

Wastewater Management in a Sugar Factory

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Abstract:- Sugar industry is one of the major and the oldest industry in India. It plays a very important role in the country's economy. Sugar industries are generally located in U. P., Bihar, Maharashtra, Punjab, Andhra and Tamilnadu states in India. India stands second in terms of sugar production in world. Considering the wide spread region of the industry and its rapid growth and significance, the wastewater of industry needs due considerations. Sugar industry wastewater is basically a readily biodegradable organic wastewater. The wastewater of sugar industry contains high BOD, nearly natural pH, high biodegradability, nutrient deficiency and sulfates. All type of biological treatment are found to be successful, but the seasonal nature of the industry is a major drawback against the feasibility of biological treatment. The broad objective of the present work is to study the environmental performance of a sugar factory and to suggest improvements in the same.

Key Words:- Bagasse, Molasses, Anaerobic lagoons, UASB.

I-Introduction:-

Sugar industry is one of the most important food processing industries of the world. Generally beet and sugar canes are used as a raw material for the manufacturing of sugar, all over the world. But in India, sugarcane is the sole raw material for this. Sugar is produced in 120 countries. Global production now at around 180 million tons a year. Approximately 80% is produced from sugar cane, which is largely grown in tropical countries. The remaining 20% is produced from sugar beet, which is grown mostly in the temperate zones of the northern hemisphere. 70 countries produce sugar from sugar cane, 40 from sugar beet, and 10 from both. The 10 largest sugar producing nations represent roughly 75% of world sugar production. Brazil alone accounts for almost 25% of world production.

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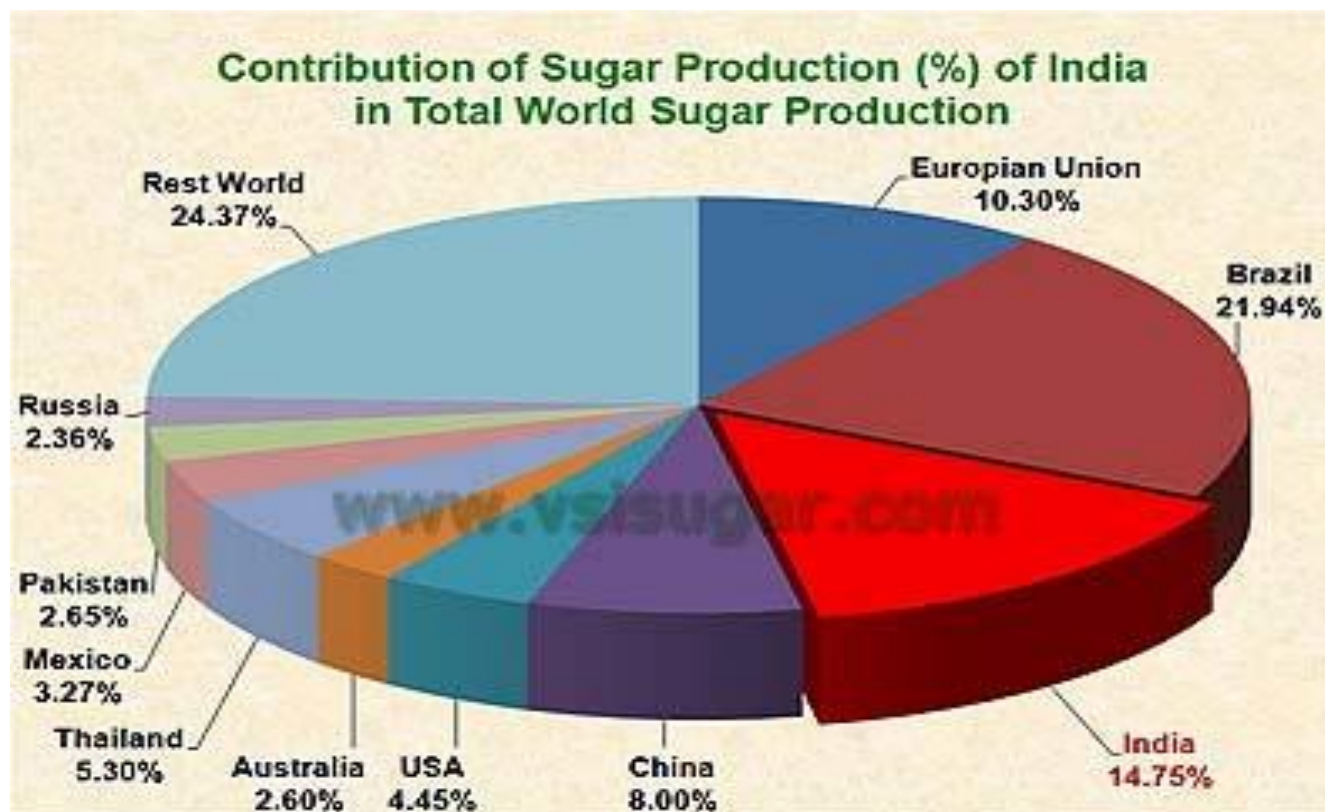


Fig.No-01 Total world sugar production in %

Table 1.Sugar industry in India at a glance.

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
No. of factories in operation	490	507	529	526	509	538	526
Cane acreage in 1000 hectares	4175	4885	5100	5279	5341	5307	5284
Sugar cane production in lakh tones	2923	3424	3538	3544	3456	3668	3369
Molasses production in 1000 tonnes	8400	10970	11824	11744	10882	12482	10837

Considering the wide spread region of the industry and its rapid growth and significance, the wastewater of industry needs due considerations. Sugar industry wastewater is basically a readily biodegradable organic wastewater. Indian standard code (ISO 4903-1968) came into existence in 1968, which gives basic information regarding the characteristic of sugar industry wastewater and recommended treatment alternatives for Indian conditions. However

efforts are always for a better technology for higher reliance and more economy. In general, the wastewater of sugar industry contain high BOD, nearly natural pH, high biodegradability, nutrient deficiency and sulfates. All type of biological treatment are found to be successful, but the seasonal nature of the industry is a major drawback against the feasibility of biological treatment. Physiochemical treatment will be inadequate but can be used as roughing unit. Very commonly anaerobic lagoons followed by oxidation ponds are used as a successful treatment for this industry's wastewater. A lot of scope for recirculation and reuse is always there not only for byproduct and wastewater, but for solid wastes also.

II-Objectives:-

- 1.Characterization of influent wastewater samples,
2. Characterization of effluent wastewater samples
3. Characterization of the sludge of the industry
4. To determine the efficiency of treatment plant
5. To verify the design of various components of treatment plant.
6. To propose possible amendments and modifications in the design of wastewater treatment plant.
7. To study the house keeping and energy efficiency of the industry.

III. Case Study

The name of the industry under study is "MADHUKAR SAHAKARI SAKHAR KARKHANA, FAIZPUR". It is situated at village Nhavi, five km from Faizpur, in YawalTaluka, DistJalgaon in Maharashtra State. The Industry works from the month of October to June. It is the period when the sugar cane is available from, fields. The industry runs in 3 shifts for 24 hours. There are about 1000 workers working in the Industry in three shifts. Out of which 500 are permanent and remaining 500 are seasonal workers. The industry uses about 2500 Metric Ton of sugarcane per day. The industry comes in a co-operative sector and the Chairman of factory is Mr J.T. Mahajan. Industry produces approximately 256031 quintal of sugar in one season. Industry uses about 3 lakh liters of water per day. Hatnur canal coming from Girna Dam situated nearby is the major source of water for the industry. But the canal contains water only during the periods of irrigation. Hence the industry lifts excess of water from the canal and stores it in a large open water reservoir, which serves the purpose of recreation also. Whenever required the water is also obtained from tube wells located in the premises of industry. The House keeping of Industry is observed to be reasonable good. However there seems to be still scope for improvement in the house keeping of the industry. At some places the floors are unlined. It reduces the aesthetic appearance. At some places the solid wastes including bagasse and bags etc. is also lying here and there in the premises. The solid waste management system needs to be upgraded. Some of the machines do not give an overall feature of cleanliness, soundness and perfection, which makes the ergonomics poor. It is recommended to increase cleanliness of the machines. The sugar cane which is coming from fields is being used for

crushing directly without washing and cleaning. The unhygienic conditions are also observed in the canteen of industry. The industry has not been successful in developing the site also. While there is a scope to develop greenery all around as the land and water both.

Form the Case Study, following points are concluded regarding sugar industry wastewater:

1. Sugar wastewater is an area that has been adequately explored by researchers. Literature available for the characteristics and possible treatment of sugar industry is in abundance..
2. The characteristics of sugar wastewater are very much fluctuating depending upon the size of industry, housekeeping, recirculation, process technology etc. The IS code 4903-1979 has given average characteristics of sugar industry's wastewater most common for Indian conditions.
3. In sugar industry there is a large scope for recirculation and reuse of water. .
4. The byproduct molasses is an input raw material for Distillery industry, which otherwise is a potential pollution.
5. The wastewater is highly organic in nature.
6. The treatment to be employed is biological. All types of biological treatment are successful because of high biodegradability.
7. The most critical problem associated with the biological treatment of this water is the seasonal nature of industry.
8. Anaerobic treatment of sugar waste by various methods like UASB etc are coming up now a days due to their economy.
8. Physico-chemical treatment methods of wastewater treatment are also getting popularity now a day.
9. Sugar industry has lot of potential for energy generation. The bagasse produced during the process can be used for electricity generation. The generation is in excess of requirement of the industry.

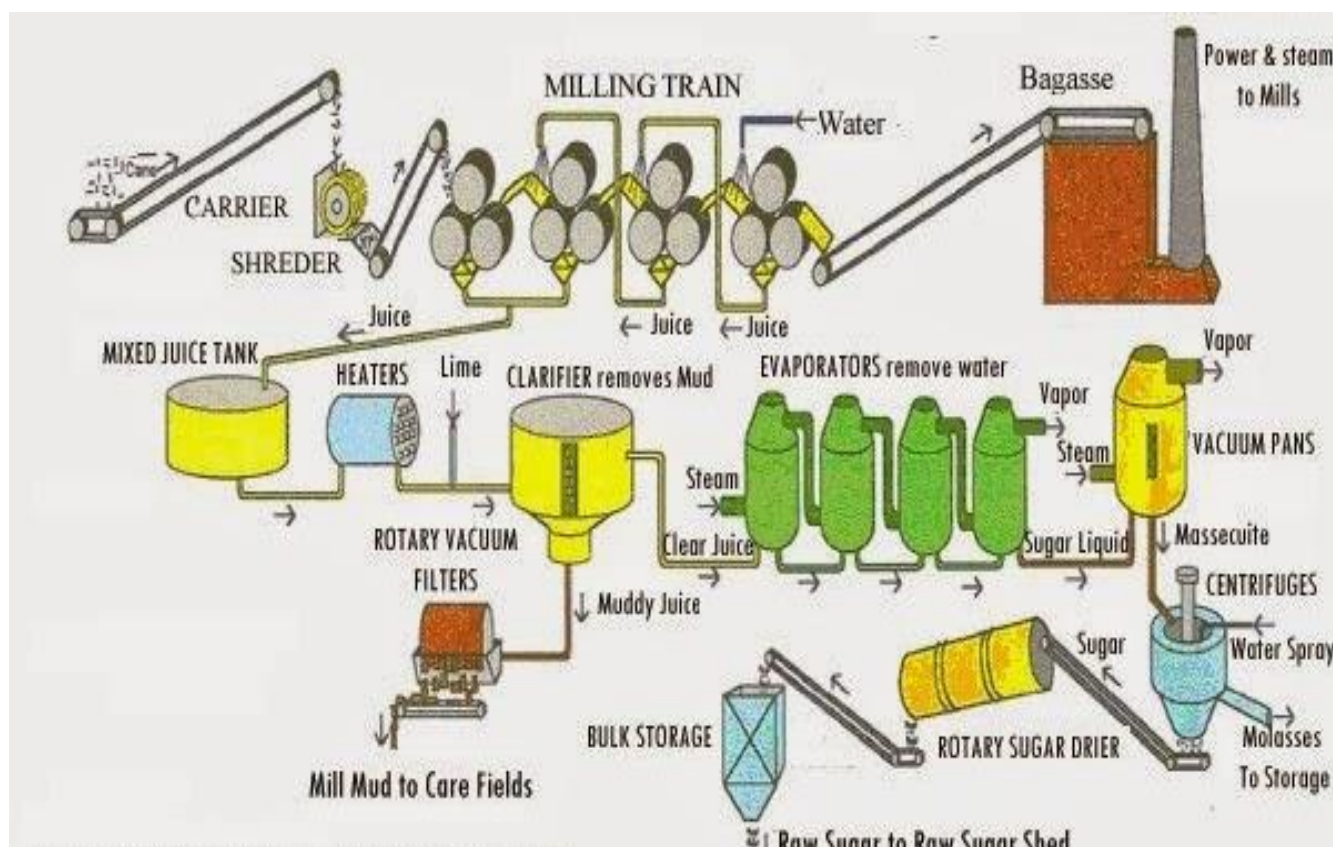


Fig.No-02 Typical Flow Diagram of Sugar Factory.

IV.Sources, volume and character of effluents.

The quantity of water used in different factories varies widely. When plentiful supply of water is available, and this is true for most of the sugar mills, the consumption varies from 1300 to 4360 liter per ton of cane crushed per day. Large amount of water is used for extraction of juice from cane and cooling the bearings of the mill tandems. This cooling water picks up grease and oils from the bearing as well as large in volume and has high BOD in the range of 120 to 300 mg/lit. are discharged per tone of cane crushed. The sludge from the clarifier after the carbonation and sulphitation process is often filtered in filter processes. The filter cakes are disposed of as solid waste. The filter cloths are washed periodically and the washings are discharged intermittently. This effluent contains large concentration of suspended solids BOD.

The effluent from boiling houses results from leakage from pumps, evaporators, crystallizers and especially from centrifuges together with periodic washing of floor. Although the discharge is intermittent which is not large in volume, it represents the most polluting fraction of the sugar effluents because of its extremely high BOD. The effluent contains high concentration of sugars which are responsible for exerting high BOD. The water from the barometric condensers of evaporators and vacuum pan is very high in volume and continuous in flow, and is cooled in spray pond or completely in the process, depending upon the quantity of fresh water supply available in a factory in most cases a sizeable volume of this water flows from the cooling ponds or towers and mixes with the other effluents discharged from the factory. If the evaporator and vacuum pans are not overloaded and the properly loss of sugar with

the water through environment of boiling sugar juice is in significant. The BOD of this waste water is normally quite low and does not add significantly to the pollution load.

Improper handling of molasses and leakage and overflow molasses carriage tanks may seriously increase the pollution load of the sugar factory effluents. The wastewater from boiler blow-off is of intermittent nature, but contains relatively high solids and alkalinity and low BOD. The volume of different types of wastewater produced in sugar factory are shown in table 2 These figures represent the average of wide range which is made during a survey carried out in the sugar factories in U.P and Bihar, and are indicative of the proportion of different of types of effluents.

Table: 2.Volume of different types of effluents from sugar factories

Sr.No.	Sources of effluent	Average quantity (lit/day/tonne cane)
1	Mill house	730
2	Boiling house and Floor washing	230
3	Filter cloth washing	360
4	Condenser water	1640

Table: 3. Characteristics of dried sludge sample

SN	Nitrogen content	Phosphorous content	Potassium content
1	10% by weight	5.5% by weight	1% by weight
2	10.8% by weight	5.3% by weight	1.2% by weight
3	10.2% by weight	4.8% by weight	1.1% by weight

Table 4. Average characteristics of sugar factory effluents.

Sr. No	Sources of effluent	pH	T.S (mg/L)	S.S (mg/L)	BOD AT 20° C(mg/L)
1	Mill house	6.7	1760	910	210

2	Filter cloth	9.5	6970	4000	1765
	Washing				
3	Boiling house	7.2	5130	120	5150

The final effluent from a sugar mill, as it leaves the premises does not appear to be bad because of its relatively clear appearance. The organic pollutants present in the effluent remain in solution being mainly sugar and others, when it remains stagnant in an area for few hours, biological action starts and anaerobic condition results in production of hydrogen sulfide gas, important black color to the effluent. If the effluent is discharged in small stream its oxygen reserve is rapidly exhausted, resulting in the dead of fish and other aquatic life.

When sugar industry waste water is discharged in to any waste body, it becomes a problem in following ways

1. Immediate fall of D.O. because of high oxygen absorption value of waste water and also because of high BOD and high biodegradability.
2. All subsequently problem like anaerobic conditions, odor, color etc. appear.
3. Death of aqua-culture. When it is discharged on land, again high B.O.D exceeds the permissible limit of land disposed, leading to the odor problems, mosquito breeding, unsightly appearance etc.

Therefore, treatment, prior to the disposal is must. However, after treatment, it may become good irrigation water.

V.Treatment methods recommended for adoption in India:

IS code 4903 1979, National Environmental Engineering Research Institute Nagpur and Central Pollution Control Board has recommended reviewing the conventional and unconventional methods of treatment of cane sugar effluents as applicable in this country, it would appear that where land is available treatment of the effluent in stabilization ponds would be most simple and economical. The effluent to be treated in two stages, the first stage being primarily anaerobic digestion in open deep pond and the second stage being aerobic oxidation in open shallow pond. The first stage may also be pre collection equalization of the flow and characteristic of the effluents in a pond having detention period of one day. The anaerobic pond may have a liquid depth of not less than 2.0 m and a detention period of six days. At an organic loading of BOD in the range of 0.24 to 0.32 kg/m³ per day. In the anaerobic pond, the reduction in BOD may reach order of 60%. The effluent from this pond can purified further from this pond can purified further in an aerobic oxidation pond having a liquid depth preferably of less than 1.2 m and a detention period varying from 10 to 20 days. A BOD loading of 4750 kg/m³ per day applied in the oxidation pond. The BOD removal by the oxidation pond may the exceed 70%. The overall reduction in BOD in the treatment plant of the order of 30% or more. The final effluent will have a BOD between 60 to 100mg/l.

Incorporation of a suitable algae culture tank for acclimatizing it to the effluent and dosing algae continuously to the oxidation pond and planting acclimated clarify the wastewater are useful in successful operation of the oxidation bond.

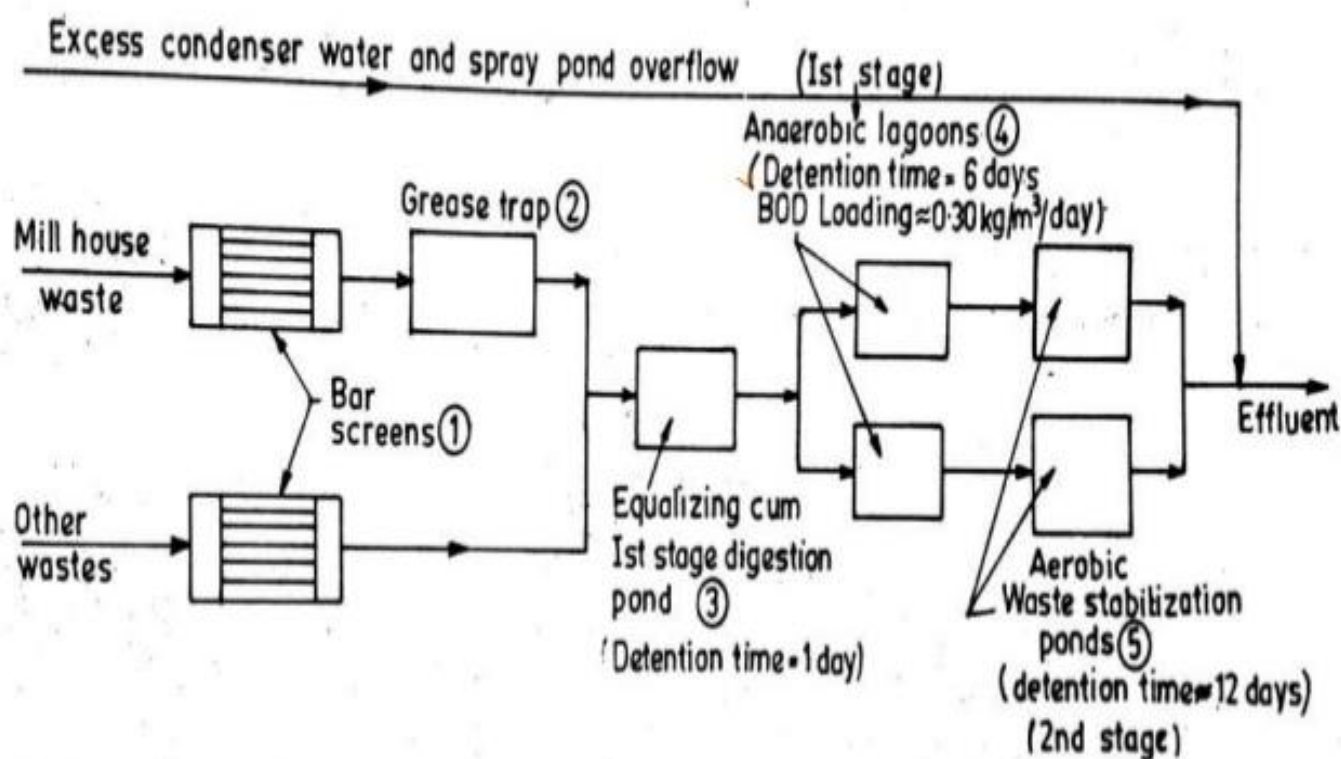


Fig.No-03 Flow Diagram for treating waste water of Sugar mill.

VI. Disposal of molasses.

The problem of disposal of molasses is equally important and needs attention has been given to its disposal in view of the hazards poses with its discharge into streams. It has been roughly estimated that the sugar mills annually produce molasses which is more than the quantity of molasses required in all the distilleries in the country. Certain percentage of this excess molasses is used for purpose other than alcohol manufacture, but it is insignificant compared to the quantity of molasses that has no consumer. This surplus molasses obviously finds its way into land and water courses at the end of the season.

Molasses is rich in potash and nitrogen and therefore, it could best utilized as a fertilizer in several ways. Composting of spent wash from digester, dry wash bio mass, digested over six application of 74 tones/hectare of the compost gave excellent finding in potash deficient soil. The surplus molasses can also be used in place of spent wash for successful composting. The mixing of molasses in water cake was reported to have been used successfully as fertilizer. Where composting is not possible, manufacture of bagasse Spent molasses can be burnt in a furnace and the ash can be used as fertilizer.

Table 5.A comparative summary of effluent characteristics for different treatment plants.

Parameter	Activated sludge process	Extended aeration	Aerated lagoon	UASB followed by oxidation pond	UASB
pH	7-7.5	7-7.5	7-7.5	7-7.5	7-7.5
Suspended solids	30	30	150	30	50
BOD	50	20	200	20	100
COD	200-250	<100	400	<100	>200
Oil and grease	<5	<5	<5	<5	<5

Energy-employment generation in sugar industries.

In general industries are consumers of energy. But sugar industries have tremendous potential for energy generation. In fact sugar industries are zero emission industries. They do not have any liquid or solid waste generated. Each and every by-product of the industry has scope of re-use in various ways. The molasses generated by the sugar industry is the starting material for distillery industry. The bagasse produced by the sugar industry is starting material for paper industry. Apart from this the bagasse each generally used as a fuel to run generators in the sugar industries to generate electricity. The molasses is a major by product of this industry. This is the starting material for distillery industry. The distillery industry itself is a major revenue generating industrial sector of India. The bagasse's is used by paper industry. This is also a major industrial sector of our country. Thus cane sugar industry is a mother of two other major industries in the country, it has no waste product and it generates additional electricity that is sold to the state electricity boards.

VII-Conclusion

The treatment being given to the wastewater presently is a conventional biological treatment, as suggested by IS codes. However, advance treatment techniques like UASB, fluidized bed bio reactor etc. can be tried at laboratory scale. The feasibility of the wastewater to be used as irrigation water needs to be investigated. In general, industry is needs improvement in terms of house-keeping, maintenance, etc. The industry is quite efficient for byproduct recoveries. Its by-product molasses is being used by a distillery industry located nearby. Its bagasse is being used for indigenous electricity generation. The cooling wastewater is being re-used and there by water conservation principle is being followed. The treated effluent is being used for developing greenery all around. The sludge is being to the nearby farmers for using as manure.

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