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Improvement of Existing Conventional Activated Sludge Dairy Industrial Wastewater Treatment

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ABSTRACT

This research made to improve the existing conventional activated sludge treatment plant of the industrial wastewater for Milky land dairy factory, which lies in 10th of Ramadan City, Egypt to achieve the new purpose of its reuse as irrigation water instead of disposing it to the city sewerage system. Two problems facing the research to be made, the first was the absence of land availability for extension in the factory, the second was the increase of inflow due to addition of new production line to the factory. All the study analyses were made in Milky land dairy factory laboratory. The existing unit was built underground from R.C. as one tank divided into three compartments for primary & final sedimentation and conventional mechanical surface aeration between them. The existing plant removal efficiency was for BOD 80%, COD 83% & TSS 85% which produces effluent with BOD 350, COD 430 & TSS 120. Additional coated steel DBAF unit had been erected above the existing plant fed by pumps from its existing effluent the unit consisted from dual biological aerated filter followed by final settling tank as second stage. Samples were taken continuously for 3 months from the inlet, outlet and between the units of treatment to determine the parameters (BOD, COD, TSS and pH), in order to get the removal efficiency for each unit as well as the overall efficiency to ensure the system success. The study illustrated the success of the additional DBAF unit to improve the effluent criteria to be 20 ppm for BOD, 35 ppm for COD, 20 ppm for TSS which are suitable for irrigation purpose of the green area inside and surrounding the factory even the flow increased from 250 to 350 m3/day. The modification increased the running cost by 15% only due to lower cost for DBAF system.

INTRODUCTION

From the early years until now, milk is a source of both energy and necessary nutrients for growth, and it is the only food of a young mammal in its first period of life. Milk also contains antibodies that are responsible for protecting the young mammal against infection and diseases [1]. The dairy industry is a major enterprise in Egypt, occupying a significant place in food supply. This industry has been identified as an important contributor to the pollution of waterways especially when large industrial establishments are involved. Dairy industries have shown tremendous growth in size and number in most countries of the world, it considered to be the largest source of processing wastewater in many countries. These industries discharge wastewater which is characterized by high chemical oxygen demand, biological oxygen demand, nutrients, organic and inorganic contents. Such wastewaters, if discharged without proper treatment, severely pollute receiving water bodies. The dairy industry is characterized by the multitude of products and therefore production lines. Plants can have as few as one or two production lines or all of them (pasteurized milk, cheese, butter, etc.) [2]. The organic components of the wastewater from dairy processing operations can be classified as proteins, lactose and fat. The organic components in dairy processing wastewater are highly biodegradable. These will affect the environment in different ways depending on their biodegradability and their solubility [3]. As evident from the low COD: BOD ratio the dairy wastes can be treated efficiently by biological processes. Moreover, these wastes contain sufficient nutrients for bacterial growth. Both high rates tricking filters and activated sludge plants can be employed very effectively for complete treatment of dairy waste. But these conventional methods involve many skilled persons and special type of equipment. Also, the low-cost treatment method like oxidation ditches is applied. [4]. Currently, the government is taking serious steps towards protection the environment from pollution. The investigation of dairy factories in Egypt shows several treatments had been applied. Nesla factory industrial wastewater treatment plant used SBR which achieved COD removal efficiency 87% with organic loading rate 7.5 gm COD/L. day and retention time 5 days. Beyti factory in Noubariya used equalization tank followed by dissolved air floatation and then SBR unit. Two stages conventional activated sludge are used in Masr for dairy factory in Damietta. Dissolved air flotation followed by roughing filter and finally conventional activated sludge are used in El Masryeen dairy factory in Giza. EL Salehaya factory used oxidation ditch. Most of the medium and small dairy factories used septic tanks followed by disposal cesspool that caused several problems to environment [5]. This lead to a

need to solve this problem by using a treatment achieves minimum area with higher efficiency which may be achieved by SBR or DBAF techniques. This study will investigate the SBR technique. The study aim was to improve the existing wastewater treatment plant in Milky land dairy factory to change its effluent quality to meet the needs for its reuse for irrigation of green areas in and surrounding the factory and also deal with the increase in inflow by 100m3/day with the reality of no space for any extension.

MATERIALS AND METHODS

The study was applied in Milky land dairy factory, which lies in 10th of Ramadan City, Egypt. The work was applied to the wastewater treatment plant in the factory. The existing unit was built underground from R.C. as one tank divided to three compartments for primary & final sedimentation and conventional mechanical surface aeration between them as shown in figure (1). The existing plant removal efficiency was for BOD 80%, COD 83% & TSS 85% which produces effluent with BOD 350, COD 430 & TSS 120 that meets the Egyptian environmental limits for drainage in the city sewerage system.

The modification which presented by figure (2) was made by additional coated steel DBAF unit which had been erected above the existing plant to overcome space problem and minimize piping cost, fed by pumps from its existing effluent the unit consisted from dual biological aerated filter followed by final settling tank as second stage treatment.

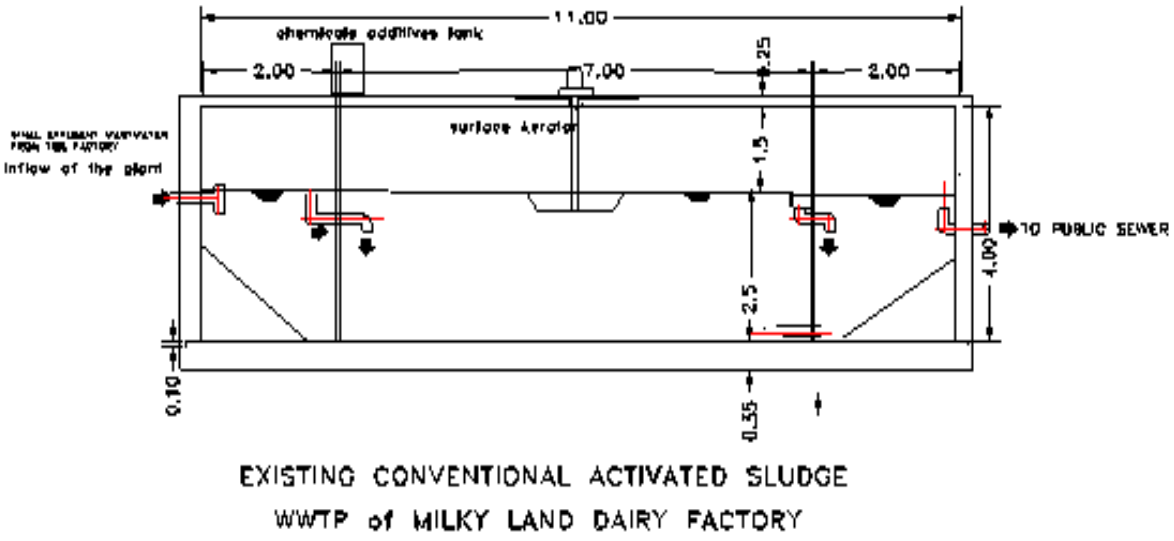

Figure (1) Existing Wastewater Treatment Plant in Milky Land Dairy Factory

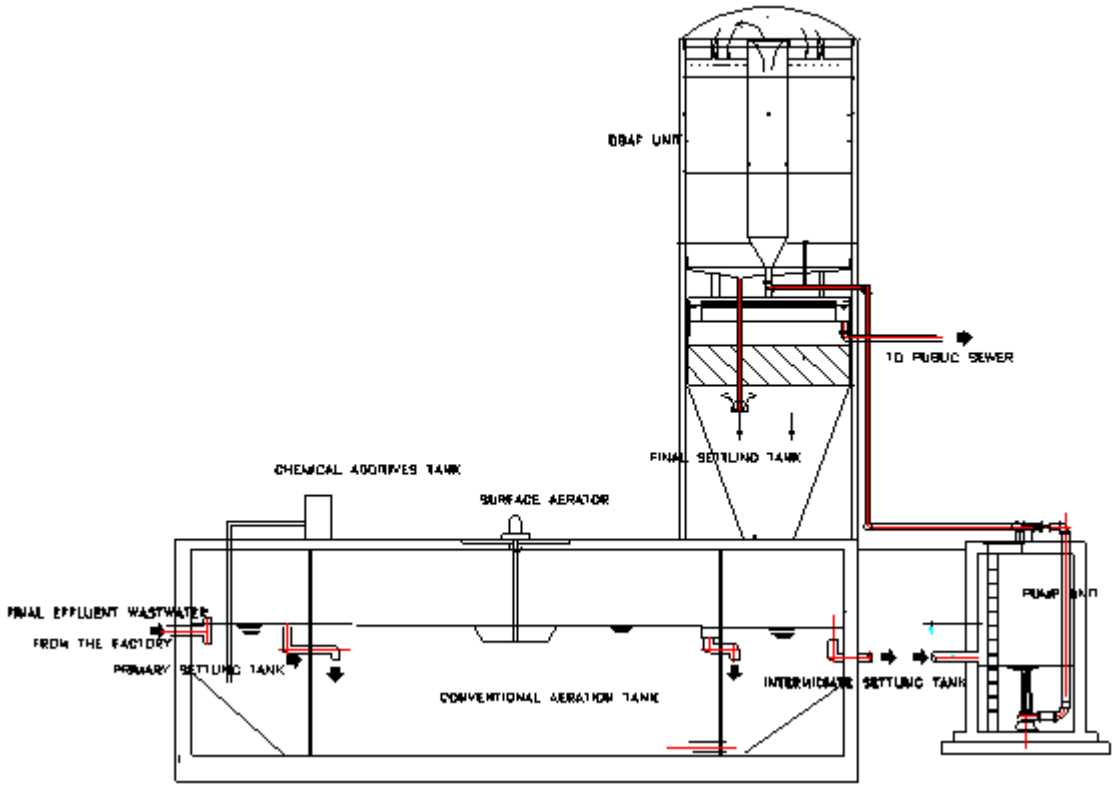

Figure (2) Modified Wastewater Treatment Plant in Milky Land Dairy Factory

The work was made through two stages one before the modification on the existing plant for one month under the overloading of inflow. The second was after the erection and start-up period for the modification for 2 months operation. The samples were taken from the inlet and the outlet of each unit of the treatment line on weekly basis for all the study period. The measuring was done for the parameters (pH, TSS BOD, COD and TDS).

RESULTS AND DISCUSSIONS

The experimental results during one month for the operation of existing plant are presented in table (1), which includes the main pollutants concentrations for each unit in the plant.

Table (1) Raw Sewage & Treated Water results

Sample No.		1	2	3	**4**
Date		**04/06/2014**	**10/06/2014**	**17/06/2014**	**25/06/2014**
COD mg/l	Inf.	5220	4700	4930	5010
	P.S.T Eff.	3480	3500	3260	3330
	A.T. Eff.	480	450	420	430
	F.S.T. Eff.	420	410	380	390
BOD mg/l	Inf.	3300	2800	2900	3200
	P.S.T Eff.	2200	1900	1960	2100
	A.T. Eff.	380	400	400	390
	F.S.T. Eff.	360	350	340	350
TSS mg/l	Inf.	410	400	395	395
	P.S.T Eff.	220	220	210	210
	A.T. Eff.	300	300	290	290
	F.S.T. Eff.	110	100	95	95
TDS mg/l	Inf.	3650	2990	2960	3070
	P.S.T Eff.	2040	1940	1990	2030
	A.T. Eff.	1900	1860	1900	2000
	F.S.T. Eff.	1900	1860	1900	2000
pH Value	Inf.	11	11	11	11
	Eff.	7.5	7.4	7.4	7.5

It is clear from the results shown in table (1) that the hydraulic overloading by additional 100m3/day against 250m3/day as design flow about 40% increase and has a minor effect on the effluent quality that the plant still produces water quality under the law limits for disposal in city sewerage system **[6]**. This shows that the existing plant was overdesigned than the required needs which are actually something good for the owner to let him always on the safe side. The COD, BOD, TSS removal ratios were 92%, 89% & 75% respectively which are almost inside the normal for such system except the TSS which is less this may be for the sludge dewatering system that disposed of sludge one time every day for both primary & final settling tanks with the morning shift. But on the other hand, the existing plant can not satisfy the needs of irrigation application for the effluent as Law limits **[7]** due to the high

loads of the influent wastewater. This leads to the modification application. After the erection of the additional works that took about three months including one month for startup and ensure the system stability, phase two of operation started for two months with weekly sampling. The experimental results during the operation of modified plant are presented in table (2), which includes the main pollutants concentrations for each unit in the plant.

Table (2) Raw Sewage & Treated Water results

Sample No.		1	2	3	4	5	6	7	8
Date		04/10	10/10	17/10	24/10	01/11	08/11	15/11	22/11
COD mg/l	Inf.	5200	5180	5300	5040	4700	4800	4900	5000
	P.S.T Eff.	3480	3500	3260	3330	3480	3500	3260	3330
	A.T. Eff.	480	450	420	430	480	450	420	430
	In.S.T. Eff.	420	410	380	390	420	410	380	390
	DBAF Eff.	660	670	650	650	670	670	650	640
	F.S.T Eff.	33	34	33	32	34	34	32	31
BOD mg/l	Inf.	3300	3200	3300	3100	2800	2900	3000	3100
	P.S.T Eff.	2200	1900	1960	2100	2200	1900	1960	2100
	A.T. Eff.	380	400	400	390	380	400	400	390
	In.S.T. Eff.	360	350	340	350	360	350	340	350
	DBAF Eff.	490	480	480	470	480	470	460	450
	F.S.T. Eff.	17	16	17	15	18	17	15	15
TSS mg/l	Inf.	410	400	390	400	410	400	390	390
	P.S.T Eff.	220	220	210	210	220	220	210	210
	A.T. Eff.	300	300	290	290	300	300	290	290
	In.S.T. Eff.	110	100	95	90	105	100	95	90
	DBAF Eff.	220	220	210	210	220	220	210	210
	F.S.T. Eff.	12	11	11	10	11	11	10	10
TDS mg/l	Inf.	3650	2990	2960	3070	3650	2990	2960	3070
	P.S.T Eff.	2040	1940	1990	2030	2040	1940	1990	2030
	A.T. Eff.	1900	1860	1900	2000	1900	1860	1900	2000
	In.S.T. Eff.	1900	1860	1900	2000	1900	1860	1900	2000
	DBAF Eff.	1400	1390	1410	1380	1400	1390	1380	1380
	F.S.T. Eff.	1400	1390	1410	1380	1400	1390	1380	1380
pH	Inf.	11	11	11	11	11	11	11	11
	In. S. T. Eff.	7.5	7.4	7.4	7.5	7.5	7.4	7.4	7.5
	Eff.	7.3	7.2	7.2	7.1	7.3	7.2	7.1	7.1

It is clear from the results shown in table (2) that the additional treatment has achieved very high removal efficiencies for all the measured parameters that put the effluent inside the limits of law for reuse in irrigation [7]. The COD, BOD, TSS removal ratios were 92%, 89% & 75% respectively after first stage simulated by the existing plant and were 92%, 95% & 90% respectively after the second stage of treatment simulated by DBAF unit that achieved total removal ratios 92%, 94% & 97% respectively that get determined very low effluent concentrations under law limits for irrigation [7]. The pH limits & the TDS values became more suitable for irrigation requirements. The modification solution used the existing plant surface to overcome the absence of land for extension. The use of light structure material by steel coated by epoxy for the extension helps to solve the problem easy.

CONCLUSIONS

The modified plant operated for three months to ensure the success of the DBAF unit to improve the effluent quality to meet the irrigation needs with very low cost and construction needs timing and easy. The DBAF unit solved the space problem and minimized piping cost. The study concluded the following:

1. The Existing plant worked as stage one achieved COD, BOD, TSS removal ratios 92%, 89% & 75% respectively which are almost inside the normal for such system except the TSS which is less.

2. The COD, BOD, TSS removal ratios were 92%, 95% & 90% respectively after the second stage of treatment simulated by DBAF unit.

3. The achieved total removal ratios for the two stages were 92%, 94% & 97% respectively that get determined very low effluent concentrations under law limits for irrigation **[7]**.

4. The pH limits & the TDS values became more suitable for irrigation requirements.

5. The use of DBAF unit succeeded in solving the space problem with low cost and timing of construction with achieving the required removal efficiency.

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