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The use of DBAF system as A treatment plant for Dairy Industrial wastewater

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ABSTRACT

The dairy industry is a major enterprise in Egypt occupying a significant place in food supply. Its wastewater is a huge environmental problem that needs a special treatment. Our study problem is to treat the effluent wastewater from one of the JUHAYNA Company factories in 6th of October city where there is very small available area for the treatment unit. A pilot had been used consisted from a DBAF unit followed by rapid sand filter and contact tank for chlorination. The target was to reuse treated water for land scape irrigation by spray system. The pilot plant operated on the design flow for a period of three months. The system used as new application for the very small area available in the factory site. From the study results it can be seen that the applied DBAF system that proposed to be made give the ability to meet the design flow and loads with high effluent criteria for BOD, COD, TDS, pH & TSS parameters. In general all effluent results are more than enough for the drainage to the city sewerage system and meet the legal requirements for reuse for irrigation for Jungle trees due to the Egyptian environmental laws [1]. Also the system takes very small area and fit inside the available area inside the factory with no erection, operation or maintenance problems due to the shortage of area.

INTRODUCTION

Dairy industries have huge growth in most countries of the world. The dairy industry is a major enterprise in Egypt occupying a significant place in food supply. Water is used throughout all steps of the dairy industry including cleaning, sanitization, heating, cooling and floor washing. Naturally the requirement of water is huge which, if not treated, could lead to increased disposal and several pollution problems. All steps in the dairy chain, including production, processing, packaging, transportation, storage, distribution, and marketing, impact the environment **[1]**.

There are a lot of systems used all over the world to treat dairy industrial wastewater. The different applied treatment methods illustrated here to present the application of dairy industry treatment in the world.

Normally biological treatment preceded by pretreatment units consists of screening, flow equalization, neutralization, and air flotation were applied in USA & Europe since 1910 with good results for the effluent to be disposed in stream bodies **[2]**. With land availability, land treatment or pond systems are potential treatment methods and applied in different countries around the world

successfully to produce sufficient effluent for disposal in agricultural drain or reused in irrigation needs **[3].**

Other possible aerobic biological treatment systems include trickling filters, rotating biological contactors, and activated sludge treatment were used for dairy industrial wastewater treatment producing high removals for all pollutants **[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 most of them achieved successfully results.

Beyti factory in Noubariya used neutralization tank followed by DAF unit that feeds SBR unit. This system achieved removal efficiencies for COD ranged from 98.87% to 94.72 %. The BOD removal range value that fluctuates between 99.6% and 98% with average 99%. TSS removal is between 98 % and 88% with average 93%. TDS removal is between 91 % and 57% **[5]**.

Nesla factory industrial wastewater treatment plant used SBR which achieved COD removal efficiency 87% with organic loading rate 7.5 gm COD/L/day with retention time 5 days **[6]**.

In **Masr for dairy** factory in Damietta, two stages conventional activated sludge are used with removal efficiencies varied between 89% and 94 % for COD, TSS and BOD and 82% for TDS **[6]**.

Dissolved air floatation followed by roughing filter and finally conventional activated sludge are used in **El Masryeen** dairy factory in Giza producing effluent meets the limits for disposal to agricultural drains as environment laws limits **[6]**.

EL Salehaya factory used oxidation ditchs and drain its effluent to irrigation system for the landscape of the factory and its surrounding street green areas **[6]**.

Milky land factory in 10^{th} of Ramadan city applied conventional activated sludge process and dispose its effluent to the city sewerage system safely **[6].**

Most of the medium and small dairy factories used septic tanks followed by disposal cesspool that caused several problems to environment specially the groundwater [**6]**

El Toukhy, et al., prove in their study the suitability of applying of DAF unit followed by SBR unit for treating the dairy factory effluent wastewater to meet the disposal limits to agricultural drain **[5]**.

El Sergany, et al., determine the optimal operating limits for the DAF followed by SBR unit application for dairy factory to achieve the irrigation limits for effluent **[8]**.

El Nadi, et al, improve a dairy industry conventional activated sludge process by pre DBAF unit to improve the plant quality to meet irrigation needs with minimum piping & area **[9]**.

In 10th of Ramadan city the 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 was done using pretreatment by DBAF unit that also make it deal with the increase in inflow by 100m3/day with the reality of no space for any extension **[9].**

Our study problem occurs from the increase in its wastewater from existing 300 m3/d to 650 m3/d with unavailable land for new extension required for the existing WWTP. The factory consisted from the old production line building and the new production line building, the administration building and the wastewater treatment plant which lies underground in the front of the new production line**.** The factory is operated seven days a week for twenty four hours per day on three shifts a day. About 50 labors works per shift.

The existing wastewater treatment plant of conventional activated sludge system was built under the ground since 12 years ago. The existing inlet flow to the plant is 300m^3/day including both industrial and domestic wastewater. In case of emergency and over flow conditions, a by Pass is used to direct the over flow to the city sewerage system.

The plant is consisted from four following units, primary sedimentation tank followed by aeration tank that is using surface aerator rotor then final sedimentation tank with under pipe for returned sludge from it to aeration tank and a sludge holding tank for sludge collection that disposed biweekly by evacuating car.

MATERIAL AND METHODS

A pilot had been used consisted from DBAF system consisted from primary plate settler tank followed by up flow aerated bio filter followed by down flow aerated bio filter followed by final plate settler tank This group called DBAF group followed by contact tank for chlorination and rapid sand filter as presented by **figure (1)**.

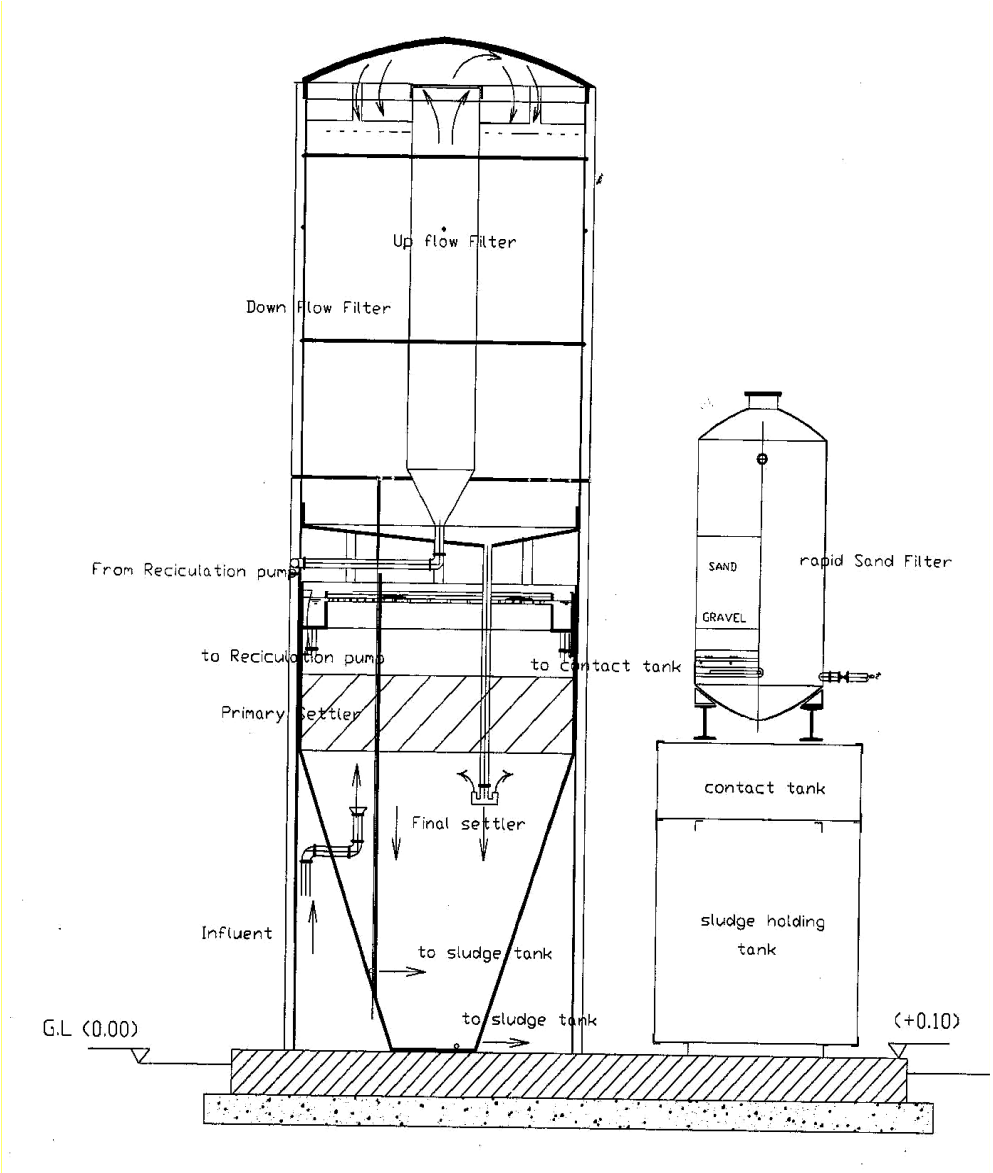

Figure (1) Pilot Line for DBAF System.

The operation program was applied on the laboratory scale pilot units according to several runs for three months to determine the performance, efficiency and suitability of such system to be applied with measuring the parameters of weekly samples for the influent and effluent of each unit for the plant.

Samples were collected at inlet and outlet of each unit in all pilot lines to evaluate and determine the performance and efficiency for each unit.

The water samples were analyzed for measuring BOD, COD, TSS & Temperature because these are the parameters mainly used for measuring waste water pollution. The measurements were taken according to the American Standard Methods for Examinations of Water & Wastewater **[11]**.

RESULT AND DISCUSSION

This step was made by operating the pilot plant for three months period to determine the solution suitability in performance, efficiency and operation. This was done by measuring the parameters of weekly samples of the influent and effluent of each unit in the plant.

The results for the plant and the calculations for removal ratios for each step in the treatment line for COD, BOD, TDS and TSS are presented in tables from (1) to (5) and Figures from (4) to (6) as follows:

COD RESULTS & DISCUSION

Table (1) shows results and removal ratios for COD of each unit from the treatment line and also for the whole plant for the DBAF system plant during the study period.

Table (1) COD Results & Removal Ratios at the DBAF System Pilot Line

Sample		Raw WW	After PST		After DBAF		After FST		After RSF		TOTAL
No.	Date		COD ppm	RR %	COD ppm	RR %	COD ppm	RR %	COD ppm	RR %	RR %
1	06/12/2016	**4250**	**2960**	**30.35**	**90**	**96.96**	**60**	**33.33**	**30**	**50.00**	**99.29**
2	13/12/2016	**4300**	**3090**	**28.14**	**89**	**97.12**	**70**	**21.35**	**35**	**50.00**	**99.19**
3	20/12/2016	**4130**	**2990**	**27.60**	**90**	**96.99**	**70**	**22.22**	**34**	**51.43**	**99.18**
4	27/12/2016	**4330**	**2950**	**31.87**	**89**	**96.98**	**70**	**21.35**	**34**	**51.43**	**99.21**
5	03/01/2017	**3550**	**2900**	**18.31**	**86**	**97.03**	**74**	**13.95**	**37**	**50.00**	**98.96**
6	10/01/2017	**3800**	**2900**	**23.68**	**90**	**96.90**	**72**	**20.0**	**35**	**51.39**	**99.08**
7	17/01/2017	**3730**	**2980**	**20.11**	**90**	**96.98**	**75**	**16.67**	**36**	**48.00**	**99.03**
8	24/01/2017	**4000**	**2980**	**25.50**	**89**	**97.01**	**71**	**20.22**	**33**	**53.52**	**99.18**
9	31/01/2017	**4030**	**3000**	**25.56**	**90**	**97.00**	**71**	**21.11**	**34**	**52.11**	**99.16**
10	07/02/2017	**3970**	**3010**	**24.18**	**92**	**96.94**	**72**	**21.74**	**35**	**51.39**	**99.12**
11	14/02/2017	**3990**	**3000**	**24.81**	**90**	**97.00**	**71**	**21.11**	**35**	**50.70**	**99.12**
12	21/02/2017	**4090**	**2990**	**26.89**	**90**	**96.99**	**71**	**21.11**	**35**	**50.70**	**99.14**
13	28/02/2017	**4140**	**2980**	**28.02**	**90**	**96.98**	**71**	**21.11**	**34**	**52.11**	**99.18**

According to **table (1)** it can be seen that the removal efficiency for COD after primary sedimentation tank for the DBAF plant was between 18.31% & 30.35% that means for this treatment unit the removal efficiency is about to be good due to the ability of plate settlers to remove the colloidal COD which was not able to be removed by normal sedimentation tank.

The removal efficiency for COD after DBAF unit for the applied plant was between 96.96% & 97.12% that means a very high quality for the unit may be for the most of COD are degradable for the aerated attached growth system.

The removal efficiency for COD after final sedimentation tank for the DBAF plant was 16.67% and 33.33% for such unit with low quality for COD removal but actually it is normal for such tank type.

The removal efficiency for COD after rapid sand filter for the DBAF plant was 48.00% and 52.11 % for such unit with good quality for COD polishing that is actually normal for such unit.

The total removal efficiency for COD for this DBAF plant was between 95% & 98% for existing plant and was between 99.03% & 99.29% which is very good and high for such treatment type.

Effluent COD results are between 30 & 37 mg/l, for DBAF system plant which is more than enough for the drainage to the city sewerage system and also it is above the legal requirements for reuse for irrigation even for Jungle trees or agricultural crops due to the Egyptian environmental laws [1]. That shows the success of such system to achieve a high removal quality for COD.

BOD RESULTS & DISCUSION

Table (2) shows results and removal ratios for BOD of each unit from the treatment line and also for the whole plant for the DBAF system plant during the study period.

Table (2) BOD Results & Removal Ratios at the DBAF System Pilot Line

Sample		Raw WW	After PST		After DBAF		After FST		After RSF		TOTAL
No.	Date		BOD ppm	RR %	BOD ppm	RR %	BOD ppm	RR %	BOD ppm	RR %	RR %
1	06/12/2016	**2250**	**1460**	**35.11**	**40**	**97.26**	**39**	**2.50**	**19**	**51.28**	**99.16**
2	13/12/2016	**2300**	**1590**	**30.87**	**43**	**97.30**	**40**	**6.98**	**20**	**50.00**	**99.13**
3	20/12/2016	**2130**	**1490**	**30.05**	**50**	**96.64**	**40**	**20.00**	**20**	**50.00**	**99.06**
4	27/12/2016	**2330**	**1450**	**37.77**	**49**	**96.62**	**40**	**18.37**	**19**	**52.50**	**99.18**
5	03/01/2017	**2550**	**1600**	**37.25**	**46**	**97.13**	**44**	**6.52**	**22**	**50.00**	**99.14**
6	10/01/2017	**2800**	**1500**	**46.43**	**40**	**97.33**	**38**	**5.00**	**19**	**50.00**	**99.32**
7	17/01/2017	**2730**	**1780**	**34.80**	**40**	**97.75**	**36**	**10.00**	**19**	**47.22**	**99.30**
8	24/01/2017	**2000**	**1280**	**36.00**	**39**	**96.95**	**38**	**2.56**	**19**	**50.00**	**99.05**
9	31/01/2017	**2030**	**1300**	**35.96**	**40**	**96.92**	**32**	**20.00**	**16**	**50.00**	**99.21**
10	07/02/2017	**1970**	**1310**	**33.50**	**42**	**96.79**	**32**	**23.81**	**17**	**46.88**	**99.14**
11	14/02/2017	**1990**	**1100**	**44.72**	**40**	**96.36**	**34**	**15.00**	**17**	**50.00**	**99.15**
12	21/02/2017	**2090**	**1290**	**38.28**	**40**	**96.90**	**35**	**12.50**	**17**	**51.43**	**99.19**
13	28/02/2017	**2140**	**1380**	**35.51**	**40**	**97.10**	**30**	**25.00**	**15**	**50.00**	**99.30**

According to **table (2)** it can be seen that the removal efficiency for BOD after primary sedimentation tank was between 30.05% & 46.43% that means for this treatment unit the removal efficiency is good and high and lies inside the upper limit for BOD removal ratio for such physical treatment.

The removal efficiency for BOD after DBAF unit was between 96.36% & 97.75% that means a high quality for the unit compared with a similar type of treatment units may for the most of BOD are degradable.

The removal efficiency for BOD after final sedimentation tank was 2.50% to 25.00% this treatment unit with low quality for BOD removal but actually it is normal for such tank type.

The removal efficiency for BOD after rapid sand filter unit was 46.88% to 51.43% this treatment unit with medium quality for BOD removal but it actually used for polishing the effluent to achieve the required target.

The total removal efficiency for BOD for this DBAF system was between 99.05% & 99/32% which is good and high for such treatment type.

Effluent BOD results are between 15 & 22 mg/l which is more than enough for the drainage to the city sewerage system and inside the legal requirements for reuse for irrigation for Jungle trees due to the Egyptian environmental laws [1].

TSS RESULTS & DISCUSION

Table (3) shows results and removal ratios for TSS of each unit from the treatment line and also for the whole plant for the DBAF system plant during the study period.

Table (3) TSS Results & Removal Ratios at the DBAF System Pilot Line

Sample		Raw WW	After PST		After DBAF		After FST		After RSF		TOTAL
No.	Date		TSS ppm	RR %	TSS ppm	RR %	TSS ppm	RR %	TSS ppm	RR %	RR %
1	06/12/2016	**550**	**350**	**36.36**	**480**	**-37.14**	**40**	**91.67**	**13**	**67.50**	**97.64**
2	13/12/2016	**500**	**350**	**30.00**	**480**	**-37.14**	**40**	**91.67**	**12**	**70.00**	**97.60**
3	20/12/2016	**630**	**430**	**31.75**	**490**	**-13.95**	**40**	**91.84**	**12**	**70.00**	**98.10**
4	27/12/2016	**530**	**330**	**37.74**	**460**	**-39.39**	**30**	**93.48**	**10**	**67.67**	**98.11**
5	03/01/2017	**550**	**350**	**36.36**	**450**	**-28.57**	**40**	**91.11**	**13**	**67.50**	**97.64**
6	10/01/2017	**500**	**350**	**30.00**	**460**	**-31.43**	**40**	**91.30**	**13**	**67.50**	**97.40**
7	17/01/2017	**430**	**300**	**30.23**	**460**	**-53.33**	**40**	**91.30**	**13**	**67.50**	**96.98**
8	24/01/2017	**500**	**350**	**30.00**	**470**	**-34.29**	**40**	**91.49**	**12**	**70.00**	**97.60**
9	31/01/2017	**430**	**300**	**30.23**	**465**	**-55.00**	**35**	**92.47**	**11**	**68.57**	**97.44**
10	07/02/2017	**470**	**320**	**31.91**	**470**	**-46.88**	**30**	**93.62**	**9**	**70.00**	**98.09**
11	14/02/2017	**490**	**340**	**30.61**	**480**	**-41.17**	**30**	**93.75**	**9**	**70.00**	**98.16**
12	21/02/2017	**390**	**270**	**30.77**	**460**	**-70.37**	**30**	**93.48**	**10**	**67.67**	**97.44**
13	28/02/2017	**440**	**290**	**34.09**	**460**	**-58.62**	**30**	**93.48**	**9**	**70.00**	**97.95**

From table (3) it can be illustrated that the removal efficiency for TSS after primary sedimentation

tank was between 30.00% & 37.74% with low quality compared with such tank type in similar treatment and this may be due to that the a lot of suspended solids are not settleable or colloidal types also a huge values of fats and O&G.

The removal efficiency for TSS after DBAF unit was with negative sign for the increase in their values due to a biological action happened for soluble organic matter which increased the suspended colloidal fractions inside the DBAF unit. This complies with normal cases for such type of treatment.

The removal efficiency for TSS after final sedimentation tank was between 91.11% & 93.48% with high quality for TSS removal but actually it is normal for such tank type.

The removal efficiency for TSS after rapid sand filter was between 67.50% & 70.00%, with high quality for TSS removal but actually it is normal for such unit type.

The total removal efficiency for TSS for this plant was ranged from 96.96 % to 98.16 % which is good and high for such treatment type.

Effluent TSS results are between 9 & 13 mg/l which is more than enough for the drainage to the city sewerage system and meets the legal requirements for reuse for irrigation due to the Egyptian environmental laws [**1**].

CONCLUSION

From previous work and results it can be seen that the applied DBAF system that proposed to be made by this study to treat the wastewater of dairy factory in 6th of October city that consisted from the plate settlers in both primary and final sedimentation tanks and DBAF unit as biological unit followed by contact tank for chlorination and rapid sand filter for polishing to meet the requirements limits of irrigation by treated wastewater.

In general all effluent results are more than enough for the drainage to the city sewerage system and meet the legal requirements for reuse for irrigation for Jungle trees due to the Egyptian environmental laws [1]. Also the system takes very small area and fit inside the available area inside the factory with no erection, operation or maintenance problems due to the shortage of area.

REFERENCES

[1] Egyptian Environmental Laws, “Law 93 for year 1962 and its modification by minister decree no. 9 for year 2000 & minister decree no. 1 for year 2015, For disposal of Industrial Wastewater on sewerage networks”, Ministry of Local Development, Cairo, Egypt, **2015**.

[2] Pescod, M.B. “Application of Pond system for industrial wastewater treatment.”, Water Science and Technology, UK, 25 (7), 11-21, **1988**

[3] John R. Buchanan & Robert W. Sea bloom, "Aerobic Treatment of Wastewater and Aerobic Treatment Units", University of Washington, November **2004**.

[4] Hammer, J. Mark, “Water & Wastewater Technology”, John Wiley & Sons, NY, USA **1978**.

[5] El Nadi, M. H., Abdel Azeem, M. M. , Nasr, N. A. H. & El Toukhy, N. M. H., "Evaluation of Wastewater Treatment Plant for Beyti Factory.", El Azhar Univ., Faculty of Eng., CERM of civil Eng., vol. 35, No. 2, April, **2013**.

[6] EEAA Annual Report, “Annual report for the environmental impact of industry in Egypt“,

EEAA, Cairo, Egypt, **2013**

[7] Monroy H.O.; Va´zquez M.F."Anaerobic-aerobic treatment of cheese wastewater with national technology in Mexico". The case of "El Sauz", **1995**.

[8] El Sergany, F.A.R, El Hosseiny, O.M. & El Nadi, M.H., "Industrial Wastewater Treatment in Dairy Industry" *International Journal of Engineering Sciences and Research Technology* (ISSN: 2277-9655) Vol. 5(11) pp.295-301, November, **2016**.

[9] El Nadi, M.H.A., El Sergany, F.A.G., El Hosseiny, O.M., "Improvement of existing conventional activated sludge dairy industrial wastewater treatment" *International Journal of Science and Research Methodology, Human Journals* Vol. 5(11), November, **2016**.

[10] El Nadi, M.H., "Water & Wastewater Treatment Works", Under Graduate Teaching Book, Ain Shams University, Cairo, Egypt, **2001**.

[11] E.W. Rice, R.B. Baird, A.D. Eaton, L.S. Clesceri, editors, "Standard Methods For The Examination of Water and Wastewater", EPHA,AWWA,WPCF, 22nd Edition**, (2012).**