Total water management, operation and maintenance, troubleshooting of ETP in sugar industry

Harush D P¹ and Hampannavar U S²
1- Process Engineer @ Gharpure Engineering and Construction Pvt Ltd (Tatva Group Company), Pune.
2- Principal and Director, Maratha Mandal Engineering College, Belgaum -09.
harush.24u@gmail.com
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ABSTRACT

Sugar is one of major product in India. Water management in the industry is one of major problem. Due to this there is lots of effluent generated to effluent treatment plant and thus efficiency getting reduced for the treatment to be achieved. Industry can be well maintained if proper water management activities can practice and applied in the required area. Recycling of condensate, segregation of high strength and low strength effluent, proper operation of ETP (Effluent Treatment Plant), etc leads to a well maintained water managements in the industry and leads to reduction of cost on water. Well Operated and maintained ETP will not have any problem and can achieve the prescribed norms by statutory board. The Paper is completely prepared based on my personal experience as consultant in sugar industry and by review of few of related articles.

Keywords: Water management, Operation and Maintenance, ETP trouble shootings, Sugar industry ETP, Effluent treatment.

1. Introduction

Sugar production in India has been cyclic in nature. An estimated 75 per cent of the population depends on the sector either directly or indirectly. Sugar industry is also expected to develop further, thereby offering more employment opportunities to a number of semi-skilled and skilled workers in the rural areas of the country thereby contributing towards their development. The sugar industry also supports diversified ancillary activities and skills that support the local economy. The dependent population creates substantial demand for local goods and services. The sector also has major social and economic impact on the nation as it is a green industry and is largely self-sufficient in energy needs through utilization of bagasse for generating electricity and steam. In fact, the sugar industry generates surplus exportable energy through cogeneration and contributes to reducing the energy deficit that India is currently facing. Sugar cane is grown in semi-tropical region and accounts for around two-third of world sugar production. Since sugar cane is used as the input for the manufacture of sugar, sugar industry is getting large production from sugar cane growing states in India namely Andhra Pradesh, Tamil Nadu, Gujarat Karnataka, Maharashatra and Uttar Pradesh.

2. Statement of Problem

Present sugar industries are facing lots of challenges and problems in total water management in the industries which is leading them face legal actions from statutory board. Increase in production capacity, variation of cost of sugar tax and duty on production and availability of
source of water and cane and its transportation has lead to have a serious look to address the issues pertaining to water management in many of the sugar industries.

2.1 Process involved in sugar manufacturing process

Sugar is manufactured in following stages:
1. Extraction of juice from sugarcane milling.
2. Clarification of juice.
3. Concentration of juice by evaporation to syrup.
4. Crystallization of sucrose by vacuum pan distillation.
5. Centrifugal separation of sugar & molasses from the massecuites.
6. Drying & cooling of sugar.
7. Sugar grading & packing.

2.2 Sources of wastewater

1. Mill House: Gland cooling & occasional floor washings that bring along high concentration of oil & grease.
2. Boiler House: Boiler blow-downs, it is, more or less, clean water but has high TDS & phosphates.
3. Condensates: Vapor from last effect evaporators and pan boiling are cooled in condensers & condensate goes to tank for reuse. Overloading or poor operating conditions leads to overflow or loss of sugar in condensates through entrainments.
4. Occasional Spills & Leakages: This is usually because of process disturbances.
5. Process Cleaning: Evaporators, juice heaters, pans etc, are cleaned once in a month for scale removal. Caustic soda washings are stored for reuse, but one-time use may lead to discharge of chemicals in drain.

2.3 Critical Issues of Handling, Conveyance, Storage of effluents, Electro-mechanical equipments

1. Excess wastewater is generated from factory and needs to be seriously dealt with respect to conservation of fresh water, reduce, reuse & recycle of condensates, washings, process leakages etc.,
2. Due to leakages and uncontrolled use of water for floor, plant & also domestic washings, discharge of excess condensates, the quantity of effluent will be exceeding the capacity of the existing ETP resulting in reduction of HRT and limiting its performance.
3. Since the sugar mills are expanding their crushing capacity, there shall be increase in the strength & also usage of water for industrial as well as domestic purposes. Hence there will an absolute requirement of upgradation & modernization of existing ETP or to construct new ETP to meet the requirements of expansion.
4. Reuse of water is not practiced in shop-floor of the mill & boiling house I almost all the industries. Hence a proper water conservation & management plan has to be adopted & implemented in the entire sugar mill to reuse the spilled, leaked, overflowed process juices & repumped to juice stations that would considerably avoid shock discharge of high strength effluents to ETP and also increase the recovery of the sugar.
5. The percolation & leakages of untreated effluents may also pollute the ground water table and create environmental problem and invite public intervention. Suitable
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drainage arrangements should be provided in ETP area to collected untreated effluents during emergencies.
6. Not providing of standby pumps in ETP. No Proper co-ordination & communication of information between the production team & ETP operators, discharge of high concentration of effluent will lead to destabilization of ETP.
7. There will be no provision of effluent flow measuring equipment or flow meter. Energy meter will not be provided for the measurement of power consumption which illustrates the running status of ETP.

3. Generation of wastewater in various sections in a sugar factory

Following Figure depicts the process flow and waste generation in a typical sugar industry.

Figure 1: Process Flow Chart in Sugar Industry

3.1 Measures for minimization of effluent generation

1. The wastewater generated should be segregated in unpolluted stream and polluted stream.
2. The unpolluted stream can be used for floor washing, process cleaning, Irrigation.
3. Polluted stream high physic-chemical characteristics shall be taken to ETP having state of the art technology to treat efficiently and use the treated for irrigation.
4. Arrangement to divert the lime house via grit chamber to condensate water channel to reclaim both water and residual lime which helps to make up of condensate water pH.
5. Collection of recirculation of leakage from pump glands to its respective process by providing a collection chamber at each section.
6. Using sugar contaminated condensate for maceration at mill house.
7. Reclamation of hot water & vapors from the boiler blowdowns.
8. Recirculation of all cooling waters.
9. Drying washing (Bagass spraying) in the sugar mill has to be encouraged.
10. Sugar factory lab should be located on the first floor, whereby the sampling refuse & sugar washings from sinks lead to raw juice tank instead of drains.
11. Arrangement for collection of all cooling water should be made, designed for cascade cooling of water which follows the recirculation. Likewise, for boiler & process condensate water, arrangement for fresh make up water should be made.
12. A close circuit heating for juice in heaters. Vacuum pans, vapor cell, semi kestner & quad bodies to be made.
13. Vapor condensate from vapor line juice heaters is collected & used in maceration.
14. The overflow of spraypond & boiler blowdowns, treated effluent can be used for spraying on bagasse & fly ash in dumping yards to prevent any fire hazards and ash flying along with air. Sprinkler system can be used for spraying.
15. Prepare the Do’s & Don’ts for the plant personnel followed with a periodic training & awareness programme’s to develop the concept of water conservations to managers, supervisors, operators & also labors.

3.2 Operation and maintenance of sugar ETP

Operation and maintenance of sugar has become one of major issue in much of sugar industries. Due those much of sugar factories are outsourcing the ETP by paying much of higher cost with respect to the actual need of investment. An improper maintained ETP leads to destabilization of ETP and resulting in not achieving the prescribed statutory norms and leading to legal action. A proper maintenance of ETP requires a proper co-ordination between the process personals and ETP operators and Environmental Engineer. A well maintained ETP gives a impressive results with a very low operational cost.

Few of the conditions laid by corporate Responsibility for Environment Protection (CREP) agreed in 2003 by the Industry and the Govt. of India are

1. The ETP stabilization should start commence one month prior to start of crushing season. This ensures the conditional requirements to take full effluent load in to ETP.
2. The entire treated effluent should be used for land application like irrigation etc. no effluent should be disposed to streams like river, lake etc.
3. The effluent quantity should not exceed 100 l/ton of cane crushed.
4. A storage capacity of 15 days for treated effluent shall be provided to take care of no demand period of irrigation.
5. Further, it is the general feeling that if Spray Pond overflow is treated along with Sugar factory effluent, the ETP performance is disturbed. It is suggested to treat Spray pond overflow separately.

3.3 How to achieve the above targets

Earlier practices were to use huge quantity of water in the process, washing etc thus resulting in generation of large amount of effluent and having smaller capacity of effluent. To reduce the quantity of effluent generation it is very much essential to minimize the use of water in the process and cleaning. Methods of recycling of cooling water and excess condensate to be used and thus reducing the effluent quantity generation and significantly altering the quality of effluent.

The industry shall initiate stabilization one month before starting of crushing season to develop enough MLSS (Mixed Liquor Suspended Solids) which can take the effluent load after the start of crushing season. The stabilization process includes filling the tank with fresh water then add the culture (natural or artificially prepared) then run the diffusers or surface aerators for aerobic for anaerobic fill it with water add culture (cow dung or artificial available culture) keep the recirculation continuously to develop enough amount of sludge ,VA, alkalinity, acidity if first time stabilization. If pre stabilized then give some organic loading and fresh culture to destabilize to capsulated activity of microbes till the desired VA, Alkalinity, Acidity is reached in pre stabilized anaerobic tanks/Digesters. Cowdung, politary waste, healthy sludge from aeration tank, mud from the field where the treated effluent is used, and artificial prepared culture available in market are the type of cultures which can be used. It is not advisable initially to take the entire effluent in to ETP which may lead to shock loading. It is necessary to earmark the land requirement for treated effluent. If the effluent generation is 500 M$^3$/d then the land requirement shall be 500/50= 10 hectares. Land requirement various based on the type of soil conditions. The industry shall take proper steps to maintain the quality of the stream for discharge on land for irrigation otherwise the industry would attract the legal action by state of central PCB.

Some of the operational and maintenance as well as trouble shooting of effluent treatment plant are discussed below. Equalization tank - Anaerobic digester/tank / biotower - aeration – clarifier – sludge drying beds – 15 days storage tank is advisable for effluent with more than 3000 mg/l of BOD. Equalization tank – two stage aeration (surface of diffused) – clarifier – sludge drying beds – 15 days storage tank is advisable for effluent having BOD less then 3000mg/l.

4. Trouble shootings in ETP

1. Low pH
   1. Anaerobic digester -: low pH in anaerobic digester is caused due to high organic loading or extraneous or toxic material, it affects the working of the digester if not taken care in initial phase then chances of destabilization of digester may take place. To recover the condition the operator should discontinue the loading temporarily, increase the alkalinity by adding lime/ sodium bicarbonates. The alkalinity and VA should be 3:1. Identify the source of toxic substance and segregate it at the stage of generation and treat it separately.
2. Aeration system -: the cause for this is high F/M ratio and it can be mitigated by reducing the organic load and maintain the F/M as per the design.

2. Low BOD/COD removal efficiency: this is due to increase in inorganic loading which causes poor performance of biological reactors. The problem can be mitigated by characterize the waste stream and segregate it separately and provide additional units if anywhere required.

3. SVI (Sludge Volume Index)
   1. For anaerobic system: due to low MLSS concentration (below 2000Mg/l) it can be mitigated by chlorinating the waste to reduce the filamentous growth.
   2. For aerobic system: due to low MLSS concentration (below 2000mg/l) the problem can be mitigated by increasing the MLSS concentration by increase the recirculation ratio of return sludge. Check the DO in the aeration tank, DO should be maintained above 1.5 mg/l.

4. Sludge Bulking: It usually occurs in settling tank and aeration tank the cause for this is growth of filamentous bacteria, flock, low available ammonia nitrogen, high organic matter, low pH, and low nutrient availability. The problem can be mitigated by stopping the organic loading temporarily and increasing the pH above 7.5 and increase the DO. If the factory is well facilitated with lab then the BOD to nitrogen ratio can be maintained 20:1. The excess sludge can be removed to sludge drying beds.

5. Sludge Rising: it usually occurs in clarifier and rarely in aeration tank and reason for this is denitrification or septic condition prevailing. The problem can be mitigated by increasing the sludge withdrawal rate from clarifier, increase the sludge recirculation rate decrease the mean cell residence time; decrease the flow from aeration tank to clarifier.

6. Blackening of water: it usually occurs in aeration tank and subsequently in clarifier this is caused due to low DO (Dissolved Oxygen) and high organic loading, reduction in HRT, it is also caused by uncontrolled proliferation rate. The problem can be mitigated by identifying change of color at the initial stage and reducing the effluent feeding remove part of water and feeding it with fresh water and add fresh culture and once color will reach brownish orange the slowly feed the effluent and increase it steadily wrt time.

7. Foaming: it occurs in aeration tank and the cause for this is growth of high filamentous organism, high loading, and sludge bulking. The problem can be mitigated by addition of bioactivators which reduces the filamentous organism growth. Chlorinating the effluent, addition of defomers at the initial stage.

8. Low DO: it occurs in aeration tank and results in poor performance. The problem can be mitigated by controlling the oxygenating capacity of aerators, check the efficiency of aerators. It is advised to purchase the aerators or blowers from reputed manufacturers.

5. Conclusions

1. Proper water management practices are results in major reduction of waste generation.
2. Reuse of condensate for imbibitions reduces major effluent generation and increases water economics.
3. Dry floor washing by bagasse leads to reduction of effluent generation.
4. Proper training to the working personals regarding water management leads to reduced effluent generation.
5. Reduction in mixing of high concentrated waste mixing in to low concentrated waste increases the quality of effluent and achieving higher efficiency of ETP.
6. Well operated and maintained ETP leads to achievement of discharge norms and thus reducing environment pollution.

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6. References


