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Feasibility Study of Zero Discharge Concept in Sugar Industry After Anaerobic Treatment: Case Study of Solapur

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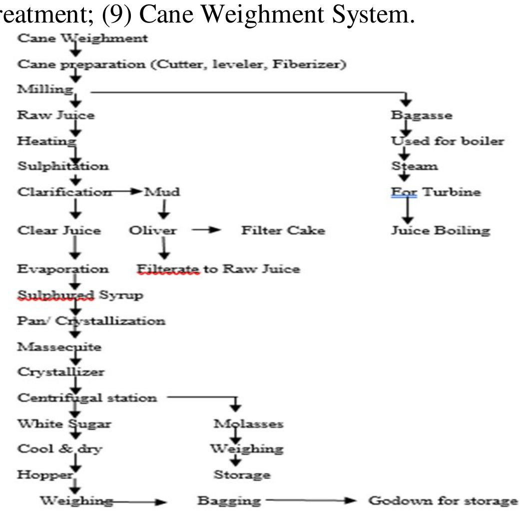
Abstract: Purification and reutilisation of waste water from different industries is a challenge for a smarter and healthier environment. An important role in Indian economy is played by an agro based industry segment which is nothing but sugar industry. But the effluent from the industry is a proven fact as a threat for environment. Effective waste water management can result in smart and healthy city environment. The treated colored effluent from the industry is not preferred for reuse and recycle, though the other BOD, COD, TDS, TSS, MPN are in permissible limit. Root zone technique is one of the important approaches for, as the process is economical, easy in operation and maintenance. Pilot plant is constructed and executed using a typical species. The intake of treated effluent and the final effluent from root zone technique were collected and tested for various contact hours. To accommodate the massive urbanization it can be used to find smarter ways to reduce expenses, manage complexities that's the treated waste water from industry can serve for following: 1) Gardening 2) Fire Fighting 3) Washing 4) Toilet Flushing etc. For a better and smart management of treated waste.
Keywords: Agro based industry, sugar industry, colored, root zone technique, species, contact hours.

I. INTRODUCTION

Today, numerous urban areas catch water from encompassing lakes, streams, or supplies, empty a large number of dollars into treating and transporting that water to homes and business, and afterward toss that water after a solitary utilization. In water scarce situations, this "expendable water" methodology is inefficient and dangerous. Over-extraction of surface and groundwater can diminish environment capacity, bring about area subsidence, and fuel clash. It additionally strains open spending plans, diverting stores into water supply extends that would be superfluous with more effective utilization of existing assets.

Vithalrao Shinde Sahakari Sakhar Karakahana Ltd. has initial installed cane crushing capacity of 2500 TCD. Sugar factory was established for manufacturing of crystal sugar by double sulphitation process from sugar cane juice and from 2001-02 cane crushing capacity up to 6000 TCD. Sugar factory shown tremendous enhancement for development in Financial & Educational, Upliftment, & overall progress in rural area. In Maharashtra, Vithalrao Shinde Sahakari Sakhar Karakahana has only the anaerobic digester i.e., (UASB Up flow Anaerobic Sludge Blanket) for treating the effluent. Sugar manufacturing process involves mainly nine stages as mentioned below(1) Cane weighing; (2) Cane handling and preparatory system; (3) Milling system; (4) Juice clarification system; (4) Evaporation; (5) Vacuum pan boiling and crystallization; (6) Curing, Drying, Grading, bagging and warehousing; (7) Final molasses storage; (8) Effluent to make treatment; (9) Cane Weighment System.



Vithalrao Shinde S. S. K. Ltd;
White Sugar Process flow chart

The main problem of associated with treated effluent after anaerobic treatment, It consist of methyl orange dye like color which becomes problem for the industry to recycle and reutilize the treated effluent in order to make zero discharge, as treated effluent analysis of BOD, COD, Solids, MPN are in permissible limit.
Sugar industry is operational for 120-200 days, during a year. The industrialist uses sugarcane stick as a crude item alongside with different substances added amid the procedure to increase the quantum of end produce. Amid the methodology the enormous measure of water is likewise utilized and the process thus utilizes more water and hence the waste water generated is more. The production of waste water from various processes is given in the table-1 below.

Table- 1: Waste water generation from each unit in a sugar industry.

Input	Unit house	Waste water generated
Sugar cane	Mill housing	Waste water from bearing house of mills, contains suspended solids and oil contents, washing of floors
Sugar juice	Process house (Juice heaters/ Evaporators/Condensers/ Crystallizers/ Rotary filters)	Washing of different components such as juice heaters / crystallizers evaporators and water circulation through condenser
Bagasse and furnace oil	Boiler house	Waste water of wet scrubbers / blow down of boiler/ fly ash particles

The influent that is generated from various processes of mill house contain layer of oily things. By using good quality of material and innovative technology consumption of water can grow lower. Sugarcane contains around 70-80 % dampness, therefore, abundance water must be arranged even if the water is reutilized. Every ton of stick smashed ought to deliver around 0.73 $m^3$of water in the event that generates sugar. Basically water is needed in the sugar processes as plant floor washing, cooling water for barometric condensers, heater sustained water, lime planning, for force pumps also, evaporators.
As per Indian industry measures, utilization of water differs from 1.3 to 4.36 m^3/day. Created water through the processes of which 20% of water is required. The sugar business with smashing limit of 5000 Tons every day obliges 10000 m^3/day of water. In the ratio of 1:2 waste water is generated by the sugar plant. The sugar business waste water is portrayed by its shading, temperature of water, low pH, slag, also, broke down natural and inorganic matter. Notwithstanding sugar factory convey the influent characteristics, for example, Biochemical Oxygen request, Chemical Oxygen request, oil and grease.

II. CONSTRUCTED WETLAND TYPES

These are the engineered waste water treatment systems filled with porous media and planted with emergent wetland plants. Depending on the wastewater flow, the CWs are divided into two types: surface flow (SF) or free water surface flow wetlands and sub-surface flow (SSF).The system is a proven fact for its low cost and sustenance.

A. *Surface Flow Constructed Wetlands*

A surface stream (SF) wetland is characterized by a shallow bowl (<1m), soil or other medium to bolster the foundations of plants and the water control structure for maintaining a shallow profundity of water (0.2-0.4 m). In this framework wastewater surface is over the substrate as indicated in Fig. 1. In SF CWs, the close surface layer is oxygen consuming whereas the more profound waters and substrate are generally anaerobic. Wetlands manufactured to treat mine seepage and agrarian overflow, are ordinarily SF wetlands. These frameworks are by and large utilized as a part of North America. The favorable circumstances of SF CWs are that their capital and working expenses is low. However they for the most part have a lower contaminant evacuation proficiency contrast with SSF. A wide assortment of submerged also, drifting plants have been utilized as a part of SF CWs e.g. Typha, Scirpus, Digitaria, Cyperus spp. and so, found there in.

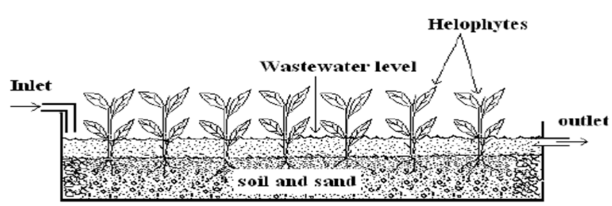


Fig. 1 Surface flow wetland

B. Subsurface Flow Constructed Wetlands

A subsurface stream (SSF) wetland comprises of a fixed bowl within which a permeable substrate of rock, rock and soil or mix of these is provided appropriately. The water level is intended to stay underneath the top of the substrate as show in Fig. 2. The wastewater is constrained into the dregs by gravity. SSF wetlands have most often been utilized to diminish biochemical oxygen request, substance oxygen interest, suspended solids, metals and supplements from residential and mechanical wastewaters. These frameworks are exceptionally main stream in Europe and South Africa. SSF CWs are further subdivided into two sorts: flat stream (HF) and vertical stream (VF), as per the stream bearing of wastewater. Also the mix of flat stream and vertical stream CWs has been utilized recently, named as half and half frameworks, for the wastewater treatment. These crossover frameworks act more productively to enhance wastewater quality. SSF CWs are more productive on an areal premise as contrast with SF frameworks. The plant species for the most part utilized as a part of SSF CWs incorporates regular reed (Phragmitis australis), cattail (Typha spps.), bulrush (schoenoplectus), Canna indica, Pseudacorus spps. And so forth, found therein.

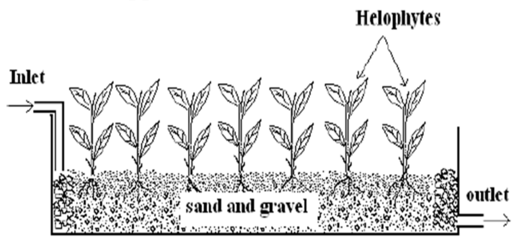


Fig. 2 Subsurface flow wetland

III. OBJECTIVE

The objectives of this research were to:

1) Analyze and characterize the treated effluent after anaerobic treatment from sugar industry i.e. (Vithalrao Shinde Sahakari Sakhar Karakahana);
2) Investigate the feasibility of applying a root zone system for the treatment of treated effluent of sugar industry.

This paper presents the results and behavior of a sub-surface vertical-flow constructed wetland used for treatment of color removal of treated effluent from sugar industry.

IV. METHODOLOGY

A. Experimental Setup

Vertical stream developed wetland is built at the pump place of Sinhgad College of Engineering, Pune. Two vertical baffle root zone system are constructed. One tray with bagasse and another without bagasse. The constructed wetland framework has canna hybrida species spotted at S.C.O.E. The built wetland model made up from plastic rectangular box with area 1083.86 cm^2 and volume of 19271 cm^3.PVC pipes for intake and outlet were installed with flow regulators. Water is percolated slowly through the bed layers with specified flow, detention period and then collected in the container.

B. Preparation of Bed

The developed wetland has a depth of 22.5 cm in which 4 cms are left on top for stacking the treated effluent. Subsequently about 18 cms are utilized to make the wetland bed out of which is 40 % was utilized to make the wetland (Soil & Plants) and the rest 60 % is utilized for substrate. Top layer comprised of the neighborhood soil. Before putting the soil in the bed, it is cleaned appropriately and is made, free from impurities. The mixture of soil and bagasse is put at the top. The soil media has a depth of 4 cm, underneath the soil layer sand of 0.50 mm set, and then the layer of aggregates with 4.50 cm depth is arranged. The centre layer is made of little stones 4.25 cm having a depth of 4.50 cm. The base of wetland unit is framed by gravel 5 cm having depth of 4.50 cm. Nine plants of canna hybrida species are planted in the soil at a depth of 5.30 cm. The treated effluent is held for a greatest period of 24 hr HRT. Inlet is given at a rate of 5 litre/day, 5 litre/12 hour, 5 litre/6 hour thus on. So as to load 5 litre of a sample collected. Tests are taken every day at an interim of 24 hour and results are tabulated.

V. RESULTS AND DISCUSSIONS

The analysis is carried out for a month through the built wetland. As BOD, COD, Solids, MPN of the effluent are basically within the limits, no further treatment is needed. But the issue is of color. Two built wetlands are constructed. One with soil and bagasse mixture, and other without bagasse. The perceptions from the developed wetland i.e. the wetland with soil and bagasse mixture demonstrated shading expulsion from orange to colorless. And the wetland without bagasse did not demonstrate that much result i.e. from orange to exceptionally light yellow. Likewise both the study built wetland plants of canna hybrida species gave a decent increment in height. The canna hybrida plant in developed wetland of soil and bagasse came about the plant stature from 10 cm to 45 cm and their number expanded from 25 to 45.While the canna hybrida plant in built wetland of soil i.e. without bagasse came about the plant tallness from 20 cm to 45 cm and the number expanded from 25 to 35.

The beneath table 2 shows concentration of various parameters of the treated effluent. The detention period for treatment of color evacuation of treated effluent taken 24 hours, 12 hours, 6 hours, and 4 hours respectively. The parameters BOD, COD, Solids, MPN after treatment of the treated gushing from the built wetland with bagasse and without bagasse did not exhibit specific change in the values of the BOD, COD, Solids and MPN as it was before in as far as in a permissible limit. The effluent treated in the bagasse developed wetland demonstrated a colossal result for 1 day detention period. The treated emanating shading like methyl orange color was changed to drab and the evacuation gave 90%.On the similar lines detainment of 12 hrs, 6 hrs, 4 hrs for the said effluent was observed and analysis for removal of color is carried out.

It is further watched that the wetland built with these plant species in vertical subsurface stream can be a superior alternative for color expulsion from the treated gushing. The canna hybrida species assume a key part, because of the oxygen dissemination from their roots which helps in supplement uptake and protection of the bed surface. It is additionally watched that increments in the detainment time build the percentage of color evacuation because of great water holding limit of neighbourhood soil. During winter, at the inlet, 5 lits of effluent added; which is found to reduce to a value 1 lit; whereas in summer season, at the inlet, 5 lits of effluent added; which is found to reduce to a value 0.5 lit. The colour expulsion from bagasse developed is very much satisfactory. On contrasting the present work and the above discoveries it can be said that built wetland for colour evacuation is a less expensive source when contrasted with different innovations i.e. activated carbon.

(1) (2)

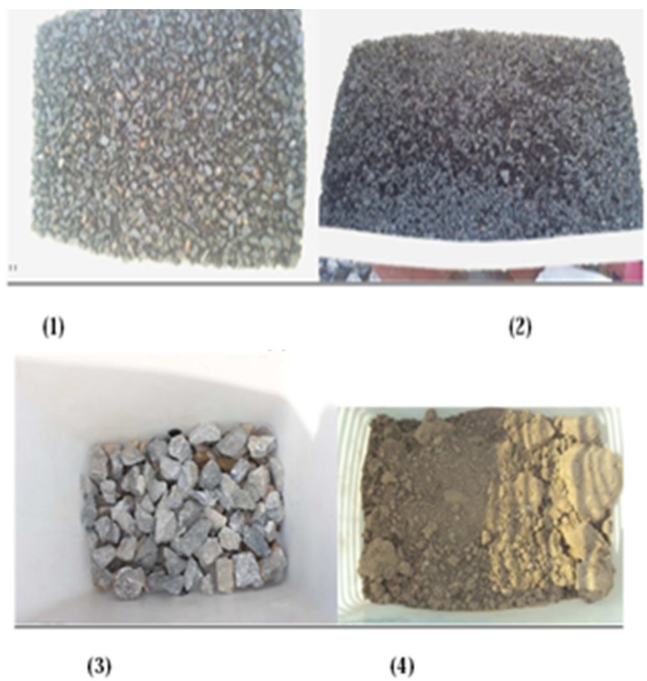


Figure 1: (1) Root zone system model.
(2) Canna hybrida species.
Blue tray: without bagasse.
Purple tray: with bagasse.

Figure 2: (1) First layer of model.
(2) Second layer of model.
(3) Third layer of model.
(4) Top layer of wetland soil.

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Table-2: Concentration of various physico chemical parameters of treated effluent before root zone system treatment.

Parameter	Dilution factor	With bagasse colour removal for 24 hours	With bagasse colour removal for 12 hours	With bagasse colour removal for 6 hours	With bagasse colour removal for 4 hours
COD	1:1	84	48	24	48
BOD	1:20	22	18	10	12
TDS		37.5	120.5	102.6	102.6
TSS		0.1	0.1	22.7	5.1
MPN		>2400	>2400	>2400	>2400

Figure 3: Raw sugarcane bagasse

Table-3: Concentration of various physico chemical parameters of treated effluent after root zone system with bagasse having detention period of 24 hrs, 12 hrs, 6 hrs, 4 hrs respectively.

Parameter	Dilution factor	Initial
COD	1:1	32.64
BOD	1:20	18
TDS		37.5
TSS		0.1
MPN		>2400

Figure 4: Colour removal sample after root zone system treatment.

Table-4: Concentration of various physico chemical parameters of treated effluent after root zone system without bagasse having detention period of 24 hrs, 12hrs, 6 hrs, 4 hrs respective

Parameter	Dilution factor	Without bagasse colour removal for 24 hours	Without bagasse colour removal for 12 hours	Without bagasse colour removal for 6 hours	Without bagasse colour removal for 4 hours
COD	1:10	160	200	80	80
BOD	1:20	10	15	20	22
TDS		102.6	12.49	37.5	12.48
TSS		22.7	1.6	0.1	1.5
MPN		>2400	>2400	>2400	>2400

VI. CONCLUSION

After rigorous experimentation and analysis, it can be concluded that canna hybrid species is a very effective species for color removal; for a series of detention period 24, 12, 6, 4 hours. However its effectivity is more when the treatment is carried out with bagasse which depicts the removal from orange to colorless for 24, 12, 6, 4 hours. Whereas in case when the treatment is carried out without bagasse the results depicts reduction in color from orange to pale yellow. Also the other parameters like BOD, COD, TDS, TSS, and MPN are within permissible limits. Among various water purification and recycling technologies, this process is a fast and inexpensive for better urbanization. Such type of colour removal technique are essential for effective reuse of waste water to urban or rural area. The reuse of water is more helpful to the region for residential and commercial use and also useful to good economic for city.

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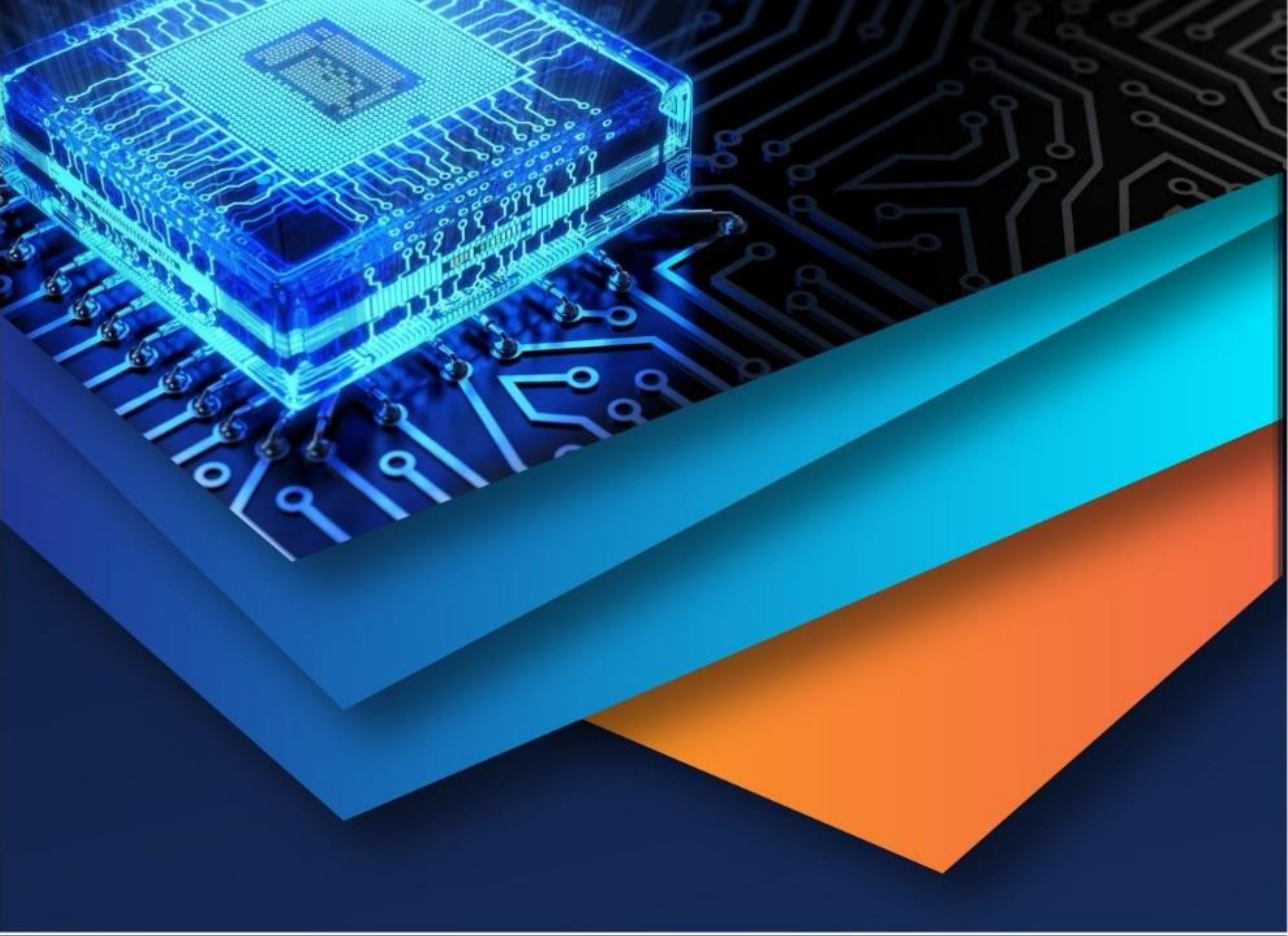

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