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CHALLENGES OF ZERO POLLUTION IN SUGAR INDUSTRY

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ABSTRACT

Sugar Industry is one of the major agro-based industries in India. Sugar Industry complex comprises of Sugar factory, Distillery, Liquor unit, Cogeneration and other bagasse based industries. Generally such units are located in rural area and are surrounded by agricultural fields. It is necessary to safeguard the soil and water and air quality of the region to protect agricultural productivity and health of workers and local population. The industry should take all necessary steps to prevent environmental pollution. Challenge of achieving zero pollution in Sugar Industry complex can be met if water conservation, waste minimization, recycling of wastes and by product recovery systems are planned and implemented scientifically.

Key Words: Coagulation, press mud, sulphitation, zero pollution and by-product recovery

INTRODUCTION

Sugar is usually manufactured by cutting the sugarcane into pieces and crushed in a series of rollers to extract the juice, in a mill house. The milk of lime and sulfur dioxide gas is then added to the juice and after heating all the colloidal and suspended impurities are coagulated; much of the color is also removed during this treatment. The coagulated juice is then clarified to remove the suspended solids in the form of sludge. This sludge is then further filtered through a filter press and then disposed off as a solid waste i. e. press mud. Color of the juice is completely bleached out in this process. The clarified juice is then heated and concentrated in evaporators and vacuum pans. The partially crystallized syrupknown as massecuite, is then transferred to the crystallizers where completely crystallization of sugar occurs. The fresh effluent from the sugar mill decomposes rapidly after a few hours of stagnation. The rapid depletion of oxygen due to biological oxidation followed by anaerobic stabilization of the waste causes a secondary pollution of offensive odor, black color and fish mortality in the water body in which the waste is disposed off.

MATERIAL METHODS

Rain water harvesting: Rain water is a precious water resource as it is freely available and water quality is good with minimum total dissolved salts. Sugar factory complex has a large area and must provide adequate arrangements for collecting all rain water from the factory premises and store it for utilization in process. The total amount of collectable rainwater can be easily calculated by determining area and runoff computations.

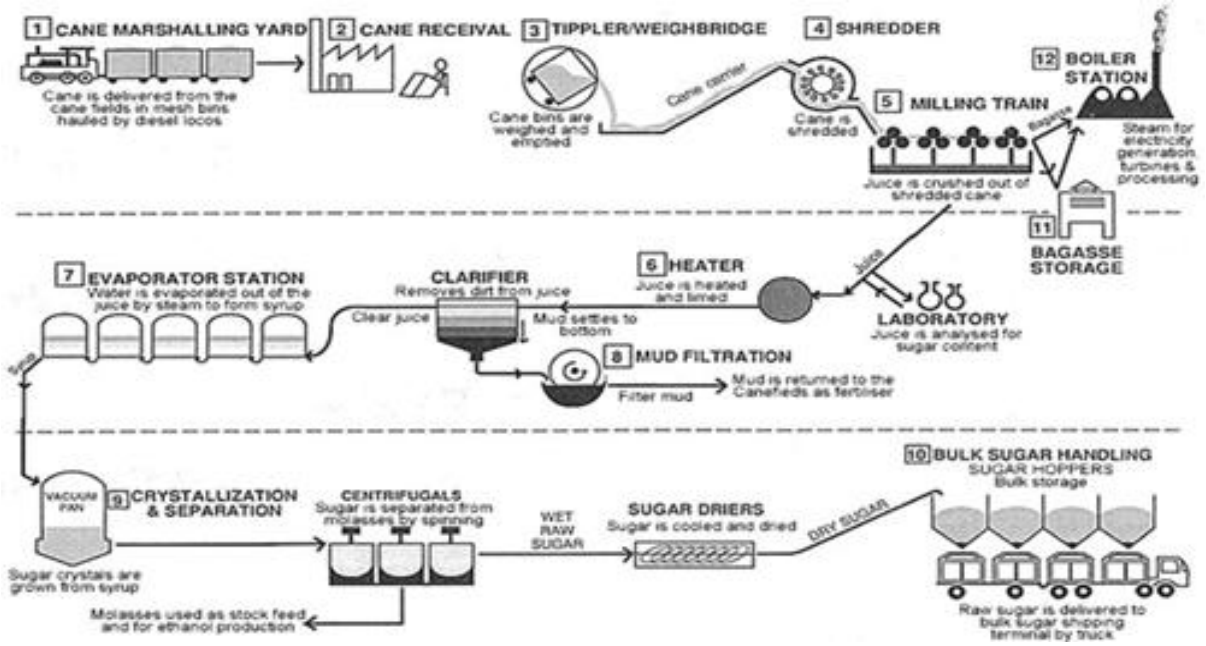

Fig. No. 1 Flow diagram showing the manufacturing process of sugar

If a sugar industry complex has 50 hectares of land where 20,000 sq m is the area of the main building, Godowns, Housing colony with proper rainwater harvesting system (runoff coefficient 0.9) and impervious roads are 30,000 sq m with side gutters (runoff coefficient 0.7) and open area is around 45 hectares (runoff coefficient 0.5), the reservoir capacity can be calculated as below.

Assuming the rainfall in the area as 100 cm per year.

1. Runoff contributed from buildings - 20,000 x 0.90 x 100/100 = 18,000 cum.
2. Runoff contributed from roads - 30,000 x 0.70 x 100/100 = 21,000 cum.
3. Runoff contributed from area - 45,000 x 0.50 x 100/100 = 22,250 cum.

Total 18,000+ 21,000+ 22250 = 61,250 cum.

Say 60,000 cum.

If all the water can be collected at one point, impervious pond of 60,000 cum capacity (150m x 200m average size x 2m depth) can be constructed for this purpose. Alternatively the water can be allowed to percolate to improve the ground water table.

The stored water can be reused for manufacturing process during the crushing season, by installing pumps and a distributaries network. In fact, the same storage tank can be used also to collect excess condensate and other recycling water. If groundwater table is recharged, the yield of the wells would substantially increase and can meet the additional demand of water during the crushing season.

Minimizing water requirement in sugar industry: Sugar cane contains 85% of water and during the process of sugar manufacturing major portion of this water is converted to vapor condensate and can be reused by providing proper interception and collection. This would reduce the external water requirement. Minimizing water consumption in sugar industry shall automatically reduce the waste water generation.

Table No. 1 Water conservation techniques

Sr. No.	Station	Option Suggested
1	Milling Plant	Use fully hot condensate instead of fresh water supplement.
2	Boiler feed water	Overflow of all condensate from the vapor cells, first body evaporator and condensate pan shall be connected to a small storage tank instead of allowing to over flow into the gutters.
3	Clarification House a) Compressors b) Sulfur Burner	a)Recirculation the cooling waters b) Use treated effluent water for cooling purpose and connects it to spray pond to reduce the temperature.
4	Oliver Filter	Instead of using fresh water spray pond water may be used to create vacuum at vacuum pump and barometric condensers.
5	Boiling & Centrifuge Section	Instead of allowing fresh water to go to spray pond after cooling at vertical crystallizes and massecuite allow it to go to service tank
6	Preparation of seed and mixtures	Use hot water instead of fresh water
7	Cooling waters	Mill drive, mill bearing, power house turbines, fiberisers, compressor, cooling waters and vertical crystallizers
8	Tap connections	Keep bear minimum
9	Excess condensate	Mini cooling tower

Water recycling in the process: If the following practices are followed, it is possible to eliminate the entire process water requirements in a Sugar Industry.

1. Analyze all Cooling Waters, Condensates, Spray pond overflow regularly.
2. Use only Hot Condensates for Mill Imbibitions and Mill Sanitation.
3. Operate the ETP efficiently and use this water as Cooling Water for Wet-Scrubbers, Spray pond Make-up Water and Sulphur Burner Cooling System etc.
4. At Oliver Filters, water is required to create vacuum for pumps and Barometric Condensers. Spray pond Overflow is being used for this purpose instead of fresh water.
5. Vertical Crystallizer and compressor cooling waters may be directly connected to service Water Reservoir.
6. Provide limited water taps at different sections for washing purpose and provide storage tanks for drinking purpose.
7. Maintain Spray pond Water Quality so that it can be reused continuously. Similarly, maintain the quality of Condensates by avoiding entrainment.

In case, some of the streams are found to be contaminated which is mainly due to entrainment, it can be treated by simple techniques such as pH correction by adding lime, sand filtration or passing through activated charcoal. The other major contaminant is high temperature of condensates which is required to be reduced. It can be achieved either by providing a cooling tower or connecting to a storage pond.

Table No. 2 Waste minimization options

Sr. No.	Station	Pollution Source	Preventive Action	Recycle & reuse
1	Cane Yard	Cane Trash & Dung	Collect as early as possible	Compost
2	Bagasse Storage Yard	Bagasse	Collect at the end of the season	Compost
3	Milling Section	Oil & Grease	Collect in trays & store in drums	Sell as low grade lubricants or burn in boilers after mixing with bagasse
		Floor washings	Adopt dry cleaning, Give proper slope to floors	--------
		Leakages & Spillovers	Use mechanical seals for all pump glands	Collect leakages & spillages in a pit and recycle into process
		Cooling Waters	Collect desuperheater & mill bearing cooling water	Recycle
4	Cane carrier	Bagasse	Use closed transfer system	Cover the drains so that bagasse do not enter into drains
5	Sulfur Burner	SO_2	Operate scrubber efficiently	Provide mask to operators
6	Lime Station	Lime Solution	Provide proper slope to the drain	Allow it to mix with the effluent
7	Clarification and vacuum filters	Leakages from pumps, glands & pipe overflow	Install overflow alarms & provide mechanical seal	Recycle cooling water
8	Boiler house	Boiler Blow down	Maintain Boiler condition & also feed water quality	Use it for irrigation along with other effluents
		Stack Emissions	Adjust air fuel ratio, Check APC performance	Fly ash can be used as soil conditioner/ Brick Mfg/ composting
9	Crystallizer & Pan Boiling	Leakages from pumps, Spillovers	provide mechanical seal, Recycle all cooling water, avoid overloading of equipments	Recycle cooling water, collect spillages & recycle in the process
10	Evaporator & juice heating	Sugar Entrainment	Provide additional external catchers for the last body evaporators & all	Recycle water if there is no entrainment and incase there is, and then use it for irrigation.

			vacuum pans, use poly baffle stainless steel instead of umbrella type save-all, pump gland shall be provide with mechanical seal to prevent leakages	
11	Cleanings of vessels, boilers and laboratory washings	High BOD & COD, Chemicals as NaOH, SulphamicAcid, Lead	Recycle NaOH for next cleaning, Provide standby units to have continuous operations, Store the effluent in a holding tank to avoid shock loads on ETP	Controlled loading in ETP from a storage tank. Segregate laboratory effluents and join to storage tank
12	Press mud	Soil Conditioner	Immediate Disposal	Use as a filler material in Composting
13	Molasses	Bye Product	Use only steel tanks	Provide mixing & cooling arrangements to avoid auto combustion
14	Fugitive emission	Sugar Dust, SO_2	Dust collectors, Scrubber	Recycle
15	Vibrating & Heavy Machinery	Sound	Use silencer pads & closed rooms	Provide earplugs & earmuffs to workers and also change the work environment frequently
16	Bagasse	Dust & Fire	Provide proper ventilation for storage and also stand posts in case of fire	Store it far away from the industry

RESULT AND DISCUSSION

Spent wash resulting from distillery is high in organic contents and can be mixed with sugar factory press mud and converted to compost bagasse cilo and boiler ash as filler materials. Biogas recovery is other alternative where the effluent needs further aerobic treatment and costly RO system for removal of dissolved salts.

Adequate measures should be taken to remove particulates from stack gases by installing ventury scrubbers and the collected ash can be used as filler in compost.

1. If Rainwater is harvested and stored for reuse, the additional water requirements of Sugar Industry during the season and off season can be met.
2. By adopting recycling and reuse techniques within the Industry more than ninety percent of water requirement can be met.
3. By adopting waste minimization techniques along with water conservation, sugar industry complex can achieve zero pollution level, would be self sufficient in water requirements and can produce valuable byproducts.

Table No. 3 Wastewater generations from 4000 tones per day sugar factory

Sr. No.	Sources	Quantity (m3 / day)
1	Mill bearings (Ex-cooling)	160
2	Hot liquor pumps gland – cooling	240
3	Daily cleaning and washing	160
4	Laboratory Use	9.6
5	Domestic	144
6	Spray condensate	163
7	Excess condensate	320
8	Boiler blow-down	120
9	Periodical cleaning	120
10	Leakage's and steam trap	160
11	**Total**	**1696 i. e. 1700**

Table No. 4 Sugar factory raw effluent

Sr. No.	Parameter	Value
1	pH	5.5 to 6.3
2	Sulfates	800 mg/ l
3	Chlorides	300 mg / l
4	D. O.	1 to 2 mg / l
5	Oil & grease	25 mg / l
6	BOD	1000 to 1500 mg / l
7	COD	2500 to 3500 mg / l
8	Total solids	7000 mg / l
9	Total dissolve solids	5500 mg / l

CONCLUSION

The salient observations made in the present study can be summarized as follows:

1. Waste generated during cleaning can be stored and by using proportioning it can be released in the ETP. It is noted that this waste is comparatively stronger to other waste streams in sugar industry.
2. Cleaning should be carried out daily or as frequently as possible because this will help to reduce the quantity of waste.
3. Recirculation and recycle of water which is less contaminated in the production process is going to reduce the total quantity of waste water
4. It is observed during the study that the leakages of water and spill out of oil & grease and other chemicals give rise to generation of wastewater; therefore this should be avoided as far as possible.
5. Best option for treatment of sugar distillery complex is waste minimization in sugar industry followed by activated sludge process and final disposal of treated effluent by irrigation.

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