Treatment of Dairy Wastewater using Hybrid Down Flow Aerobic Trickling Filter Bed Reactor

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Abstract— Dairy industries have indicated huge development in size and number in many nations of the world. It is also one of the most polluting industries. In this study, dairy wastewater is collected from Belagavi Milk Union Limited (BMUL) located at Belagavi district. The industries effluents of dairy wastewater which is characterized by high pH, Chemical Oxygen Demand , Biological Oxygen Demand , nutrients and organic and in organics contents. Such wastewater, if discharged without proper treatment, severely pollutes receiving water bodies. To treat this dairy wastewater, the Hybrid Down flow Aerobic Trickling Filter Bed (DATFB) reactor is developed. In this experiment study, multi filter media namely Plastic scrubber, Sponge and Polypropylene pall rings used. The reactor has sufficient space to grow microorganisms and bacteria's. This pilot scale setup was operated for varying Hydraulic Retention Time (HRT) for 6 hours, 12 hours, 18 hours and 24 hour with different flow rate 0.02 L/min, 0.003 L/min, 0.005 L/min and 0.009 L/min. The results obtained from the experimental study showed removal efficiency for BOD as 92.4 %, COD as 87.4 % and Total Solids as 79 % for optimum HRT 18 hours. From the above results it is concluded that the Hybrid DATFB reactor gives more efficiency and good results. The filter media which is used in this reactor gives more than 90% efficiency in these results.

Key words: Hybrid Down Flow Aerobic Trickling Filter Bed Reactor, Treatment of Dairy Wastewater

I. INTRODUCTION

Water is transparent, colourless, odourless and tasteless. Water is clear colorless liquid, odourless and tasteless when pure, that occurs as rain, snow, and ice. Structures streams, lakes, and oceans, and is basic forever. Normally happening water grabs shading and taste from substances in its condition The earth surface is secured by water around 7%, among these 96.5% of the planet's outside layer water is found in the oceans and seas, and 1.7% in groundwater, 1.7% in icy masses and 0.001% is found in air as vapor, mists and precipitation. As just 2.5% of this waster is available in crisp water and under 0.3% of all new water is in waterways, lakes and climate and even measure of earths freshwater is contained with natural bodies and fabricated items.

II. DAIRY WASTEWATER

A. Belagavi Milk Union Limited (BMUL)

Milk union specializes in processing and marketing of "Nandini-Kunda". It has more than 411 functioning covering 10 taluks. Union marketing of milk and milk product activity is established in the district as well as the neighbouring state of Goa and Maharashtra. The belagavi milk union possess 1 lakh litre handling capacity infrastructure at Belagavi. Also have its chilling centres at Gokak with 30,000 litres per day (LPD), Ramdurga with 20,000 LPD, Athani with 30,000 LPD and chikkodi 10,000 LPD.

There are variety of milk products obtained from dairy industries such as yogurt, butter, fluid milk, flavoured milk, cheese, ice cream, milk powder etc. As continuous operations place such as receiving and storing of raw materials, processing into finished products, packing and storing of finished products are examples of dairy wastewater industry. Dairy industry is a standout amongst the most dirtying industry, it is in things of release produced, as well as in things of its qualities also. It creates very nearly 0.2 – 10 liters of radiation for each liter of took care of drain with a middle stride of about 2.5 liters of wastewater for every liter of the drain fixed.

Wastewater treatment process in diaries: Wastewater which is generated from dairy industry has low COD and BOD ratio as it can be treated with efficiency of biological treatment process. As these wastewater contains enough nutrient for bacteria growth and can be prevented by:

- The arising of spills, escape of liquid and dropping of milk from cans.
- During washing the amount of water usage must be minimised.
- The perfect cooling water is segregated and the same is recycled.

Characteristics	Typical Values
pH	7.2 (mg/L)
Alkalinity (mg/L)	250-580 (mg/L)
BOD (mg/L)	100 (mg/L)
COD (mg/L)	260 (mg/L)
Turbidity (NTU)	5-10 NTU
Dissolved Solids (mg/L)	1020 (mg/L)
Suspended Solids (mg/L)	g/L)

Table 1: Characteristics of Dairy wastewater:

III. OBJECTIVES OF THE STUDY

- Treatment of dairy industry wastewater using Hybrid Down flow Aerobic Trickling Filter Bed Reactor
- To study the initial characteristics of dairy wastewater.
- Design the laboratory Pilot scale setup of Hybrid DATFB Reactor.
- To study the final characteristics of treated dairy wastewater.
- To study the optimum Hydraulic Retention Time (HRT) of Hybrid DATFB Reactor.
- To study the optimum parameters like pH, COD, BOD, Alkalinity, Turbidity, Conductivity, Dissolved Solids and Suspended Solids.
- To Study the more efficiency of hybrid filter media (Polypropylene pall rings, Sponge & Plastic Scrubber)

IV. LITERATURE REVIEW

Laginestra (1992) in this paper entitled that regarding the filter media used in trickling filter is used to settle the film frameworks are less defenceless to danger and stun loads than initiated slime frameworks. Be that as it may, TFs are more delicate than suspended development to temperature drop and commonly to provide food for icy temperature atmospheres, Trickling Filters are larger than average for winter. TFs have customarily taken up more land. With the high rate plastic media TF prepare, this is not true anymore. As a result of the high grouping of biomass joined to the media surface territory, the reactors can deal with higher burdens per unit volume than enacted slop. Effluent quality is not respected to be equivalent to that of the conventional activated sludge process as it may, TF is viewed as giving a decent good quality and the procedure is fit for critical expulsion of contaminates (counting COD, smelling salts nitrogen, oil and oil).

Tandukar et al.,(2007) In this paper DHS Bio tower is an aerobic treatment system is similar to trickling filter. The use of polyurethane foam (Sponge) works as growing and supporting medium for micro-organisms and this phenomenon maintain Dissolved oxygen (DO) concentration in the wastewater at a level which it surpasses curtailing the need of any outer constrained air circulation not at all like a large portion of the current oxygen consuming treatment. As sponge has more void ratio as more than 90% which it provides sufficient growth and fixed film wastewater treatment process as it gives high performance efficiency.

Vijay kale et al, (2006), Dairy wastewater is recognized by the high BOD and COD substance, abnormal state of broke down or suspended solids, including fats, oil and oil, supplements, for example, smelling salts or minerals and phosphates. Since, it creates immense amounts of wastewater, it is basic to treat the dairy wastewater before it is arranged in arrive or close-by water bodies.

Devandra P. S et al., (2014) they have designed laboratory scale of biological trickling filter made up of poly vinyl chloride with height 36 of inch outer diameter 14 inch and inner diameter 12.4 inch with 22 litre capacity. They designed two layers were outer layer consists of steel cage with diameter of 11 inch and 24 inch height and inside layer the pipe was used to hold the filter media and it consists of 12 litre effective volume . The different types of packing media used such as polystyrene plastic, rubber and stones. To collect the treated waste water, under drain system (height 8 inch) was placed with an outlet at a height of 3 inch. A shower rose diameter 8 inch has a flow rate of 80 litre per minute which is supported on the top of filter bed media and distributes waste water. For recirculation of water, a water pump was used. Within two consecutive years the reactor was used for two period of 4 months during summer (25^0-35^0C) and for 4 months during winter (5^0 -15^0 C) for 48 hrs. In the present review, the results of BTF utilizing 4 media (elastic, plastic, polystyrene, stone) at two temperatures reaches at 5^0 -15^0 C and 25^0-35^0C for municipal waste water demonstrated that everyone of the media utilized as a part of BTF produced good quality emanating with respect to carbonaceous matter (BOD) and faecal coliforms expulsion. The efficiency of wastewater treatment increased with treatment times from 12 to 48 hrs and normal BOD removal values taken from plastic, stone, rubber and polystyrene media were 89.4, 93.4, 81.9 and 86.3%. At temperature range of 25^0-35^0C the highest BOD efficiency removal was observed in the rubber media (94.85%).

V. MATERIALS AND METHODOLOGY

A. Sampling

The dairy wastewater sample collected from a Belgavi Milk Union Limited (BMUL) which is located in Belgavi, Karnataka. Dairy wastewater is generated in milk processing unit, they introduce it into dairy products s for example, buyer drain, cheddar, spread, yogurt, dried drain, consolidated drain and frozen yogurt. Its procedures are additionally, for example, purification, penetrating and homogenization of liquid drain. Wastewater is likewise produced from the procedure of can washing, hand washing, vehicle washing, conditioner discharging and so forth. Cleaning in place (CIP) system is used for cleaning solution through some of equipment in which water rinse, acid solution wash, caustic solution wash etc are some of chemicals which is also part of wastewater. Big tanks are used for storing wastewater in which used for further treatment process. Samples were collected from the screen outlet to the plastic water cans.

A characteristic of Dairy wastewater sample was conducted immediately after the sample arrived to the laboratory. During dairy wastewater samples collected, observation are made that there will be minimize changes in the chemistry of the sample. As to maintain changes in the chemistry of the sample preservation methods such as refrigeration from light were performed.

Fig. 1: Dairy wastewater collection tank

Fabrication of Hybrid Down flow Aerobic Trickling Filter Bed Reactor.

1) Materials following used

- Acrylic tube and sheets.
- CPVC pipes and fittings materials.
- Miscellaneous fittings materials.

a) Acrylic tube and sheets

The another name for Acrylic sheet is Polymethyl methacrylate (PMMA). Sheet and tube both are transparent thermoplastic. It is Sold mainly as a clear glazing sheet, as it must be worked correctly to avoid breaking and cracking It frequently utilized as light weight contrasted with glass yet infrequently it is called acrylic glass. Artificially, it is the engineered polymer of methyl methacrylate. Acrylic is favoured because of its direct properties, minimal effort, simple taking care of and handling, however acts weak way when stacked. But it is more susceptible to scratching and transmission of UV. Various other sizes and shapes are available thickness. Sheet isn't always cheaper. Acrylic is also available in colours, though not from diy suppliers.

b) Piping and Fittings materials

A fitting is used in pipe system to connect straight pipe or tubing sections, where it has different sizes or shapes and for other purposes. Piping is described as high performance conveyance of fluids in specialized applications.

Chlorinated polyvinyl chloride (CPVC) is a thermoplastic which is produced by chlorination of Polyvinyl chloride (PVC) resin as it is more flexible and can also with stand higher temperature than standard PVC. It can use both cold and hot water pipes and industrial liquid handling. Following properties of CPVC are Normal Size = ½ inch, Inner Diameter = 0.608 mm, Outer Diameter = 0.840 mm, Wall thickness = 0.109 mm

c) Miscellaneous Materials

- Plastic hose pipes = ½ inch
- Bonding Solutions
- Argon flow regulator
- Handling tools and accessories
- Gun metal valves.

2) Packing Material

Sponge: It is tool or cleaning aid consists of Soft, porous material. Usually it is need for cleaning impervious surfaces, sponges are especially good at absorbing water and water based solutions. As it is made from cellulose wood fibers or foamed plastic polymers. There are also some natural sponges which are still sold, with most of them uses now either as body or facial sponges or bath sponges or sponge painting. The shape of sponge was Cube shaped sponge. The sponge exhibits good efficiency in removing the organics. As it has high void space where it can remove more than 90% of water or organics from sponge. It is economic and easily maintenance process. It is often used due to light weight and also available in all colors.

Material	Dimensions (Length x Width x Height) in cm^3	Density in gm/cm^3	Void Space in %
Sponge	2.4 x 2.4 x 3.2	0.651	More than 90%

Table 2: Properties of sponge

a) Plastic Scrubber

It is made up of plastic with a high void ratio. It usually used for Utensils, Dish washing etc. This plastic is also used in filter media as a absorbing agent. It is often used due to its light in weight and has high mass transfer efficiency.

b) Polypropylene Pall Rings

It is also known polypropylene (PP). It is made of thermoplastic polymer which is in variety of applications including packaging and labelling, textiles, plastic parts and reusable containers of various types, laboratory equipments and polymer bank notes. Polypropylene is used as packing material in many industries. Its specifications are having low pressure drop , high free volume , high flooding point , low mass transfer unit height, small specific gravity and so on. PP are used in scrubbing , stripping and absorption services and also able to adapt alternative to metal pall rings, constant decompress, all kind of separation, decarbonisation plant, separation of methylbenzene and separation of ethylbenezene.

Fig. 2: Sponge

B. Design of Reactor

The Trickling Filter reactor works on the principle of continuously sprayed or trickled over the filter. This type of reactor works or operates under aerobic conditions. The dairy wastewater is continuously fed into the reactor through inlet tank and the effluent is allowed to pass through aerobic reactor. The reactor is fabricated from material that is non corrosive, non-reactive and acrylic tubes of 3mm thick were used.

The laboratory scale set up of Hybrid Down-flow Aerobic Trickling Filter Bed Reactor was fabricated from acrylic tubes and sheets with overall dimension 90mm dia x 610mm height. A schematic diagram of the reactor is shown below in fig. The empty reactor consists of volume 3.2 L with one end closed and other end open which is kept for air circulation. A perforated acrylic sheet plate is provided at distance of 50mm from the bottom which provides the sludge by rising down to the outlet. Initially the arrangement is made inside of the reactor from downwards to upwards first they insert the plastic scrubber, next sponges and polypropylene pall rings. As the filter media is inserted in the reactor, in between them perforated plates are fixed.

The 20 L tank contains dairy wastewater which is connected to inlet control valve as well as flow regulator. A distributor (sprinkler nozzle) is connected to bottom of flow regulator which is distance of 50 mm from the top of the filter media. 80% of the hybrid aerobic reactor is completely filled with three different types of filter media. The reactor is completely in the presence of oxygen.

The details of Hybrid DATFBR:

Total height	610 mm
Effective height	510 mm
Inner diameter	84mm
Outer diameter	90mm
Effective volume (litre)	3.29 L
Sludge	50 mm
No of Sampling ports	3

Table 3: Details of Hybrid DATFBR

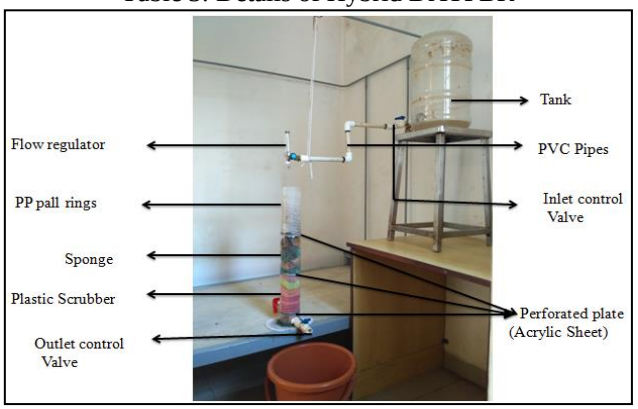

Fig. 3: Hybrid Aerobic Trickling Filter Bed Reactor

C. Methodology

1) Start-up of the reactor

- The total volume of Hybrid Down-flow Aerobic Trickling Filter Bed Reactor is 3.29 litres
- Initially the leakage testing of the reactor is done. About 10% of cow dung slurry is added to the reactor. It is necessary to introduce the bacteria and micro-organisms into the reactor for start up the aerobic decomposition process. In this reactor fresh cow dung slurry is used.
- Initially the reactor was loaded with diary wastewater with COD concentration of 260 mg/L.
- Reactor is kept for acclimatization period under aerobic condition. Acclimatization is the process in which each individual organism gets adjusted to a change in its environment, which includes change in humidity, altitude, pH or temperature, which allowing it to maintain performance across a range of environmental conditions. It usually occurs in short period of time from days to week and where the bacteria's and organisms grown within lifetime.
- For the acclimatization process , initial 20% of wastewater and 80% of freshwater was taken for 20L tank and added 10 .% of cow dung slurry to it. Similarly it is continued for 40% wastewater, 60% freshwater and so on till 100% wastewater sample is added to reactor.
- For the present working reactor under aerobic condition, the acclimatization period was kept about 16 days.
- Hydraulic Detention Time is kept as 48 hours.
- During this Hybrid DATF bed reactor, the COD analysis was carried out twice or thrice in a week.

VI. RESULTS AND DISCUSSIONS

Dairy wastewater was collected from Belagavi Milk Union Limited (BMUL), located in Belagavi, and analyzed in KLE Society's Dr. M. S. Sheshgiri College of Engineering and Technology laboratory. Dairy wastewater was treated using Hybrid Down flow Aerobic Trickling Filter Bed Reactor. The characteristics of dairy wastewater used in the study are given in Table 2.

Characteristics	Average value
pH	10-12
Colour	White
Conductivity	9.52 mS/cm
Turbidity	410 NTU
Alkalinity (mg/L)	320 mg/L
BOD (mg/L)	1075 mg/L
COD (mg/L)	1660 mg/L
Total Solids (mg/L)	5800 mg/L
Dissolved Solids (mg/L)	4035 mg/L
Suspended Solids (mg/L)	1765 mg/L

Table 4: Characteristics of dairy wastewater

A. Reactor Operation

The reactor was inoculated with 1.8 L of cow dung slurry. In the aerobic reactor plastic scrubber, sponge and Polypropylene pall rings are used as packing material. These packing material are used as 80 % of the reactor volume. The reactor was filled with dairy wastewater and cow dung slurry and kept it for acclimatization for 16 days.

1) pH Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Table 3 pH reduction in Hybrid DATF Bed Reactor

Initial concentration	HRT in hours	Final concentration using HDATFBR
11.6	24	6.7
11.8	18	7.4
11.5	12	7.6
11.6	6	8.2

Table 5: pH Removal: Reactor Operation varying with HRT

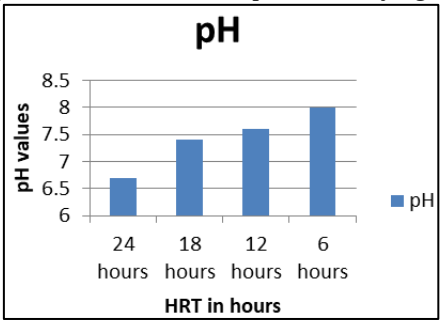

Fig. 4: pH removal efficiency in % at different HRT

After collection of dairy wastewater, immediately lab test was done. Before treatment pH was 10-12. After treatment the pH lies in the range of 7-8.

2) Total Solids Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Initial Feed concentration in mg/L	HRT in hours	Final concentration using HDATFBR in mg/L	Efficiency in %
5685	24	1600	73 %
5830	18	1230	79 %
5590	12	1412	75 %
5756	6	1710	70 %

Table 4: Total Solids reduction in Hybrid DATF Bed Reactor

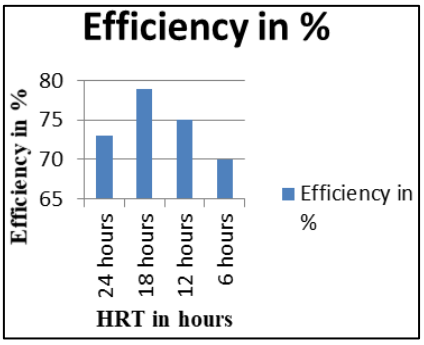

Fig. 5: Total solids removal efficiency in % at different HRT

From the results, it is seen that optimum TS is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum TS is 1230 mg/L for 18 hours with maximum TS removal efficiency is 79 %. At 5830 mg/L feed concentration, the TS removal efficiency was only 79 %.

3) Total Dissolved Solids Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Initial Feed concentration in mg/L	HRT in hours	Final concentration using HDATFBR in mg/L	Efficiency in %
4035	24	960	76. %
4028	18	840	79 %
4034	12	1010	75 %
4000	6	1015	74 %

Table 5: TDS reduction in Hybrid DATF Bed Reactor

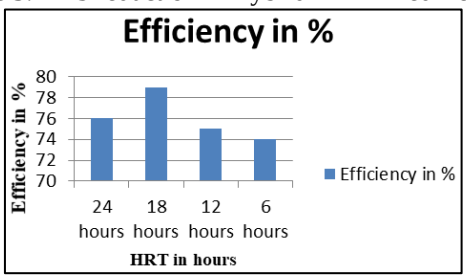

Fig. 6: Total Dissolved solids removal efficiency in % at different HRT

From the results, it is seen that optimum TDS is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum TDS is 840 mg/L for 18 hours with maximum TDS removal efficiency is 79%. At 4028 mg/L feed concentration, the TDS removal efficiency was only 79 %.

4) Suspended Solids Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Feed concentration in mg/L	HRT in hours	Final concentration using HDATFBR in mg/L	Efficiency in %
1657	24	640	61 %
1802	18	360	80 %
1556	12	402	74 %
1756	6	695	60 %

Table 6: Suspended Solids reduction in Hybrid DATF Bed Reactor

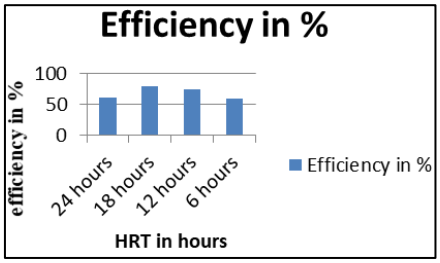

Fig. 7: Dissolved solids removal efficiency in % at different HRT

From the results, it is seen that optimum Suspended Solids is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum Suspended Solids is 360 mg/L for 18 hours with maximum Suspended Solids removal efficiency is 80 %. At 1662 mg/L feed concentration, the Suspended Solids removal efficiency was only 80 %.

5) Turbidity Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Initial concentration in (NTU)	HRT in hours	Final concentration using HDATFBR (NTU)	Efficiency in %
390 NTU	24	9	97 %
405 NTU	18	5.5	99 %
385 NTU	12	6	98.4 %
392 NTU	6	7.2	98 %

Table 7: Turbidity reduction in Hybrid DATF Bed Reactor

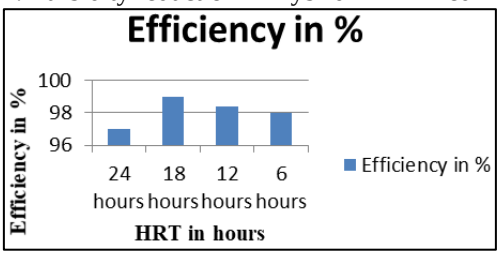

Fig. 8: Turbidity removal efficiency in % at different HRT

From the results, it is seen that optimum turbidity is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum Turbidity is 5.5 NTU for 18 hours with maximum turbidity removal efficiency is 99 %. Trials were done until to reach the maximum efficiency reached. So the water appears to clean and transparent.

6) Conductivity Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Initial Feed concentration in (mS/cm)	HRT in hours	Final concentration using HDATFBR (mS/cm)	Efficiency in %
9.44mS/cm	24	0.400	95 %
9.52mS/cm	18	0.320	97 %
9.48mS/cm	12	0.460	96 %
9.46mS/cm	6	0.591	94 %

Table 8: Conductivity reduction in Hybrid DATF Bed Reactor

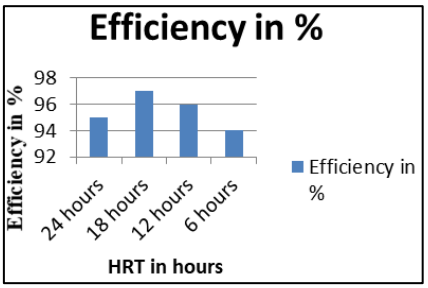

Fig. 9: Conductivity removal efficiency in % at different HRT

From the results, it is seen that optimum conductivity is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum conductivity is 0.320 mS/cm for 18 hours with maximum conductivity removal efficiency is 97 %. Trials were done

until to reach the maximum efficiency reached. Conductivity mainly depends on pH, as pH decreases then there is decrease in conductivity

7) BOD Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Initial Feed concentration in mg/L	HRT in hours	Final concentration using HDATFBR in mg/L	Efficiency in %
1075	24	126	88 %
1060	18	80	92.4 %
1054	12	104	90 %
1062	6	112	89 %

Table 9: BOD reduction in Hybrid DATF Bed Reactor

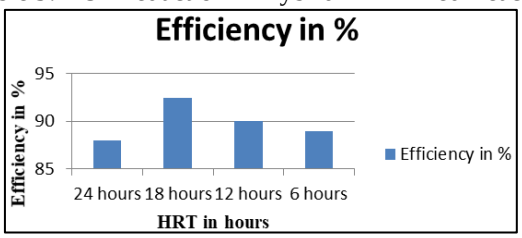

Fig. 10: BOD removal efficiency in % at different HRT

From the results, it is seen that optimum BOD is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum BOD is 80 mg/L for 18 hours with maximum BOD removal efficiency is 92.4%. At 1060 mg/L feed concentration, the BOD removal efficiency was only 92.4%

8) COD Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Initial Feed concentration in mg/L	HRT in hours	Final concentration using HDATFBR in mg/L	Efficiency in %
1620	24	280	83 %
1590	18	200	87.4%
1606	12	230	86 %
1598	6	245	85 %

Table 10: COD reduction in Hybrid DATF Bed Reactor

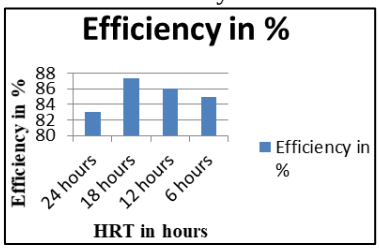

Fig. 11: COD removal efficiency in % at different HRT

From the results, it is seen optimum COD is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum COD is 200 mg/L for 18 hours with maximum COD removal efficiency is 87.4 %. At 1590 mg/L feed concentration, the COD removal efficiency was only 87.4%.

9) Alkalinity Removal: Reactor Operation varying with HRT

Initially the reactor was filled with dairy wastewater. The HRT for the reactor was set for 24hrs, 12hrs, 18hrs and 6hrs with different flow rate 0.002L/min, 0.003 L/min, 0.005L/ min and 0.009 L/min. The results are given in a table below.

Initial Feed concentration in mg/L	HRT in hours	Final concentration using HDATFBR in mg/L	Efficiency in %
320	24	206	35 %
312	18	165	48 %
310	12	180	42 %
315	6	200	37 %

Table 11: Alkalinity reduction in Hybrid DATF Bed Reactor

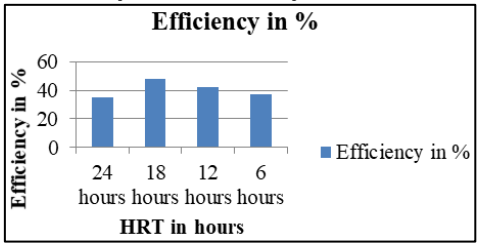

Fig. 12: Alkalinity removal efficiency in % at different HRT

From the results, it is seen that optimum alkalinity is found for different HRT's of period for 24 hours, 18hours, 12hours and 6 hours. The optimum alkalinity is 165 mg/L for 18 hours with maximum alkalinity removal efficiency is 48 %. At 312 mg/L feed concentration, the removal efficiency of alkalinity was only 48 %.

VII. DISCUSSION

Parameters	24 hours	18 hours	12 hours	6 hours
Total Solids	73 %	79 %	75 %	70 %
TDS	76 %	79 %	75 %	74 %
Suspended Solids	61 %	80 %	74 %	60 %
Conductivity	95 %	97 %	96 %	94 %
Turbidity	97 %	99 %	98.4 %	98 %
BOD	88 %	92.4 %	90 %	89 %
COD	83 %	87.4 %	86 %	85 %
Alkalinity	35 %	48 %	42 %	37 %

Table 12 : Over all efficiency Results

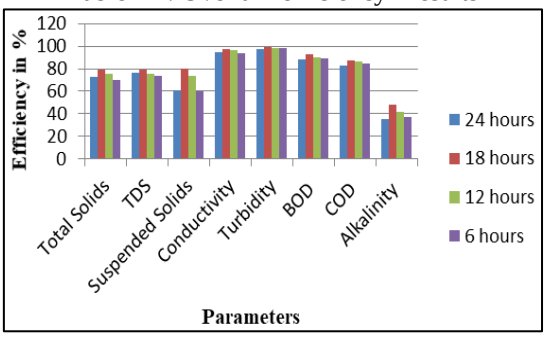

Fig. 5: Graph of Results

VIII. CONCLUSIONS

1) Dairy Wastewater is generated from the processes like diluted milk, yogurt, butter, can washing , cleaning floor and so on, with following characteristics; pH-10-12, colour-white, Turbidity 410 NTU, Conductivity 9.52mS/cm, COD-1620 mg/L, BOD-1075 mg/L, Total solids-5830mg/L, Dissolved solids-4035 mg/L, Suspended solids 1662 mg/L.

2) A laboratory scale Hybrid DATFB reactor of dimensions 90mm diameter x 610 mm height, with experimental volume of 3.29 L reactor was fabricated by using acrylic tube and PVC pipes.
3) In the present work; in Hybrid DATF Bed Reactor 80% of the reactor volume was filled by the filter media (Polypropylene pall rings, Sponge, Plastic Scrubber).
4) The Hybrid DATFB reactor was vaccinated with cow dung slurry of 10 % of the reactor volume for growing the bacteria and microorganisms in the aerobic reactor.
5) The pH varied between 7 to 8 and the temperature varied between 25-32 ^{0}C during the study. This variation in the pH and temperature affected the bacterial activity in the aerobic reactor.
6) At optimum loading rate, there was 79 % reduction in total solids, 79% reduction in dissolved solids and 80% reduction in suspended solids. Hence it is optimum to HRT 18 hours that is near to permissible limit.
7) Initially, before the treatment of dairy wastewater concentration of COD was 1620 mg/L and after the treatment the COD was 200 mg/L which is within the permissible limit 260 mg/L and removal efficiency was about 87.4% of this reactor.
8) Initially the concentration of BOD was 1075 mg/L before treatment and after treatment of wastewater the concentration was reduced to 80 mg/L. Thus, the efficiency of the reactor was found to be 92% which is within the permissible limit of HRT 18 hrs.
9) From the above observed results, it can be concluded that Hybrid DATFB reactor gives more efficiency and good results. Where the reactor has sufficient space to grow bacteria's and microorganism to treat the wastewater.
10) Turbidity and Conductivity of dairy wastewater removal efficiency was 99 % and 97 % where it has removed maximum amount of turbidity and removal of metal ions from treated dairy wastewater.
11) According to test of alkalinity, the removal efficiency was 48 % so it has slightly present in dairy wastewater .Acidity is absent in dairy wastewater.
12) The cost of down flow reactor is economic and feasible compared to up flow reactor because the peristaltic pump is used to lift the water.

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