

POLLUTION CONTROL AND SAFETY

Sugar industry is basically seasonal in nature and operates only for 120 to 200 days in a year (early November to April). A significantly large volume of waste is generated during the manufacture of sugar and contains a high amount of pollutional load particularly in terms of suspended solids, organic matter, and press mud, bagasse and air pollutants. Therefore an attempt has been made to present an overview of waste management in sugar industry in India.

Waste generation:

(A) Wastewater

Mill house: Mill house wastewater is derived from continuous gland cooling and intermittent floor washing and contains high amounts of oils and grease and sugar from spills and leaks.

Boiler Blow-down: Boiler blow-down is fairly clean water except that it contains high dissolved solids and phosphates.

Rotary filter: Filter cloth is periodically washed and constitutes a source of wastewater.

Condensates: The vapours from the last effect evaporator and pan boiling are separately cooled in barometric condensers and the condensate goes to the pond. A part of the cooled water from the pond is recycled into the sugar mill, but a large portion is discharged as wastewater. If the mill operates without overloading, the evaporator and vacuum pan condensate is quite clean and the entire quantity can be reused. But many a times, overloading and poor operating conditions can lead to significant sugar losses in the condensates through entrainment and thus polluting the water.

Occasional Spills and Leaks: Leaks from pumps and pipes in the evaporators and centrifuge house, along with periodical floor washings, constitute another source of wastewater. Although the flow is intermittent and volume discharged is not large, it represents the most polluting fraction of sugar mill wastewater.

Condensate Washings: Evaporators, juice heaters, pans, etc are cleaned once in 20 days for removal of deposited scales. Caustic soda, sodium bicarbonate and hydrochloric acid are used for scale removal. Normally the caustic soda washings are stored and reused for cleaning operations. However, in India, most of the sugar mills discharge these chemicals into the drains. After the equipment is boiled with caustic soda and rinsed with fresh water, it is cleaned with dilute hydrochloric acid using an inhibitor. The wastewater is discharged into the drains, as the recovery of the chemicals may not prove to be economical. It is seen that the wastewater has small organic load but inorganic content may be high to pose a shock-load to wastewater treatment facility (occasional discharge, once in fortnight). It is suggested to have a holding tank and mix this wastewater gradually to the final effluent to avoid shock loading on the treatment plant.

Sulphur and Lime Houses: The washings of sulphur and lime house would contain a considerable amount of inorganic solids, which include carbonates and sulphates. The effluents from these two units when combined would give neutral pH value of waste. This wastewater does not contribute to organic pollution but can be characterized as inorganic wastewater.

Wastewater parameters

BOD: - This is the measure of the oxygen consuming capabilities of organic matter. During decomposition, organic effluents exert a BOD that can deplete oxygen supply. BOD is generally measured and expressed in parts per million or milligrams per litre. The effluents from a raw sugar factory can vary between hundred to several thousands mg/l.

Dissolved Oxygen: - This is water quality constituent. It is measured and expressed as parts per million or mg/l.

Total Suspended Solids (TSS): - Suspended solids when they settle form sludge on the stream, lakebed and they are most damaging to the life in water.

The different modes of disposal of wastes are:

- Disposal into water bodies (River/Nallah, stream)
- Evaporation in open pits
- Disposal into ocean
- Press mud for fertilizer
- Bagasse for paper and pulp and fibre

(B) Solid Wastes

Bagasse: It is estimated that bagasse contributes to 33.3% residue of the total cane crushed. It has a calorific value of about 1920 kcal/kg and is mainly used as fuel in boilers for steam generation.

Press Mud: It contains all non-sucrose impurities along with CaCO_3 precipitate and sulphate. Press mud from double sulphitation process contains valuable nutrients like nitrogen, phosphorous, potassium, etc, and therefore used as fertilizer. The press mud from double carbonation process is used for land filling and is not used as manure.

(C) Air Pollutants

The bagasse, on burning, produces particulates, viz., unburnt fibres, carbon particles and gaseous pollutants like oxides of nitrogen, water vapour and other organic compounds. Of the particulate waste, the heavier particles slowly settle down in the surrounding area. Such dust fall leads to the problems of cleaning, reduction in property value, effect on vegetation, etc. The main gaseous pollutants are CO, which is altogether not measured by any unit, and CO_2 is reported to be in the range of 12 – 14%.

Wastewater reduction and by-product recovery:

The following areas are important to economize the usage of water.

(A) Cooling Water

- Mainly used for condenser, bearing cooling, sulphur/lime houses and crystallizer for formation of crystal
- In condenser, water gets mixed with vapour. However, adjusting pH along with make-up water to keep dissolved solids in check can recycle it.
- Evaporator cooling water contains entrained sugar and acid because of excess of SO₂ and can be recycled. Improvement in the designs of evaporator/pan boiler can reduce the loss. Losses will also be due to evaporation, splashing and percolations.
- Keeping the temperature of incoming water between 30o and 35oC can reduce losses due to evaporation. Splashing and percolation can be checked by proper maintainance.
- Cooling water for bearings, power generation, etc., can be reused safely.

(B) Process Water

Sugar mill employs both hot and cold water for its various processes such as Macreation, filter cake washing, lime preparation, dilution for lowering brix, Dilution in evaporators and pans, Massecuite, Magma making and Crystal washing in centrifugals.

- Water requirement before evaporator storage is about 1/5 to 1/4 of steam used while that used after evaporator requires approximately equal amounts, as for steam. Careful attention is required after evaporator stage to control water usage.
- Hot water can be used in place of cold water to reduce the quantity of steam required.
- It is preferable to use 18 – 20% maceration by equally adjusting it from the top and the bottom of bagasse bed feeding to the last mill at a pressure of 7 – 14 kg/cm² rather than merely pouring the same at 25 to 30% of cane (about 5 – 7% water can be saved).
- If maceration is high enough, there will not be any need of dilution water for juice.
- To reduce water quantity, light molasses can be used for magma making.

Washing Water: Wash water may contain sugar and therefore requires treatment and should not be recycled. Periodic cleaning results in high BOD and it also contain caustic soda and weak acids. Returning it to the service water tank can reuse water.

Testing Water: This water is safe for returning it to the service water tank.

Oil and Grease: providing suitable oil and grease traps can eliminate this.

Chemical Reuse: The stored and settled supernatant can be reused with a little addition of fresh caustic soda for next cleaning operation.

Molasses Handling: It is necessary to store molasses in RCC tanks or steel tanks above ground level. Otherwise, there is a possibility of ground water contamination. The high BOD of molasses may cause pollution problems due to mishandling.

(C) Product Recovery

The by-products available from sugar mills are bagasse, furnace ash, molasses and filter mud. The uses of these byproducts are given below. If all the byproducts are used for transformation into value added products, (resource recovery), it will minimize the pollution to large extent.

Bagasse: These are used for steam, power, charcoal, briquettes and methane & producer gas.

Molasses: These are used for fertilizer and cattle feed.

Filter mud: For fertilizer.

Boiler ash: For foundry material.

Safety:

Sugar in boiler feed water causes water to foam, which will lead accidents. If not present in large quantity. It is decomposed by heat into products that are detrimental to the tubes and shells of boilers causing pitting and overheating.

If sugar is present in small amounts their traces will be eventually accumulated on the boiler tubes as a harmful and dangerous carbonaceous deposit.

The break down of sugar also forms harmful organic acids. To prevent this lime is added to feed water to maintain pH = 8.0. A pronounced odour develops in the steam if boiler water contains sugar. Under such conditions the contaminated feed water is turned to sewer and the boilers are blown off.

To prevent these hazards tests are conducted to determine amount of sugar traces in water. The most commonly used tests are Naphthol test and Aresenomolybdate test.