TREATMENT OF DAIRY EFFLUENT USING ROTATING BIOLOGICAL CONTACTORS (RBC)

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Abstract : The disposal of sewage waste plays a vital role which creates huge problem in urban cities as it is very harmful which effects to the environment. Sludge is the main product from sewage waste. Conventional brick is mostly made by using clay. Chemical composition of sludge is similar to the clay. And therefore sludge can be used as a replacement for a clay, soil in manufacturing of bricks. In this study , bricks were produced with sewage sludge addition ranging from 10, 20, 30, 40 and 50% by dry weight respectively and compare produce brick with regular brick. Also from this investigation, we can solve the disposal problem completely and also construct and economical structure with easy designing.

Index Terms - : Aerobic, ASP, Biodegradable, BOD, COD, Nitrate, RBC, Sludge, Treatment,

I INTRODUCTION:-

Waste-water from dairy mainly consists of biodegradable and organic matter which disrupts the marine life. Due to the high pollution load of dairy wastewater, the milk-processing industries discharges untreated/partially treated wastewater causing serious environmental problems. Hence, it is important to carry out a treatment as a starting point in order for the optimization of a simple and economic method for the treatment of whole dairy effluent. Appropriate processes are required so as to meet the discharge standards specified by the government. The treatment does not offer any financial profit to the industry owners therefore they are directly to nearby water streams or ashore (i.e. in nature) by giving just some of the treatment that may be due to lack of awareness or lack of funds in this regard.

II PROBLEM STATEMENT:-

Waste is also one of the important aspect of many problems, therefore the facilities must also be enhanced. The very huge volume of waste not only creates accumulation problems, but also gives rise to other issues, by reducing infertility of land by avoiding disposal of dairy waste in land to increase the efficiency of dairy waste treatment plant.

Study Area

The area extends for about 60 hectares of land where as treatment plant is placed over an area of about 3 hectares situated in Goregaon a suburb in the Mumbai city, in the Mumbai Suburban district of India. The area has the geographical features having an elevation of 14.7 meters (48.23 feet). The district has latitude of 19.1551° N and longitude of 72.8679° E. There are number of plants in the vicinity namely Mother dairy, Dynamix dairy industries limited, Maharashta Shasan Aarey milk centre, Unit no. 10 (Central Dairy), Shree Thakkar dairy farm, Azam dairy, Aarey colony and Shree Jain dairy farm. Mahanand dairy has milk procurement system which spreads over the district of Maharashtra. Mahanand dairy is distributing 30 lakhs liters of milk per day in Mumbai with the help of one packing depot strategically located at Navi Mumbai. The water left out after the production of several products is termed as dairy waste water. The effluent from milk production units contains soluble organics, suspended solids, trace organics which releases gases,which causes taste and odor, imparts colour and turbidity, and promote eutrophication which affects and disturb the environment. [8] Hence proper treatment is required before disposal however instead of disposing this dairy waste is recycled after givng proper treatment and further used for washing and gardening purpose.

Desing Details

- Mahanand industry utilizes about 5000 m3/day of fresh water.
- The treated and untreated effluent discharge amount was 2750 m3/day i.e. 55% of the total water used.
- Waste water quality was determined by estimating physical, chemical, and biological characteristics of waste water.
- Waste water sample was collected by fabricated water sample of its capacity and transported to lab, where analysis was done for a period of 2 days.
- The collected sample were analyzed for temperature, pH, BOD and COD.
- Temperature of waste water is ranged from 26.2℃ to 35.40℃
- The colour of dairy waste water was white.
- pH was found as 9.68
- BOD value was around 250 mg/l
- COD value was 781.57 mg/l

IV METHODOLOGY

1 Screening

Screening is the very first operation carried out at a sewage treatment plant. It functions for the removal of the floating materials. The screens are kept inclined near about 30to 60° to the direction of flow. The velocity through which the screens should be not more than 0.8 to 1 m/s. We have provided steel bars in the screen, having width of 1 cm and paced at 5 cm clear spacing.

2 Design of Grit Chamber

A rectangular grit chamber is so designed to remove the particles with diameter 0.2 mm with specific gravity of 2.65.Taking settling velocity of particles ain the range of 0.016 to 0.022. Horizontal velocity of flow is taken as 0.3 m/s.

$$Vs = \frac{(G-1)\times\gamma_w\times d^2}{18\mu} = \frac{(2.65-1)\times 9810\times 0.0002^2}{18\times(8.90\times10^{-4})} = 0.04 m/s$$

The settling velocity of 0.2 mm sized organic particles in water. As waste water viscosity will be greater than water which will affect the settling velocity .Hence taking 50% of settling velocity as compared to settling velocity of particles in water.

Q = 2750 m3/d =31.83 l/s =0.03183 ≅
0.032 m3/s
Q = **A×V**
0.032 = A 0.3
A = 0.12 m2
Providing a depth of 1.2 m, free board of 0.3 m and 0.3 m space for accumulation of grits and width of grit chamber as 1m.

Length of channel:-

Horizontal velocity detention period. It means that more the detention period, is more horizontal distance could be travelled. Settling velocity is taken as 0.02 m/s

Detention Period = $\frac{Watwer\ Depth}{Settling\ Velocity}$ = $\frac{0.6}{0.02}$ =30seconds.

L = 0.3 × 30 = 9m
Increasing by (10 to 50) taking it as 30%
12.85=15m
Provide a grit chamber of size as 15×1×1.2 m having a flow velocity of 0.3 m/s

3 Design of Primary Sedimentation Tank

1. Plan area of tank = $\frac{Q_D}{Over\ Flow\ Rate}$

$=\frac{2750}{18}$
$= 152.77 \approx 160 m^2$

Q = 2.75 MLD, SS0=450 mg/l Preferring plain sedimentation. Assuming overflow rate of 18 m3/m2/dayProvide tank of 200m2
LxB =200m2
L= 20m
B= 10m
2. Assuming detention period of 4 hr
Volume of tank = QD× t_D= $\frac{2750}{24}$ × 4 = 600
Height of tank =600/200 = 3m Design a rectangular continuous tank of size as 20×10×3 m. Setting velocity of concerned particles is called as surface overflow rate which decides efficiency of tank Vs=18m/day =0.208 mm/s The flow velocity of tank
Vf = $\frac{L \times V_S}{H}$=$\frac{20 \times 1000 \times 0.208}{3 \times 1000}$ = 1.39 mm/s

Design of RBC module to treat 2750 m3/day ≈ 3000 m3/da
Assumptions: - Hydraulic loading rate =110 l/m2/day, Diameter of disc = 3m, c/c spacing between disc=20mm.
Q = 3000 m3/day = 0.035 m3/sec.
Area of disc = ×32 =7.068 m2
Total surface area of 1 disc = (2× 7.068) + (πD×0.1) . =14.14 m2
Total surface area required=$\frac{3000 \times 1000}{110}$ =27272.73M^2
No. of discs =$\frac{27272.73}{14.14}$=1928.7≅1930
Total length of shaft required = 1930×0.02 = 38.6m.
Assumption
Let length of each shaft be 10m Therefore total number of Rotating Biological contactor required = 3.86≅4
Therefore provide 4 - RBC in series with 50% submergence in water with clear spacing of 10 cm rotating at 6 rpm
Volume of tank = × (3+0.1)2 ×0.5×4×10 = 150 m3 Hydraulic Retention Time $\frac{150}{125}$= 1.2hr. **Check should be between 1-1.5 hrs OK** Raw BOD5 = 250 mg/l
Influent BOD = 0.7 ×250 =175 mg/l.
Oganic loading =$\frac{\frac{175 \times 10^{-6}}{10^{-3}} \times 3000}{27272.7}$ = 0.019$\frac{Kg}{\frac{m^2}{day}}$ (upto
0.022) OK

4 Secondary Sedimentation Tank
Surface loading rate mostly preferred for secondary sedimentation tank is 15 to 30 m3/m2/day. Adopting a surface loading rate of 20 m3 /day/m2 Q = 2750 m3/day1. Surface area required =$\frac{2750}{20}$ = 137.5 m2.
Adopting solids loading of 125 kg/day/m2 for MLSS of 2000 mg/l
2. Surface area required =$\frac{2750 \times 2000}{1000} \times \frac{1}{125}$ = 44 m^2
Preferring maximum surface area of 137.5 m2 Surface Area = 137.5 m2 140 m2Adopting a circular tank, Area =140
= D = 13.35 m 15 m. Weir loading for circular weir placed along periphery of tank having length equal to
= $\frac{2750}{15}$= 58.35 m3/day/m < **150 OK**
Hence, provide settling tank of 15 m diameter

5 Design of Sludge Digestion Tank

Assumptions: - 2.75 MLD treatment plant, 60 suspended solid removal in PST. Moisture content of sludge is 96 %; digested sludge solid content is 8% Specific gravity of raw and digested sludge is 1. 1.03 and 1.04 respectively Mean cell residence time is 15 days and efficiency, = 60 %
Weight of solids in raw sludge w =$Q_o \times SS_o$
= 742.5 kg/day 750 k/day.

Weight of volatile solids = 0.7 750 = 525 kg/day.
Weight of non volatile solids = 0.3 750 = 225
kg/day.
Volume of raw sludge, $V_1 = \frac{100\times750}{(100-96)}$ = 18.20 m3/day. Weight of non volatile solid in digested sludge
= 0.35 52
= 183.75 kg/day.
Volume of raw sludge, = 18.20 m3/day.
Weight of non volatile solid in digested sludge = 0.35× 525 = 183.75 kg/day.
Total weight of digested sludge = 183.75 + 225 =408.75 kg/day.
Volume of digested sludge, V2 =$\frac{100\times750}{(100-96)} \times \frac{1}{1.03\times1000}$ = 4.91 m^2/day.
Volume (V) =$V_1 - \frac{2}{3}(V_1 - V_2) \times t_p$
=$(18.20 - \frac{2}{3} \times (18.20 - 4.91) \times 15$
= 140.1 m3
Volume of gas = 0.6 525 = 315 m3 OR Volume of gas = 0.9 0.65 525 = 307.12 m3 Selecting the maximum two values.
Volume of CH4 = 0.65 × 315 = 204.75 m3. Calorific value = 8600×204.75 = 1.76 ×106 kcal.
Preferring High Rate Sludge Digester

V. RESULTS AND DISCUSSION

- Provide a Grit Chamber of size as 15m ×1m ×1.2m.
- Designing a rectangular Sedimentation Tank of size as 20 m × 10 m × 3 m.
- Providing 4 - RBC in series with 50% of submergence in water with clear spacing of 10 cm at 6 rpm.
- Provide Secondary Sedimentation Tank of 15 m diameter.
- Preferring High Rate Sludge Digester with volume of Sludge Digester as 140 m3.

VI. CONCLUSION

Mahanand Dairy plant currently uses Activated Sludge Process in which the sludge is to be recirculated and proper F/M ratio is to be maintained, thus providing to be hectic and costly. In this paper we have successfully designed various unit of the plant using Rotating Biological Contactor as a biological method to decompose the organic matter by bringing it in sufficient contact of air as RBC is an effective method for treating wastewater and which offers an alternative technology to conventional activated sludge process because of its ease to maintain and operate, having high process stability with less space requirement. RBC system proves to be economical as tertiary removal is not required.

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