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SUGAR INDUSTRY WATER MANAGEMENT

Dr. Ravindranath V. Gabadi
Associate Professor & Special Officer, Dept of Sugar Technology,
GU. P.G.Centre , Bidar.

ABSTRACT

Consumption of water Day by day increasing for domastic and irrigation water is becoming scarce. At present the sugar factories consume huge quantity of underground water hence there is a need for proper planning for conserving this dependence on the ground water could be reduced/eliminated and how if not for drinking at least for irrigation, more water could be contributed by the sugar factories which could eventually be treated to supply drinking water for the factory community surrounding the factory.

The conventional water demand of 2500 TCD plant is said to be between 50,000-60,000 gallons per day i.e. 1 to 2.5 million liters for a sugar mill producing 150 to 300 tones sugar per day. The idea is to reduce this water consumption by closed water system such that ground water is required only for initial start of the factory.

KEYWORDS: *cold water, condensate water, WWT.*

The water used in the sugar plants could be categorized as follows: -

i) The cold water, which is mostly required for cooling of machinery as well as for cleaning. This is reclaimable and can be used over and again by a proper closed water system. Also taking up the cooling water temperature could easily reduce the quantity of this water up by 3-5°C in each case of its application. Unfortunately at present such cooling water is usually discarded to drains. Monitored recycling of such water will reduce the need of total fresh water.

ii) The water derived from sugarcane is consumed to a large extent in the subsequent operations in the factory. This water content of the juice is to a large extent evaporated in the evaporators and the vapours from different bodies (except for last body) are condensed in various heat exchange vessels and produce condensate water. The best quality of condensate water is sent to boilers and condensate not fit for boilers used at different stages in the sugar manufacturing process thus the different quality of condensate water produced is usable and reclaimable in different stages. Very often this condensate control quantity is not sufficient and fresh makeup water is added but strict control on condensate management with condensate polishing and its proper use can bring down the requirement of process water.

iii) Wastage of water by blowing steam out of the process through steams traps and ammonia blow off connection etc. If controlled can bring down the need of boiler feed water makeup requirement drastically in the context of Indian Sugar Factories.

iv) A large quantity of water is also wasted during periodical general cleaning and routine washings etc. Treatment and repeated recycling of the water once used for cleaning will to a large extent reduce the requirement of fresh water for this purpose.

v) Cooling of injecting water after it has been used for vapour condensation of vapours generated by the evaporators and pans and its recycling is an important activity in every sugar factory. During this process huge quantity of water is lost due to evaporation from spray pond/cooling towers water sprays and also due to underground seepage from the spray pond and inlet outlet channels of injection water. To restrict wastages of water at this station we authors suggest having a closed big heat exchanger working on coolant and as heat pumps to bring down the temperature of injection water. However, detailed engineering for such a big capacity heat exchanger. the initial installation costs, recurring running cost energy need for such system are to be studied in future or a suitable heat need for such a system are to be studied in future. Or a suitable heat sink be provided underground to cost the injections water..

Water balance for a sugar factory could be summed up to composition of Sugarcane brings with it self.

Brix	- 15.5% cane
Fiber	- 14%cane
Brix Free Cane Water	- 2.8% cane
Water	- 67.7% cane

Assuming 150 and 100% mixed juice on cane received in the boiling house the condensate at juice heaters, evaporator and pan are used in the process in the following.

manner: -

Mills	-22-28% cane
Boilers	-3-5% cane
Clarification for chemicals	-3% cane
Pans	- 5% cane
Centrifugal and melting -	- 5% cane
Crystallizers	- Nil by re circulating of water in closed system
Miscellaneous	- 5% cane
Total	- 46-54% cane

So there could be a net saving of 67-54 = 13% on cane. Which could be exactly given out for irrigation or after treatment for drinking purpose to the colony rather than depending upon ground water.

In present actual working in most of the factories much higher quantity of imbibitation water is being used. With the result that mixed juice % cane is often as high as 110% and brix of mixed juice has come down to about 12.5-13.5. If we calculate the requirement of water at different stations on this basis the data will somewhat differ from the above set of data which has been taken as average data from earlier published literature. The net water saving in fact will be a little higher than 13% as mentioned above.

OPTIMUM UTILIZATION OF CONDENSATE

The following are measures to be taken for optimum utilization of the condensate.

1. Proper storage of condensates in tanks, attention to insulation of condensate pipes and tanks and avoiding condensate flow into drains are essential prerequisites of condensate continuations.
2. On mills only hot condensate to be used for imbibition without admixture with cold water.
3. (i) A boiler blow downs should be just sufficient to maintain the level of dissolved solids in boiler water with in the prescribed limits.

(ii) In factories quite often the feed water tank overflows into gutter due to continuous additions of makeup water, which is mostly condensate from second body evaporator.

4. The wastage can be avoided by level controller installation and regulations of make up water on the basis of level in the feed thank.
5. Pans: Water used in the pan boiling should be metered and recorded for controlling use of hot water.
6. The most important point which disturbs the condensate formation and reutilization cycle is periodical blow of exhaust steam. In case of many sugar factories, authors have observed many instances when exhaust is blown out to the atmosphere just from the back of the power turbine during periods when electrical load on the turbine is below optimum and the back pressure rises above the designed level. Exhaust steam may and be blown out from line just before the evaporators either because the running clear juice quantity is too less or some of pans are not in use.
7. Also the ammonia connection of vessels should be kept open to the minimum required to avoid loss of condensate in form of vapors.

OPTIMUM USE OF COLD WATER IN PROCESS

For optimum use of cold water in the factory the following steps are to be taken: -

1. The water used for cooling of bearing at mills and other power generating units should be collected in a tank and cooled before recycling the same.
2. The water from the Sulphur station and crystallizer, which is at temperature of 45- 50°C, should be sent to condenser water cooling system, being unsuitable for recycling.
3. All condenser water including that from vacuum filter has to be sent to spray pond or cooling tower.
4. Use of cold water for imbibition at mills and also for boiler can be dispensed with. Condensate of 70-85°C has been found to be effective in improving mill performance and the slippage at mills due to high temperature water can be overcome by new techniques of roller arcing etc. Similarly proper conservation of condensate obviates use of cold water for boiler feed makeup.
5. For maintaining sanitary conditions in the plant, washing of floors, platform is unavoidable but in the absence of proper control overuse of water for this purpose enormous wastage is possible. Treatment and recycling of this water will significantly reduce the requirement of fresh cold water.
6. In a factory where low temperature condensate is properly collected and cycled in the process no fresh cold water should be needed for preparing milk of lime.

RECENT PROBLEMS IN UTILIZATION OF PROCESS CONDENSATE WATER AT BOILERS.

The authors had opportunity to visit many sugar factories during last three years and also earlier. We noted that where as about 15 yeas back almost all factories where able to get enough suitable condensate water from evaporators, juice heaters and pans to run their boilers today it is not possible to do so. Because the boiler pressure has gone up and the quality needs of the boiler feed water have become much more stringent. On the other hand the exhaust temperature in the calendria of evaporator initial bodies and the clear juice boiling temperature is today 15 to 20°C higher compared to days when long tube rising film evaporators and falling film evaporators had not arrived because of this the condensate formed by condensation of the first vapours of the juice is completely different from what it was when simple short tube vapour cell and Robert body evaporator only were in use.

SUGAR MILL WASTE WATER

This water is mostly contaminated with
1. Oils or greasy matter.
2. Carbohydrates from the sugar bearing liquids leaking from pump glands, overflows etc.
3. Suspended matter like small amounts of bagasse, filter cake dropping on the floor, the logical method of treatment has to be based on eliminating the suspended matter and degradation of carbohydrate and other organic matter.

WASTE WATER TREATMENT

The wastewater flowing through channel is initially passed through a small pit fitted with stationary screens for eliminating oil and greasy material large fibrous matter in suspension. The water then flows into equalization tank where lime is added to neutralize the acids and raise pH to 7.0 from the equalization tank the water flows into a large tank with a residence time of 2-3 days where in bacterial decomposition of organic matter takes places and the suspended impurities as also the sludge settle down. To facilitate bacterial growth and their activity the nutrients like urea and super phosphate are added and initially some starter has to be added containing the bacteria. The overflow from anaerobic digestion pond is led to aeration tanks where surface aeration brings about bio-oxidation of organic matter the resulting water being fit for letting into public streams.

Standard for discharge of effluents into irrigation system

1. pH	5.5-9.0
2. Dissolved solids	2100 mgm/liters
3. Suspended solids	200 mgs/liters
4. Oil and Grease	10 mgs/liters
5. B.O.D.	100 mgs/liters
6. Sodium	60 mgs/liters
7. Chloride	600 mgs/liters
8. Sulphate	1000 mgs/liters

SUMMARY OF WATER TREATMENT

As we have discussed in previous pages different qualities of water are used reused, recycled and sometimes lost in various sugar factory operations in fact there are several loops of water utilization depending on quality of water and the type of use to which it has been applied. Many times these loops intercross and the quantities are transferred from one loop to other loop. As far as quality is concerned we have (i) very high temperature condensate (ii) medium temperature condensate (iii) hot water (iv) cold water (v) water cooled by coolers i.e. spray pond etc. (vi) water contaminated by sugar house products and by products (vii) effluent water. These different qualities of water, after one use, can be treated in a specified manner and reused either in the same loop or in another loop with an eye on the ultimate aim to reduce the total quantity required. In this connection there are recommendation in the literature, which is summed up below:

Process	**Application or Objective**	**Limitations**
Sedimentation without chemical treatment	Removal or suspended solids by gravity setting.	Suitable for removal of large or dense suspended solids. Not suitable for removal of colloidal suspended solids or soluble organic matter or colour.
Coagulation Chemical treatment with inorganic coagulants and or polymers.	Destabilization of colloidal suspended particles and organic matter in order to permit them to be flocculated.	Frequently requires adjustment of pH coagulant dose must be established by laboratory experiments.
Flocculation mechanical or hydraulic controlled agitation to encourage coagulated material to flocculate and form particle cluster or large size.	Applied to coagulated water to produce large floc particles, which may be removed by sedimentation or filtration.	Treatment chemicals must be thoroughly and uniformly mixed into water before flocculation. Condition of agitation must produce collision of particles without excessive shearing.

Combined coagulation flocculation and sedimentation.	Used for clarification of waters where the concentration of suspended of coagulant required produces a concentration of floc, which is too great to pass directly on to filtration units.	Requires sedimentation tank especially designed to effect solids in the raw water, or the quality the correct hydraulic and chemical condition for coagulation, flocculation and sedimentation. May be horizontal flow, radial flow or up flow reaction vessel with sludge blanket or sludge recirculation facilities.
Filtration without chemical treatment.	Removal or suspended solids by filtration through a fixed bed of sand, anthracite or a combination of both. Designs based on up flow or down flow filtration.	Will not tolerate high concentration of suspended solids suitable as a roughing stage where high quality filtrate is not required.
Filtration after coagulation.	As final polishing stage after coagulation flocculation and sedimentation or used directly as combined flocculation/filter where level of suspended solids in raw water is low.	Filters may be of open gravity or pressure type. Where used without a pre-sedimentation filter, run times will be shorter and careful control of chemical coagulation conditions essential.
Precipitation softening (cold lime softening)	Used to remove alkaline hardness and reduce total alkalinity and total dissolved solids.	Reaction vessel usually of sludge blanket or sludge recirculation type. Residual alkaline hardness depends upon raw water composition but normally about 30-60 mg/1 as CaCo3. Requires subsequent filtration and possible pH correction.
Precipitation softening (hot-lime softening)	Reduction in soluble silica can be achieved by hot process provided raw water contains sufficient magnesium hardness or magnesium salts are added with lime dose. Lower residual alkaline hardness and faster throughput rates can be achieved by hot operation	To prevent silica pickup the final filters should be charged with anthracite rather than sand. Waste water from filter back wash and desludge of lime softening reaction vessel will be at operating temperature.
Precipitation softening (lime-soda)	Largely replaced by ion exchange or lime softening plus ion exchange. Is capable of softening to give residual hardness of about 15 mg/1. Reduction in alkalinity and TDS not as good as with other process	Requires final filtration as with all precipitation process, produces waste effluent in the form of sludge, which may create a disposal problem. Careful control of chemical dosing required.

Sodium ion exchange (base exchange)	Almost complete elimination of hardness does not reduce alkalinity or TDS. Simple to operate can be fully automated. Raw water should not contain suspended solids	Not suitable for boiler makeup, if raw water alkalinity forms a high portion of TDS. Steam condensate may contain appreciable quantities of Co2 owing to breakdown of bicarbonate in the boiler
Lime softening- filter Sodium ion exchange.	. Lime softener used to clarify water and also reduces alkaline hardness. Ion exchange unit removes remainder of hardness.	Filtrations required between limes softener and ion exchange unit. Reduction in alkalinity by lime softener reduces danger of Co2 in condensate.
Weaken acid cation exchange- base exchange	Suitable for water with low turbidity. Almost complete elimination of alkaline hardness and corresponding reduction in TDS. Base exchange removes remainder of hardness.	Co2 generated in WAC unit must be removed in degassing tower. Probably the most frequently used process for low-pressure bilkers where raw water has high alkalinity. Should be followed by mechanical de aeration.
Stronger acid cation (hydrogen form) blend base exchange.	Raw water passed through hydrogen form SAC and sodium-form units in parallel and the treated water mixed so that the FMA from the former destroys the alkalinity of the latter. The process gives low alkalinity and hardness.	The H.1-Na blend process has higher operating cost than WAC followed by BE. It is usually used where the alkalinity of the raw water is predominantly due to sodium bicarbonate. Co2 produced should be removed by degassing tower and the feed water to the boiler should be mechanically de-aerated.
Demineralization , strong acid cation, degassing weak-acidification.	The process removes virtually all dissolved solids except the residual Co2 after degassing and the silica.	Often used as part treatment where demineralized water is blended with base exchange softened water to produce a soft makeup with reduced TDS.
Demineralization, strong-acid cation, degassing strong- base anion.	Demineralization where removal of silica and residual Co2 is required.	Used for treated of makeup to high-pressure boilers or where silica limitation must be imposed.
Mixed bed demineralizer.	Sometimes used for direct treatment or preceded by base exchange if the raw water is very hard. Normally used as polishing unit after two-stage demineralizer. Also used for condensate polishing in high-pressure boiler operation.	Quality of treated water usually better than obtained by two-stage demineralizer but operating costs higher.

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TDS	-	Total dissolved solids.
WAC	-	Weak and cation.
BE	-	Base Exchange.
FMA	-	Free mineral acidity.