International Journal of Civil Engineering and Technology (IJCIET)
Volume 7, Issue 5, September-October 2016, pp. 368–381, Article ID: IJCIET_07_05_040
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=7&IType=5
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

ASSESSMENT OF DAIRY WASTE TREATMENT BASED ON SLUDGE VOLUME INDEX TECHNIQUE

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ABSTRACT

Unscientific and Improperly treated sewage and industrial waste disposals causes environmental pollution. New technologies for modernity and change in life style of humans attribute new industries for their easiness and comfortability on one side which results in highly complicated and dangerous waste generation on the other side. Present study deals with the industrial waste treatment. Dairy industry is one among the highly objectionable waste producing sectors which increases the pollution rate of the total environment. Dairy industry consumes 2.5 to 4 litres of water per litre of milk process which comes out as waste water. Various studies revealed that dairy waste water is diluted milk and it contains BOD, COD, TSS, Oil & Grease and sometimes pH. So, treatment of dairy waste need special attention and adequate care is to be given before its final discharge to water bodies or to land. This work is an assessment of the performance of few dairies based on Sludge Volume Index whichhas been discussed and further scope of research area has been identified.

Key words: Dairy, Efficiency, Effluent Treatment Plant, Settleablity, Sludge Volume Index.

Cite this Article: Leena A.V , Dr. N. Balasundaram, Dr. C. Meiaraj, Assessment of Dairy Waste Treatment Based on Sludge Volume Index Technique. *International Journal of Civil Engineering and Technology*, 7(5), 2016, pp.368 –381.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=7&IType=5

1. INTRODUCTION

Dairy industries are engaged in the manufacturing of various types of milk products such as milk, butter, cheese, yogurt, condensed milk, flavoured milk, milk powder, ice cream, etc. A sequence of operations is involved in dairy industry. Receiving and storing of raw materials, processing of raw materials into finished products, packaging and storing of finished products and a group of other supplementary operations are some of the operations performed in the dairy industries. Homogenization, standardization, clarification, separation, and pasteurization are the common initial operations in most dairy plants. Clarification and separation, generally, are accomplished by specially designed large centrifuges. Drying, condensing, etc. are also used in dairy industries for the production of various products. The raw material

input and final products manufactured determines the type and size of processes and equipments used. The dairy industry is one among the most polluting industries, not only in terms of the volume of effluent generated but also in terms of its characteristics as well. Reports reveal that the milk processing units generates about 10 liters of effluent per liter of processed milk with an average generation of about 2.5 liters of wastewater per liter of the milk processed. In the dairy industry, majority of waste water generated during cleaning operations especially between product changes when different types of products are produced and some amount of wastewater gets generated during starting, equilibrating, stopping, and rinsing of the processing units. Dairy processing effluents are generated in an intermittent way and the flow rates of these effluents change significantly.

This paper deals with an evaluation study of various dairy waste treatment plants. Its performance was evaluated based on the overall removal efficiency of various characteristics such as Total Suspended Solids, Biochemical Oxygen Demand, Chemical Oxygen Demand, and Oil & Grease. The overall performance of the Treatment Plant was also evaluated by considering Sludge Volume Index as tool. Through the study, further possibilities for the improvement of the dairy waste treatment was sought to make the final effluent and sludge disposal more environment friendly.

2. DAIRY INDUSTRY: OVER THE TIME

Traditionally, in the past, the complete milk production was done in the villages in India. Even today, a large percentage of total milk supply in our country comes from cattle owners in village areas. The marketing facilities did not exist in those days,for this reason they generally converted the surplus milk into ghee and sold in the village or in the nearby small markets

India's first five year plan in 1951 accelerated the modernization of the dairy industry in India. With an objective of catering clean milk for the growing population in urban areas, the government organized milk schemes for large cities as an initial action in this regard. The main objective of the scheme was to provide proper arrangements for transmitting the milk produced in the rural areas to the dairy plants situated in cities and distribution of processed milk to the consumers.

In India, the establishment of milk co-operatives is another feature of the modern dairy industry and it is necessary for the successful functioning of economic enterprises in villages. The first co-operative dairy society was established at Allahabad (U.P.) in 1913 and subsequently spread in different parts of our country. Systematic break through could be noticed since 1946 when Kaira District Co-operative Milk producers' Union Limited (KDCMPUL) popularly known as 'Amul Dairy' which was set up at Anand in the Gujarat state.

2.1. Dairy Technology

Milk treatment is necessary for milk processing and it is the preparation of raw milk including heat treatment. The milk treatment is done in the preparation room and it is the first process in diary plant. The processing of milk gives assurance for the quality in manufacturing and packing of diary based products also on the basis of treated milk [4]. The diary industries have several production sectors and each sector produces wastewater of a characteristic composition according to the product like milk, cheese, butter, and milk powder.

2.2. Milk Processes

A great variety of operations are performed in the diary industries such as receiving and storing of raw materials, processing of raw material into finished products, packing and storing of finished products and other ancillary operations. The common initial operations in most plants and products are standardization, homogenization, clarification, separation, and pasteurization. Specially designed large centrifuges are generally used for the operations such as clarification and separation. The processes like drying and condensing also used for the production of various products in diary industries [1].

2.3. Water Consumption, Sources, and Generation of Waste Water

Basically, the range of heat treatments in a dairy determines the microbiological quality of milk. It affects the usage of cooling water in heat exchangers and the consumption of cleaning water [7].

Dairy factories discharges huge amount of effluent from various processing units and cleaning, and the ratio varies according to the type of product. The effluent discharge was often noticed as 85 – 90% of the consumed water in the case of pasteurized milk, 90 – 95% for butter and cheese, for milk powder and condensed milk it was more than 100%. Dairy waste contains milk solids entering from almost all of the operations in dilute condition with varying concentration. Generally, the wastes generated from dairy industry are as follows:

- The washing and cleaning out of product remaining in equipments like tank, trucks and cans. 2. Spill out is produced due to overflow, leaks, boiling over, freezing-on and careless handling.
- Losses during milk processing are (1) Sludge discharge from settling tank, (2) Discharges from bottles and washers and (3) Splashing and container breakage in automatic packaging equipment.
- Detergents and other compounds are used in the washing and sanitizing solution [4], [6], [3].

2.4. Characteristics of the Effluent

The effluent characteristics of dairy industry can be determined by the parameters such as color, temperature, DO, pH, COD, BOD, suspended solids, dissolved solids, sulphate, chlorides, oil and grease. These parameters largely depend on the quantity of milk and milk products. Dairy wastes are usually white in color. It is slightly alkaline in nature, but due to the fermentation of milk it becomes acidic and they have high BOD level in all liquids. Due to the curd content in cheese waste there is significant quantity of suspended matter found in dairy waste. High oxygen demand is arising due to the dairy waste pollution. As a result of the decomposition of casein heavy black sludge and strong butyric acid odours are formed [8], [1].

2.5. Methods of Treatment and Disposal

Proper management of dairy wastes plays an important role in protecting, preserving, and improving the quality of surface and ground waters. The best management practices can prevent direct discharge of wastewater and can enhance the operational efficiency of the dairy unit. The dairy waste can also be used for beneficial purposes such as fertilizer, compost, or bedding. Agricultural Utilization Systems of treatment and disposal effluents of dairy industry is one of the pioneer methods which include (a) Ridge and furrow system, (b) Flood irrigation and (c) Spray irrigation.

All over the world various treatment methods and technologies developed in this sector. The treatment of dairy effluents in India consists of Preliminary, Primary and Secondary treatment of effluents and which became the conventional treatment units. Preliminary treatment involves removal of oil, grease and coarse solids, Primary treatment involves dilution with water and anaerobic lagooning or aerated lagooning for a shorter period unlike settling and digesting the sludge in usual waste treatment practice and the secondary treatment consists of Oxidation ditch/ Aerated lagoon/ Anaerobic lagoon followed by stabilization pond [5].

2.6. Effects of Effluents

The waste water generated from dairy industry contains huge amount of milk constituents like inorganic salts, caseins, along with sanitizers and detergents used for washing. All these components will make increase the BOD and COD levels higher than the specified limits in BIS for industrial effluent discharge. So disposal of these wastes to river or land, without prior treatment cause serious problems to the environment [4], [1].

3. MATERIALS AND METHODS

3.1. Study Area

Initial Studies have been conducted on 4 Dairies in which one is at Karnataka and other three from Kerala. As instructed by the Dairy authorities and as directed by the experts, it is unable to provide the name of the Dairies along with the data. Instead, it was decided to provide the names of dairies as A, B, C and D. The study was carried out in the period of January – December 2014. The Dairy selected for the study at Karnataka has a processing capacity of about 7 Lakh Litres per day. The dairies selected from Kerala have production capacity of 100,000, 1. 1, 25,000 and 50,000 liters per day respectively.

3.2. Methodology

Sampling of waste water was done before and after treatment as per Standard methods. All the samples were analyzed for BOD, COD, Oil &Grease, and TSS in accordance with standard procedures [10]. Mixed liquor suspended solids (MLSS) of influent and effluent of dairies were measured to determine Sludge Volume Index (SVI). Fresh sample of mixed liquor used for the tests and was collected from the effluent end of the aeration system, just upstream of the secondary clarifier. In SVI test; 1-liter graduated cylinder for the MLSS settling test was used. The test results were tabulated for detailed analysis and interpretations.

4. RESULTS AND DISCUSSIONS

The initial studies were conducted in the above four Dairies. Here the name of dairies is mentioned as Dairy-A, Dairy-B, Dairy-C, and Dairy-D for the studies, which are not in order or sequence as mentioned earlier.

Table 1 Details of water consumption and waste water Generation in Litres

Sl No	Name of Dairy	Capacity of Dairy	Water Consumption	Waste water generated	Capacity of ETP
1	Dairy - A	700000	1540000	1447600	1500000
2	Dairy - B	125000	312500	296875	300000
3	Dairy - C	100000	220000	208032	200000
4	Dairy - D	50000	125000	116250	100000

While going through the water consumption with respect to the capacity of dairy, Dairy - A and Dairy - C consumes 2.20 times of dairy capacity whereas Dairy – B and Dairy – D‘s water demand seems to be as 2.50 times of dairy capacity. In the case of waste water generation Dairy – A generates 94% of its water consumption while Dairy – B generates 95% of its water consumption. This is 94.6% and 93% for the case of Dairy – C and Dairy – D respectively.

4.1. Effluent Treatment Plant

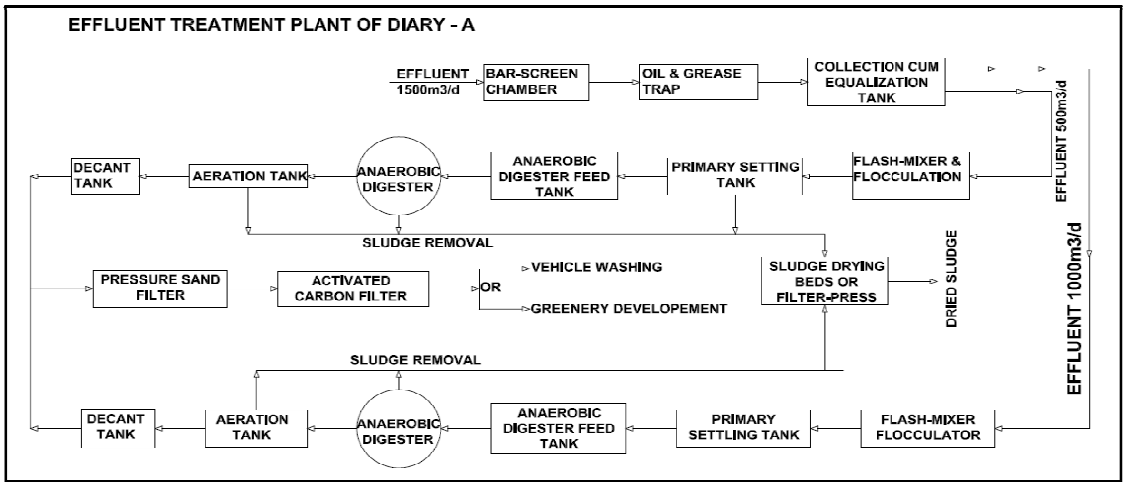

Figure 1 Effluent Treatment Plant of Dairy-A

Figure 1 describes about the ETP of Dairy – A. In this ETP the first three units, the Bar Screen Chamber, the Oil & Grease trap and the Equalization Tank are acting as the preliminary treatment units. After chemical dosing, the effluent is allowed to the Primary treatment including the primary settling. The effluent is then passed to the anaerobic digester and to the aeration tank for further possibilities of settling. The sludge from the primary settling tank, Digester, and the Aeration Tank are permitted to the sludge drying bed. The units after the Primary treatment to the drying bed are to be considered as the secondary treatment units. The decant unit, Pressure Filter and Carbon Filter units are to be considered as the tertiary units. Introduction of the tertiary units are seen as the main advantage of this ETP, which produce better performance of the plant's total performance.

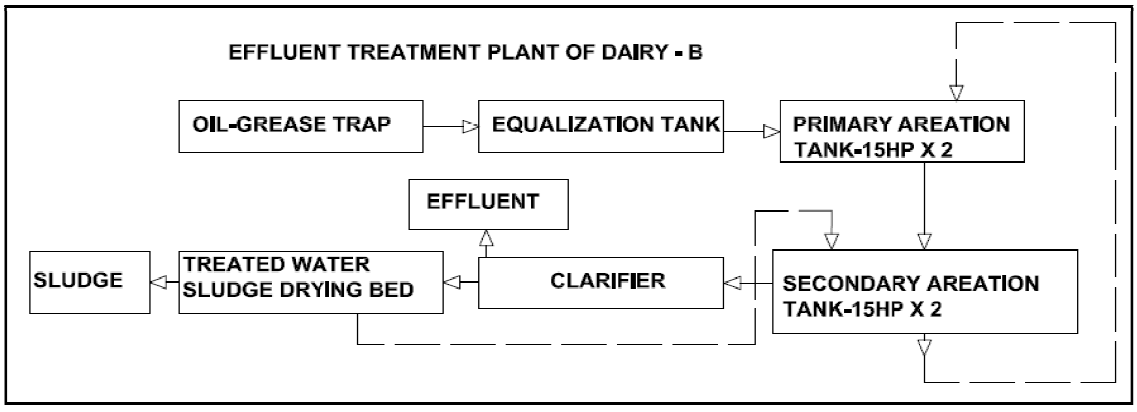

Figure 2 ETP of Dairy –B

Figure 2 provides the ETP of dairy – B. The screening unit, Oil & Grease trap and the Equalization Tank are the preliminary treatment units. The Primary Aeration Tank and Secondary Aeration tanks considered as the primary treatment units and the secondary treatment units are clarifier and the treated sludge drying beds. The final effluent from the clarifier is used for gardening purpose or a land discharge. The sludge from the secondary aeration tank is re-circulated through the primary aeration tank to stabilize the waste to its maximum possible extent. The final sludge from the clarifier is transferred to the drying bed to reduce its volume to the possible extent before disposing the same for land filling purposes. The effluent collected through the under drains of the drying bed is seen re-circulated to the secondary aeration tank.

The ETP for dairy –C and dairy –D are seen as same as that of ETP of dairy – B.

Table 2 Effluents Discharge Standards

Sl No	Parameters	ISI Standards	
		Water Body	Land
1	pH	5.5-9.0	5.5-9.0
2	BOD mg/L	30	100
3	COD mg/L	250	--
4	TSS mg/L	100	200
5	O & G mg/L	10	10

Table 3 says the characteristic of influent and effluent from Dairy – A. According to IS standard the TSS concentration of effluent from dairies is limited to 100mg/L for discharge to water bodies and 200mg/L to land. Concentration of TSS in the effluent from dairy –A is found to be less than 100mg/L for all months from January to December in 2014 and it is within the limit. The highest value for TSS found is 91mg/L in November. In the case of BOD the maximum allowable value of effluent discharge is 30mg/L and 100mg/L for inland surface water and land irrigation respectively. Here, effluent from dairy – A, value of BOD is found in between 300-400mg/L for every month in the year and proper treatment have to be done for making the BOD level in the effluent to the permissible level. In the case of COD the maximum allowable value of effluent discharge is 250mg/L for inland surface water and COD should be zero for land irrigation. Value of COD is found in between 700-800mg/L in effluent from dairy –A for every month in the year and more treatment required to make the effluent to the permissible level. The maximum value of Oil & Grease content of effluent discharge is 10mg/L for both inland surface water and land irrigation. In Dairy –A, it is greater than the permissible value in standard, so this require further treatment.

Table 3 Influent – Effluent Characteristics of Dairy- A

Inlet- Influent, Outlet- Effluent, TSS, BOD,COD and O&G in mg/L and SVI in mL/g										
Characteristics of Dairy-A										
Date	TSS		BOD		COD		O & G		SVI	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Jan-14	301	83	1560	350	3368	747	236	41	1200	210
Feb-14	302	85	1511	340	3400	800	240	42	1080	206
Mar-14	310	86	1571	342	3406	788	245	45	1020	198
Apr-14	311	87	1567	353	3401	789	250	46	980	172
May-14	306	84	1516	311	3398	752	249	43	690	135
Jun-14	295	72	1561	349	3393	728	241	43	984	169
Jul-14	293	70	1546	309	3361	733	240	40	1016	218
Aug-14	300	75	1552	352	3370	738	238	35	1120	224
Sep-14	302	88	1548	311	3381	724	232	32	1096	202
Oct-14	301	89	1597	356	3396	773	240	42	992	196
Nov-14	305	91	1560	353	3432	755	241	43	1025	190
Dec-14	299	68	1564	355	3440	762	249	40	1184	214

Table 4 Influent – Effluent Characteristics of Dairy- B

Inlet- Influent, Outlet- Effluent, TSS, BOD,COD and O&G in mg/l and SVI in ml/g										
Characteristicts of Dairy-B										
	TSS		BOD		COD		O & G		SVI	
Date	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Jan-14	353	176	1857	526	5253	1317	404	155	1440	370
Feb-14	354	149	1788	482	5307	1417	413	127	1296	347
Mar-14	365	135	1872	469	5316	1382	425	117	1524	387
Apr-14	365	182	1867	530	5309	1428	435	165	1476	384
May-14	359	177	1794	470	5303	1366	433	160	1828	452
Jun-14	344	131	1858	495	5295	1297	414	128	1580	412
Jul-14	340	113	1837	424	5242	1249	413	107	1619	432
Aug-14	351	165	1845	528	5257	1301	408	140	1344	456
Sep-14	354	183	1839	470	5275	1321	396	134	1315	392
Oct-14	353	155	1909	505	5301	1330	414	126	1490	385
Nov-14	359	141	1856	485	5360	1284	416	113	1430	408
Dec-14	349	155	1862	532	5373	1341	433	153	1420	394

Table 4 says the characteristic of influent and effluent from Dairy – B. Concentration of TSS in the effluent from dairy –B is found in between 100 -200 mg/L for all months and it is greater than the permissible value (100mg/L) for discharging into water body and it is within the limit for land disposal (200mg/L). So it needs further treatment for discharging in to water bodies. In the case of BOD the maximum allowable value of effluent discharge is 30mg/L and 100mg/L for inland surface water and land irrigation respectively. Here, effluent from dairy – B, value of BOD is found to be greater than 400mg/L in every month in the year and further treatment is required for making the BOD level of the effluent to the permissible level. The value of COD is found in the range of 1000mg/L for every month and it is very much greater than the allowable value. So it cannot discharge to environment without further treatment. In Dairy –B value of Oil & Grease content is greater than the standard value (10 mg/L) of effluent discharge to the environment, so this require further treatment.

Table 5 Influent – Effluent Characteristics of Dairy- C

Inlet- Influent, Outlet- Effluent, TSS, BOD,COD and O&G in mg/L and SVI in mL/g										
Characteristics of Dairy-C										
	TSS		BOD		COD		O & G		SVI	
Date	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Jan-14	335	182	1755	484	4210	1055	364	154	1390	295
Feb-14	336	169	1700	458	4250	1138	369	140	1216	272
Mar-14	345	143	1768	433	4257	1096	378	117	1276	246
Apr-14	345	158	1763	460	4252	1111	385	133	1326	282
May-14	340	183	1705	440	4248	1092	383	157	1278	285
Jun-14	328	155	1756	468	4241	1048	370	141	1200	299
Jul-14	325	126	1739	396	4202	996	369	110	1271	268
Aug-14	334	145	1746	458	4213	1016	366	116	1294	262
Sep-14	336	187	1741	440	4226	1058	358	140	1265	250

Oct-14	335	174	1797	476	4246	1073	370	139	1210	262
Nov-14	340	148	1755	446	4290	1023	371	114	1382	320
Dec-14	332	137	1759	461	4300	1046	384	125	1370	264

The characteristic of influent and effluent from Dairy – C is depicted through Table 5. TSS Concentration in the effluent from dairy –C also found in between 100 -200 mg/L as dairy –B from January to December and it is greater than the permissible value (100mg/L) in the case of discharging to water bodies. So it needs further treatment for disposing to the inland surface water. For land disposal TSS is within the permissible limit. In the case of BOD the maximum allowable value of effluent discharge is 30mg/L and 100mg/L for inland surface water and land irrigation respectively. Here, effluent from dairy – C, value of BOD is found much greater than the permissible value in every month in the year and further treatment is required for making the BOD level in the effluent to the permissible level. In the effluent from dairy –C also the value of COD is found near 1000mg/L for every month and it is very much greater than the limited value. For this reason, it cannot discharge to environment without further treatment. The value of Oil & Grease content of effluent discharge from this dairy is in the range of hundreds which is greater than maximum allowable value 10mg/L, so this require further treatment for discharging to both water and land.

Table 6 Influent – Effluent Characteristics of Dairy- D

Inlet- Influent, Outlet- Effluent, TSS, BOD,COD and O&G in mg/L and SVI in mL/g										
Characteristicts of Dairy-D										
	TSS		**BOD**		**COD**		**O & G**		**SVI**	
Date	**Inlet**	**Outlet**	**Inlet**	**Outlet**	**Inlet**	**Outlet**	**Inlet**	**Outlet**	**Inlet**	**Outlet**
Jan-14	349	159	1791	466	4296	1048	372	129	1380	302
Feb-14	350	146	1735	439	4337	1133	377	115	1242	257
Mar-14	360	125	1805	419	4344	1096	386	97	1173	228
Apr-14	360	139	1799	446	4339	1110	393	112	1127	298
May-14	355	148	1740	409	4335	1074	391	120	794	255
Jun-14	342	147	1792	465	4328	1056	378	131	1132	294
Jul-14	339	130	1775	404	4288	1016	377	112	1168	251
Aug-14	348	113	1782	431	4299	1000	374	82	1288	258
Sep-14	350	140	1777	397	4313	1027	366	91	1260	232
Oct-14	349	155	1834	461	4333	1070	378	117	1141	225
Nov-14	355	144	1791	446	4378	1034	379	107	1179	219
Dec-14	346	130	1795	459	4388	1056	392	116	1362	246

In Table 6, the characteristic of influent and effluent from Dairy – D is tabulated. The effluent from dairy –D also have TSS Concentration in between 100 -200 mg/L as dairy –B and dairy –C in the whole year and it is greater than the permissible value (100mg/L) for water bodies and it is within the limit for land disposal (200mg/L). As this reason it needs further treatment for disposing to the inland surface water. While taking the parameter BOD, in dairy- D, its value is greater than 400mg/L in most of the months and that is much greater than the permissible values for discharging to environment. Regarding the COD, the value is found much greater than the permissible limit insisted by the Environmental Protection rules 1986. As this reason, it cannot discharge to environment without further treatment. The value of Oil & Grease content of effluent discharge from the dairy -D is much greater than the maximum allowable value 10mg/L. In view of this, it requires further treatment for discharging to water body or to land.

Further, a comparison among the four dairy ETPs based on the removal efficiency of the TSS has been carried out.

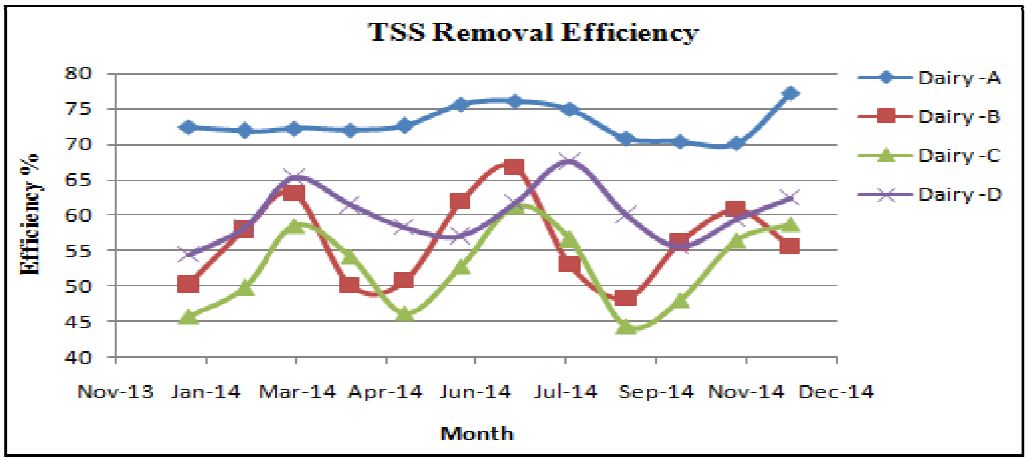

Figure 3 Comparison of TSS Removal Efficiency

A comparison study of the total suspended solids (TSS) removal efficiency of the treatment plants is depicted through Figure 3. ETP of dairy has given much better performance than other ETPs. About 70% of TSS removal efficiency was achieved through the ETP of dairy-A and also a consistency is seen in the performance of the ETP. Regarding the ETPs of the other dairies much fluctuation are seen in the TSS removal efficiency on a month wise analysis. This indicates that flow to these ETPs may not be uniform. Performance of the ETP of dairy –C is seen as very poor compared to others.

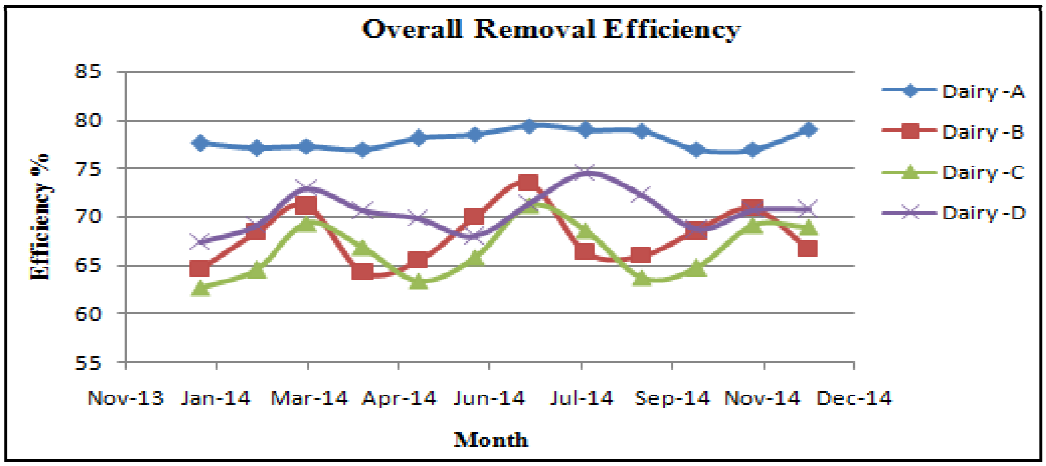

Figure 4 Overall Efficiency

About the overall efficiency of the plants also, ETP of Dairy –A shows the highest performance and comparison of efficiencies of ETPs of these plants is depicted through Figure 4. Here, ETP of Dairy-A possessing a status of an average efficiency of 77%, the performance of Dairy-D holds the second position with a status of an average efficiency of 72% and Dairy-B holds the third position with an average efficiency of 68%. Dairy-C could satisfy with the fourth position only for an average efficiency of 66%. This indicates that the performance of all the four ETPs is not upto the standard. Considering the concentration of the influent characteristics of dairy waste treatment plants a minimum of 95% of the removal efficiency is essentially required to bring the final effluent to the standards for discharging to the environment. In view of the results achieved there are possibilities for further improvement in the ETP of dairy –A, for which certain additional treatment methodologies can be adopted. But in the case of other dairies a total improvement in all units are seen required.

4.2. Computation of Sludge Volume Index (SVI)

Sludge Volume Index (SVI) is an extremely useful parameter in analysis of wastewater treatment process [8]. SVI is the result of a mathematical calculation which considers the results of 30-minute settle ability test and the activated sludge mixed liquor suspended solids (MLSS) test. SVI number gives more accurate sludge settling characteristics.

The changes taking place in an activated sludge treatment process can be monitored by SVI. Operators can prevent problems by utilizing SVI data over a period of time. SVI determined during the waste water treatment process when running at optimum should be used as a benchmark.

SVI (mL/g) = (Settled Sludge Volume (mL/L) X 1000) / Mixed Liquor Suspended Solids (g/L)

The SVI's of influent and effluent of all the Dairies under study is provided in the Table 9. SVI of the influent of Dairy A is in the range of 690 to 1200 and for the effluent the SVI was noticed as 135 to 224. Based on the literature, if SVI is 250 mL/g or higher the sludge settles very slowly and compacts poorly in the settleability test [9]. In the case of Influent, the SVI is greater than 250 and it indicates that the MLSS status will be light and fluffy, not as very dense. While the effluent gives the SVI values are below 250. The values indicate that the sludge typically settles more slowly and traps more particulate matter as it forms a uniform blanket before settling. According to the literature, the microscopic examination of this MLSS would show an irregularly shaped floc particle with some filaments forming a backbone for floc-forming bacteria to attach and colonize [9].

Table 7 Sludge Volume Index (SVI) of the Influent and Effluent

	Dairy-A		**Dairy-B**		**Dairy-C**		**Dairy-D**	
Date	**Inlet**	**Outlet**	**Inlet**	**Outlet**	**Inlet**	**Outlet**	**Inlet**	**Outlet**
Jan-14	1200	210	1440	370	1390	295	1380	302
Feb-14	1080	206	1296	347	1216	272	1242	257
Mar-14	1020	198	1524	387	1276	246	1173	228
Apr-14	980	172	1476	384	1326	282	1127	298
May-14	690	135	1828	452	1278	285	794	255
Jun-14	984	169	1580	412	1200	299	1132	294
Jul-14	1016	218	1619	432	1271	268	1168	251
Aug-14	1120	224	1344	456	1294	262	1288	258
Sep-14	1096	202	1315	392	1265	250	1260	232
Oct-14	992	196	1490	385	1210	262	1141	225
Nov-14	1025	190	1430	408	1382	320	1179	219
Dec-14	1184	214	1420	394	1370	264	1362	246

To know the consistency of the treatments the Influent- Effluent relationship was studied with the SVI using regression analysis. The relationship is depicted through the figure 5 and found that the 'r' value is 0.86698, and the Coefficient of determination 'r^2'was found as 0.752. The value reveals that the treatment is uniform and has consistancy which maintained with the influent-effluent relationships. The relationship was found as linear (Y =a+bX) with 'a' the 'Y'intercept as 2.29 and the 'b' slope as 0.166.

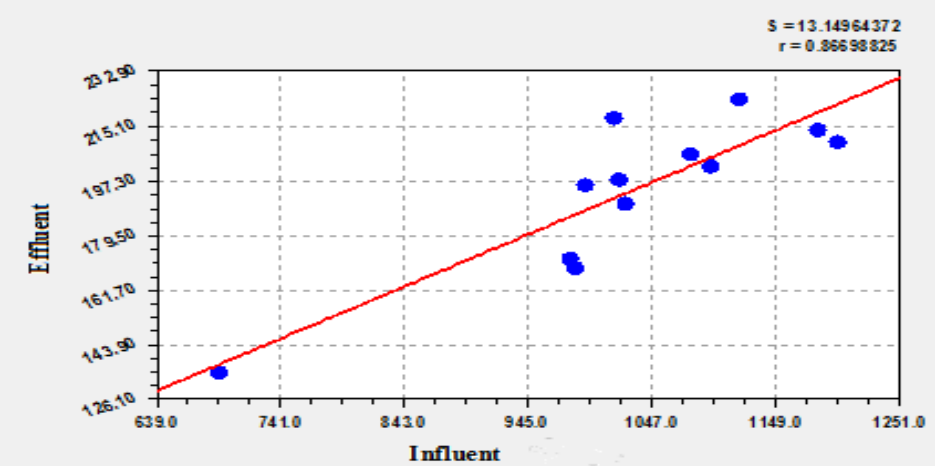

Figure 5 Sludge Volume Index in ml/g of Dairy – A

SVI of the influent of Dairy B is in the range of 1296 to 1828 and for the effluent the SVI was noticed as 370 to 456. Here, the SVI is greater than 250, which indicates that the MLSS status will be light and fluffy, not as very dense. This is the case for both influent and effluent. As the SVI is poor, it is advised to take urgent actions to improve the treatment unit's efficiency or the ETP as such is to be improved. A high SVI may also indicate filamentous sludge bulking. In this case, a microscopic examination is recommended and might show light floc particles that contain long filaments extending out of the particle and touching filaments from other particles. The filaments may be contained within the floc, causing a dispersed, open floc structure. In these cases, the liquid above the sludge blanket is usually very clear. The sludge can sit in the settleability test container for long periods and settle very little, or not at all.

The Influent- Effluent relationship which is studied with the SVI using regression analysis is depicted in figure 6 to know the consistency of the treatments. It is found that the 'r' value is 0.52748, and the Coefficient of determination 'r^2'value was 0.278. Even though the 'r' value found to be as greater than 0.50, the 'r^2' do not provide a hopeful result. The value reveals that the treatment is not uniform and the influent-effluent relationship is not strong enough. The relationship was found as linear (Y =a+bX) with 'a' the 'Y'intercpt as 23.10 and the 'b'the slope as 0.116.

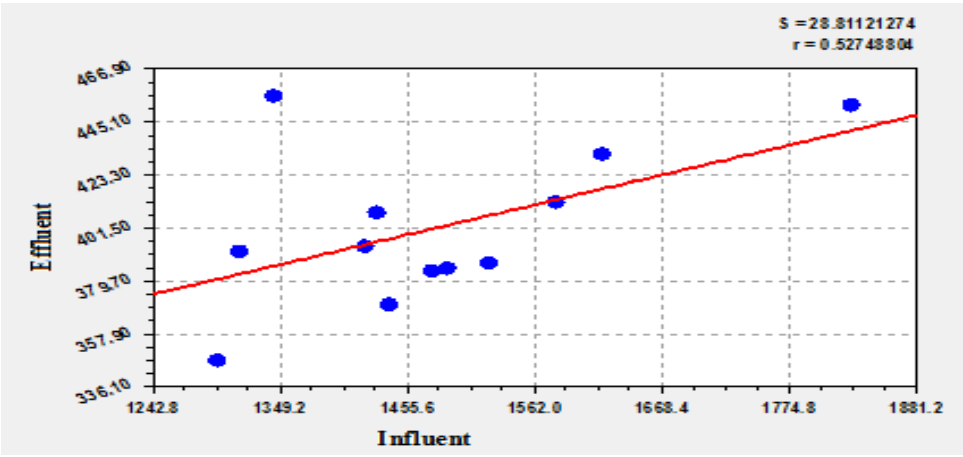

Figure 6 Sludge Volume Index in ml/g of Dairy - B

SVI of the influent of Dairy C is in the range of 1200 to 1390 and for the effluent the SVI was observed as 246 to 320. As the SVI is about 250 mL/g and higher the sludge settles very slowly and compacts poorly in the settleability test. In the case of Influent, the SVI is greater than 250 and it indicates that the MLSS status will be light and fluffy, not as very dense. While the effluent gives the SVI values are about 250 and

above, attention is to be given to the treatment side to bring the performance of the units of the palnt to bring down the SVI to the maximum possible.

The Influent- Effluent relationship is depicted through the figure 7 to know the consistency of the treatments with the SVI using regression analysis and found that the 'r' value is 0.35923, and the Coefficient of determination 'r^2'was found as 0.067. The value reveals that the treatment is not uniform and has no consistency with poor relationships between the influent and effluent. The existing relationship was found as linear (Y =a+bX) with 'a' the 'Y'intercept as 12.30 and the 'b' slope as 0.118. Adequate attention is required to improve the efficiency and performance of the ETP.

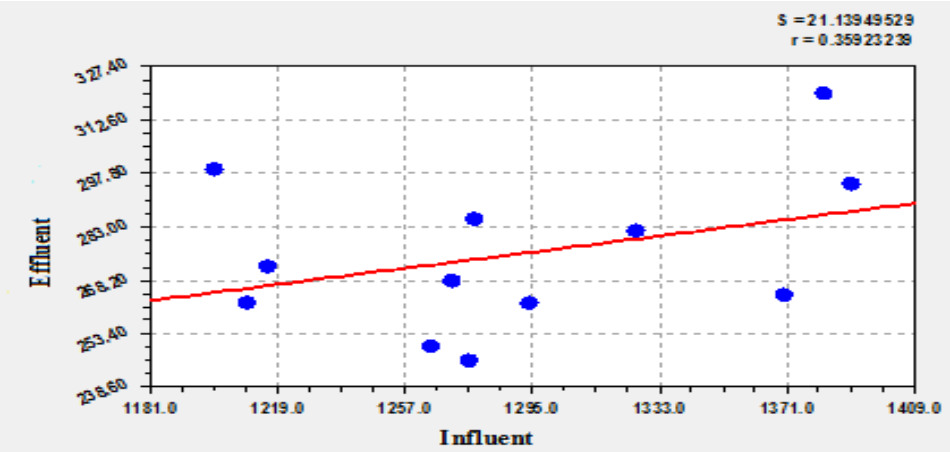

Figure 7 Sludge Volume Index in ml/g of Dairy – C

In the case of the Dairy D, the SVI of the influent is in the range of 794 to 1380 and that for the effluent was 219 to 302. Even though the influent SVI seems to be as very poor, that for the effluent is about 250, for which the sludge settles very slowly and compacts poorly in the settleability test. In the case of Influent, the SVI is greater than 250 and it indicates that the MLSS status will be light and fluffy, not as very dense. While the effluent gives the SVI values which are below and about 250. The values indicate that the sludge typically settles more slowly and traps more particulate matter as it forms a uniform blanket before settling. In this case also on the microscopic examination of this MLSS would show an irregularly shaped floc particle with some filaments forming a backbone for floc-forming bacteria to attach and colonize.

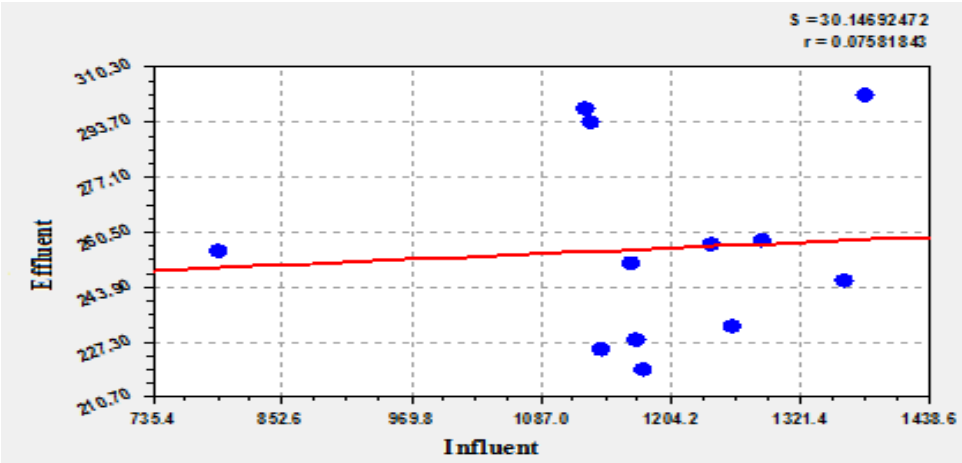

Figure 8 Sludge Volume Index in ml/g of Dairy – D

Further, to know the consistency of the treatments the Influent- Effluent relationship was studied with the SVI using regression analysis. The relationship is depicted through the figure 8 and found that the 'r' value is 0.07581, and the Coefficient of determination 'r^2'was found as 0.00575. The value reveals that the

treatment is not at all uniform and has no consistency and no relationship is seen maintained between the influent and effluent. On the assessment for the linear relationship it was found as linear (Y =a+bX) with 'a' the 'Y' intercept as 23.80 and the 'b' the slope as 0.0145. This reveals that the plant as such is to be renovated and a uniform flow is to be maintained.

As the evaluation of the selected Plants is described in detail as above, it is now concluded below for further studies.

5. CONCLUSIONS AND SCOPE OF FURTHER STUDIES

- Dairy A and Dairy C consume 2.20 liters of water per liter of Milk while Dairy B and Dairy D consume 2.50 litres of water per liter of Milk. Regarding the Consumption of Water, this is within the average of the water requirement noticed by various researchers for the Dairy industry.
- The waste water produced from Dairy D is noted as the minimum, 93% of the consumed water. Dairy A generates about 94% waste water against its water consumption and that for Dairy B is 95% and 94.6% for Dairy C.
- Effluent Treatment Plants of Dairies C and D are seen overloaded than its installed capacities.
- TSS values of the effluent of Dairy A are seen with in the permissible level and all the other parameters are beyond the admissible level. For other Dairies all the effluent parameters are seen as beyond the permissible levels.
- The overall efficiency of the ETP of Dairy A was found as 77% and that for other dairies found as 68% for Dairy B, 66% for Dairy C and 72% for Dairy D. Consistency in performance was seen in Dairy A whereas other Dairies' efficiency was seen fluctuating.
- As SVI is an indicator of settleability of suspended solids, none of the treatment plant was able to produce good results. But Dairy A provides a strong relationship between its Influent- Effluent SVI values in a month wise analysis.
- The Influent- Effluent SVI relationship found as linear and its coefficient of determination found as 0.752, further studies are possible to improve the standards of the effluent characteristics of Dairy A.

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