}}{tank} \times Cycle \frac{Time}{Aeration\ Time}/Cycle \quad (44)$$

Required Ave. Actual Oxygen Transfer Rate/ Aerated Periods, AOTR= 8.78 lb/hr/tank.

Pressure at Mid-Depth, $P_D = (P_{atm}) + (gH_2O(\frac{d_{Diff}}{2})/144\ in^2/ft^2$ (45)

Pressure at Mid-Depth, Pd= 18.6 psi

$$Design\ Air\ Density, r_{air} = MW_{air}/\frac{100\frac{kPa}{bar}}{R_{Ideal}Gas} \times (Tww_F + 459.67) \quad (46)$$

Design Air density ρ air= .0762 lb/hr/tank

Actual O2 Transfer Effic.,

$$\text{AOTE} = \text{SOTE} \times \text{a} \times \text{F} \times \left(\text{B} \times \frac{P_D}{P_{std}} \times C_s - \frac{C_L}{C_{ss}}\right) \times 1.024^{(Tww_C-20)} \quad (47)$$

Act. O2 Transf. Effic, AOTE= 15.52%

$Blower\ Outlet\ Press, P_{B2} = P_{atm} + DP_{diff}\left(0.0361\frac{psi}{in}H_2O\right) + g_{H20} \times d_{diff/(144in^2/ft^2})$ (48)

Blower Outlet Press, PB2= 22.9 psi

Required Air Flow Rate (per tank - during aerated periods):

ACFM=$\frac{AOTR}{AOTE} \times MW_{air} \div Mole\ Fract_{02} \times MW_{02} \times r_{air} \times 60\ min/hr$ (49)

Required Air Flow Rate (per tank-during aerated periods), ACMM= 53.6 ACFM

SCFM=ACFM$((P_{atm} - DP_{inlet})/P_{std})(T_{std}/T_{ww}) \times (T_{std} \& T_{ww} are\ abs\ temp)$ (50)

Required Air Flow Rate (per tank-during aerated periods), SCMM= 53.2 SCFM

Design Increases Factor, F= 1.5 Design Std. Air Flow Rate per Tank= (51)

79.8 SCFM

DAF Design Formulas [3]

Design inputs for a DAF unit system

Flow Rate, Q= .120 MGD

Temperature=32.5 Celsius=90.5 Fahrenheit

Recycle Pressure= 40 psi

Atmospheric Pressure 14.7 psi

Efficiency Factor, f=0.5

TSS (Total suspended solids)= 283 mg/L

Oil & Greases, O_G= 2 mg/L

Polymer added, CH= 0 mg/L

Design Solids Loading, Ls= 2 lb/ft^2/hr

Design Hydraulic, Lh= 1.4 gpm/ft^2

Air Solubility $S_a = -(2 \times 10^{-5})T^3 + 0.005933T^2 - 0.6784T + 45.09$ (52)

Sa=17.46 mL/L

Absolute Recycle Pressure $P = P_a + P_{atm}$ (53)

P=3.72 atm

$Recycle\ percentage = \frac{R}{Q}$ (54)

%Recycle= 100%

Influent Suspended solids Ss= Influent TSS+ Influent Oil & Grease Chemical Addition (55)

Sa=285 mg/L

$Air\ to\ Solids\ \frac{A}{S} = \frac{1.3S_a(f_p - 1)}{S_a}$ (56)

A/S=0.0685548 mL/mg

Solids Rate $S = QS_a \times (\frac{8.34}{24})$ (57)

S=11.9 lb./hr=89.8 g/min

Air required:

SCFM= $SFCM(\frac{P}{1})(\frac{60+459.67}{T+459.67})$ (58)

SFCM=0.2175 SFCM

Air required:

AFCM=$(\frac{A}{S})(S\ in\ \frac{g}{\min})(\frac{0.0353147\ ft^3}{L})$ (59)

AFCM=0.2175 AFCM

Air Density at P&T: pair=$\frac{28.97(P_g + P_{atm})}{(10.37(T+459.67)}$ (60)

Air Density at P&T: pair=0.2684 lb/ft^3

Air Requirements in lb/hr= (ACFM) (pair) (61)

Air Requirements in lb/hr= 3.503 lb/hr

Daf area based on Hydraulic Loading = $\frac{Q \times 10^6}{24 \times 60} \times L_h$ (62)

Daf area based on Solids Loading = $\frac{S}{L_s}$ (63)

$DAF\ Solids\ Loading\ in\ (\frac{lb}{ft^2}/hr) = \frac{S}{DAF\ AREA}$ (64)

DAF Hydraulic Loading(gpm/ft^2) = $\frac{\frac{Q \times 10^6}{24 \times 60}}{DAF\ Area}$ (65)

Required DAF Area (Based on Solids Loading) =5.94ft^2

Required DAF area (Based on Hydraulic Loading) =59.524ft^2

DISCUSSION

After taking into consideration all the possibilities to improve the water treatment plant and after the design analysis, an SBR Tank and DAF Unit System are the best options to respond to the problem and the objective of this project. The SBR tank is going to have a liquid volume of 2,229 ft^3. with a depth of 22 ft. and a diameter of 24 ft. The tank is going to be installed behind the control room and a new digester tank is going to be installed. After the equalization tank 1, the process will be running through either the existing SBR tank or the new one. The SBR tank is going to be able to treat the extra 40,000 gallons per day that need to be treated to stop hauling and avoid unnecessary expenses (figures 2 and 3). Also, a DAF unit system is going to be installed following the equalization tank and water is going to go through this DAF before arriving to the SBR tanks.

Figure 2
Diagram after Improvements of Water Treatment Plant

Figure 3
Diagram after Improvements of Water Treatment Plant

After the design for the DAF system, there would be a solids loading area of 6 ft^2 and a hydraulic loading area of 60 ft^2. Nevertheless, several additional costs need to be taken into consideration. A permit for increase in water discharge is going to be needed to be allowed to treat this amount of processed waters. The cost for this permit is going to be a one-time payment of approximately $50,000. Furthermore, the plant is going to have an increase in maintenance cost, which includes additional employees, chemicals, electricity and disposal of sludge waste. There will be no increase in personnel cost for three supervisors in the plant because this will not be an additional expense, since the plant will not need another supervisor or operator to run that part of the plant. As for the chemicals, these are used in the equalization tanks and not the SBR tank and sometimes a polymer is added in the SBR tank, but this is not a significant cost to consider for this analysis. As for the disposal of material, there will be an increase from $2,000 to $3,000 for the new 40,000 gal/day that will need to be treated. Three pumps for the blowers, one for the agitator and one to pass the water from equalization tank 1 to SBR is going to be needed, therefore there will be an increase in energy consumption. The cost for the blower pump (1) will be $160,000 per year, the cost for the agitator pump will be $60,000 per year and the cost for the pump that will send water from equalization tank 1 to the new SBR tank will be $10,000. DAF electricity cost is going to be $20,000 per year. Nevertheless, the cost for overhauling a year is around $350,000, not counting the potential penalties the plant could get for not complying. Taking into account the expenses considered by adding this equipment and the savings generated by eliminating the overhauling, there will be a net savings of $103,000 (table 1).

CONCLUSION

After these improvements, the maintenance cost will increase in the area of electricity, water, operations, chemicals and disposals for the new equipment. Nevertheless, this will lower the amount of overhauling and the company will be able to comply with local agencies to discharge the amount approved for discharge. The overhauling is a temporary solution that local agencies allow while you improve the water treatment plant. The new DAF unit system will also remove a high percentage of suspended solids, BOD, oils, grease and metals.

Table 1
Costs Before and After Improvements to the Water Treatment Plant

Month	Before Improvements to the Plant	After Improvements to the Plant (DAF and SBR Installation)
July	$18,290	($0/Overhauling+$13,333+$5,000+$833+$1,666) = $20,832
August	$35,452	($0/Overhauling+$13,333+$5,000+$833+$1,666) = $20,832
September	$34,560	($0/Overhauling+$13,333+$5,000+$833+$1,666) = $20,832
Total (3 Months)	$88,302	$62,496
Total Estimated (12 months)	$353,208	$249,984
Savings by DAF and SBR Installation= $103,224		

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