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Zero Fresh Water Consumption and Zero Liquid Discharge in Sugar Industry

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ABSTRACT

India is on the brink of worst ever water crisis with 600 million people facing acute water shortage. The crisis is likely to worsen by 2030 as we see ground water levels declining across the country. Sugarcane cultivation and processing of sugarcane juice for producing sugar are considered intense water consuming activity. With a view to minimize fresh water consumption and discharge of effluent, now sugar factories are actively participating in "save water, save environment mission". With advent of sugar complexes, it is possible to attain the objective of zero fresh water consumption and zero liquid discharge as discussed here in.

Keywords : Zero fresh water consumption, zero liquid discharge, environment, global warming.

INTRODUCTION

From the concept of "Stand alone sugar factory" to "Integrated sugar complex" having facilities for production of sugar, power and ethanol, the Indian sugar industry has travelled a long way. However, one area where the industry is still required to work upon holistically is about conserving water. Now, the water management is not to be looked in isolation for the sugar factory alone but for the complex as a whole and efforts are required to be made to achieve zero fresh water consumption (ZFC) and zero liquid discharge (ZLD) from the industry adopting various R's i.e., reduce, reuse, recycle and respect, following the "Best Available Technologies (BAT)" and "Standard Operating Procedures (SOP's). With the havoc of climate change and global warming already making the life tougher, the water crisis which increased manifolds during the last few years is getting worsened day by day. While cultivation of sugarcane is considered to consume substantial quantities of water, even with the change in landscape of sugar production, the sugar factories continue to draw fresh water to meet their processing needs (CPCB 2018).

Despite the fact that sugarcane itself contain 68-72% of water which becomes available during processing and can be recycled and reused, many sugar factories in the country keep on consuming significant quantity of fresh water and also discharge treated effluent in large quantities. During the crushing season 2022-23, survey of 147 sugar factories situated in subtropical India indicates fresh water consumption and effluent discharge to be in the range of 50-80 litre/ton and 150-180 litres per ton of sugarcane crushed respectively (NSI 2023).

This calls for urgent measurable action to save this precious water when the sugar industry is now crushing 300 MMT or more of sugarcane every year. Hence, while for the sugar complexes, need of the hour is to have a closed loop system to achieve "ZFC" and "ZLD by utilizing the surpluses in the system as per requirement, Incase of stand alone sugar factories, while reducing the fresh water consumption, the quality of the treated effluent is to be maintained such so as to use it for multiple purposes viz. as irrigation water, for coping up with other needs and even for potable purposes so as to safeguard the environment. In case

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of complexes having sugar unintegrated with power generation and ethanol units, surplus condensate from sugar factory may be utilized to meet requirements of attached unit. Apart from adopting model condensate conservation and water management system, installing waste water treatment mechanism for facilitating maximum utilization of treated water is required to attain the pre-set goals of "ZFC" and "ZLD". Authors in the present paper while discussing water balance have also discussed about one such mechanism developed by M/s UY Trienviro Pvt. Ltd.

Importance of water consumption and sugar industry

Despite of efforts being made by sugar industry, still sugar factories consume significant quantities of the fresh water to extent of 50-80 litres per tonne of cane (with exception of few who use lesser quantity) and also discharge effluent @ 150-180 litre per tonne of cane.

There is global scarcity of safe water and India also faces the similar situation which is going to worsen further.

This fresh water consumption and effluent quality vary significantly and is dependent upon various factors including:

1. Quality of sugarcane i.e., water available in sugarcane itself.
2. Processing technique i.e., production of plantation white sugar or refined sugar etc.
3. Availability and configuration of co-gen units i.e, back pressure or condensing turbines.
4. Climatic condition as evaporation/ drift losses varies depending upon ambient temperature and wind velocity.
5. Diversion of intermediate process liquors.
6. Efficiency of water management and over all technical efficiency of the plant.

The country faces water scarcity challenge with ground water level declining across the country. The country is already facing worst ever water crisis as requirement of water is projected to be twice the availability.

Thus, the status of Maharashtra, Karnataka and Gujarat where sugarcane grown in substantial quantity and processed, water management assumes greater significance (www.engtechmag.wordpress.com).

Many sugar units and in-fact sugar complexes worked on the area of reducing fresh water consumption and limiting effluent discharge. Many institution and technology provider's joined hands with sugar industry in this campaign. As a results of measures taken few factories could operate without fresh water requirements except for first fill or use only during stoppages of crushing.

Concept for zero water consumption and zero liquid discharge with possibility of providing potable water in sugar industries was elaborated by Gurunatha et al. (2019), wherein they described water balance of a 3500 TCD sugar plant having 15 MW co-gen and concluded that the saved water can either be used to operate a 60 KLPD distillery to achieve ZLD and ZFC or can be converted to potable grade thus earning revenue through is sale.

Awasthi and Goel (2023) discussed a road map of water management for integrated 3500TCD sugar plant, 20 MW co-gen plant and 35 KLPD multi product distillery complex.

Kshetry and Jain (2016) also suggested technologies solution for recycling of water in integrated sugar complex. Yadav (2016) provided details of effluent management by adopting 4 'R's so as to work with zero fresh water consumption. Various other research workers carried out studies on efficient ways and means for cold and hot water management so as to achieve the desire target zero fresh water intake. Some sugar factories in U.P, Maharashtra and Karnataka also reported successful working with zero fresh water consumption. However, in many cases, consistent performance could not be achieved.

RESULTS AND DISCUSSION

Proposed water management system and water balance for a sugar complex

As mentioned in the earlier paragraphs various factors affect the water management system because of varying quantities of condensates available thus, the overall water or effluent management has to be considered in light of all such factors. As regards complex having

sugar, power and ethanol units, the surplus condensate from sugar units can be utilised after due treatment. Central Pollution Control Board also suggested adoption of best available technologies and standard operating procedure as per broad details mentioned here below.

The surplus condensate after cooling can be used as makeup water replacing the fresh water. Likewise, most of the re-circulating water for cooling can be re-used after cooling through fan-less cooling towers and stored in underground reservoirs. Any shortfall in the quantity of cold water can be met through surplus cooled condensate instead of using the fresh water thus reducing fresh water requirement and effluent generation as well.

Although, many and particularly those sugar factories established during the last decade have adopted reasonable instrumentation and automation so as to derive higher technical efficiency but still large no. of sugar factories lack on having such facilities and no proper monitoring or recording of process parameter including utilization of fresh water, usage of cold (fresh) water and hot (condensate) water for various usage is carried out. Even the factories which have gone for DCS based automation, in general, do not have facility for observing behaviour of water usage at various unit operations. The standalone sugar factories, except for the first fill while starting the crushing season, should not require fresh water its processing or in case of any stoppages needs on continuing basis.

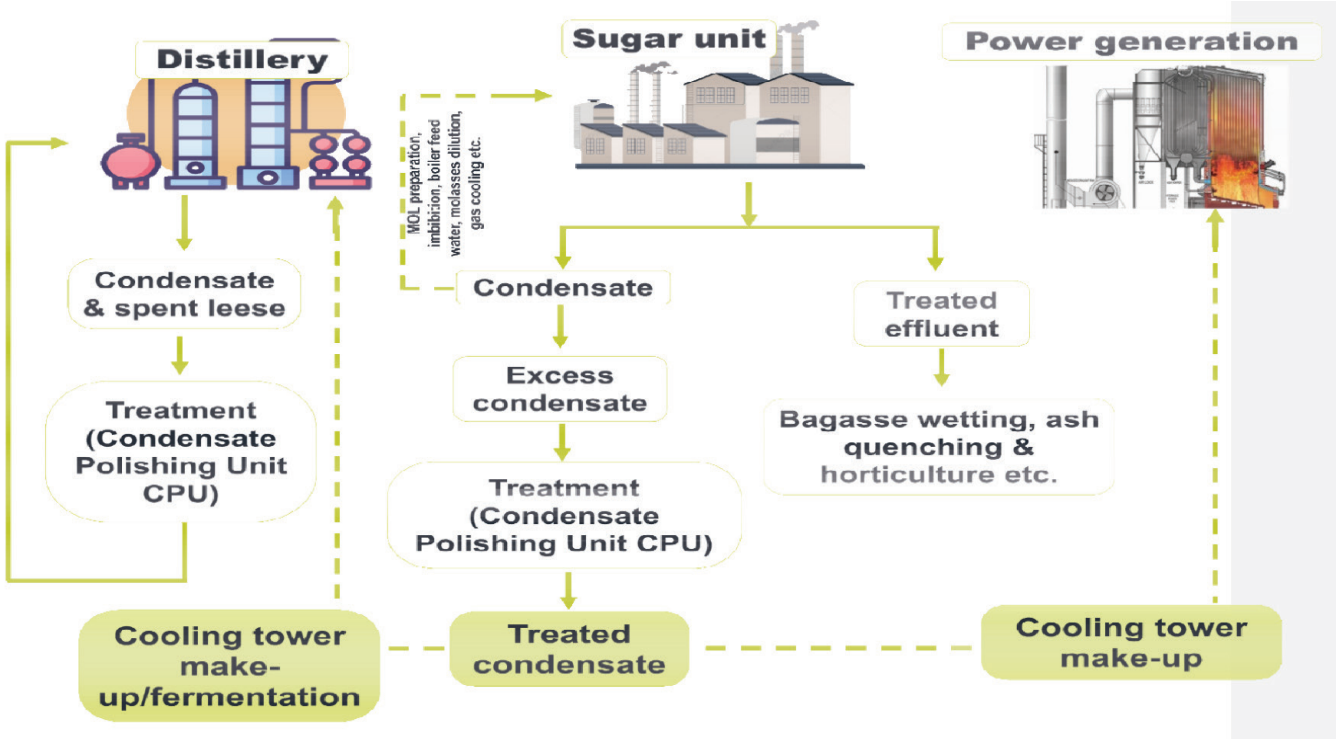

Figure 1 : CPU for distillery, sugar unit and power generation

This shall be possible only when apart from taking various appropriate measure at various unit operations, closed loop hot and cold water circulation system are put in place and proper monitoring and recording of water usage is made so as to take corrective action. The factories generally provide a flow meter in the common line of the tube well delivery catering to the needs of sugar plant, co-generation, colony and other miscellaneous- purposes and thus it is not possible to ascertain the fresh water requirements for sugar process house. Similarly, except for the imbibition water, flow meters are generally not provided by the sugar factories to measure and ascertain the flow of cold and hot water for various purposes. In their own

interest and for proper water management, the sugar factories should install flow metres at all consumption points and record the readings;

By implementing the model condensate conservation and water management system and judiciously implementing the version as prescribed in the CPCB charter also, the motive of zero liquid discharge and zero fresh water consumption is a sugar complexes achievable is available. An overview of the same is given in Table and Figure:

As mentioned in the earlier paragraphs, utilization of condensate assumes greater significant to achieve the target zero fresh water consumption and zero liquid discharge. Although for treatment of the condensate, several systems have been adopted by the sugar factories but could not deliver the results on sustainable basis.

M/S U/Y Trienvero Pvt. Ltd., has developed nitrification based system which is being successful operated in many sugar factories. The schematic diagram of the system is mentioned in Figure 3.

Table 1 : Hot Water generation and requirement during processing

S. No	Particulars	% on cane
A - Hot Water Generation		
1.	Clear juice % on cane	118-120
2.	Total condensate generation at clear juice brix-13.83 and syrup brix-60	92-93
3.	Flashing and condensate losses	2.5-3.0
4.	**Net condensate available (excluding exhaust condensate) in process**	**90-91 Say 90**
B - Hot Water Required During Processing		
1.	For imbibition at mills	35-40
2.	For MOL preparation & chemical preparation.	2-3
3.	At vacuum filter for filter cake wash	5-6
4.	Movement water required for pan boiling	3-4
5.	SHWW for batch centrifugals	3-4
6.	Hot wash water for continuous C/F	2-3
7.	For (B،C،C1،A1) Sugar melting	5-6
8.	For Evaporator bodies chemical boiling & pan water boiling	2-3
9.	Miscellaneous	3-4
	Total	**68-72 Say 70**
10.	Surplus hot condensate available after using in process	20
11.	Drift and evaporation losses while cooling of surplus hot condensate	0.5
	Surplus Condensate Available After Cooling	**19.50 Say 20**

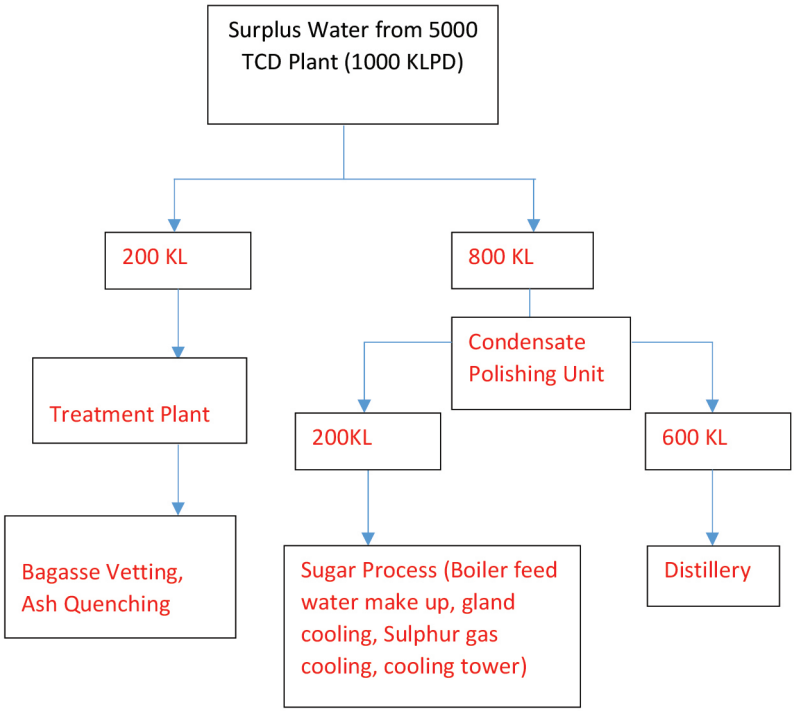

Figure 2 : CPU for distillery, sugar unit and power generation

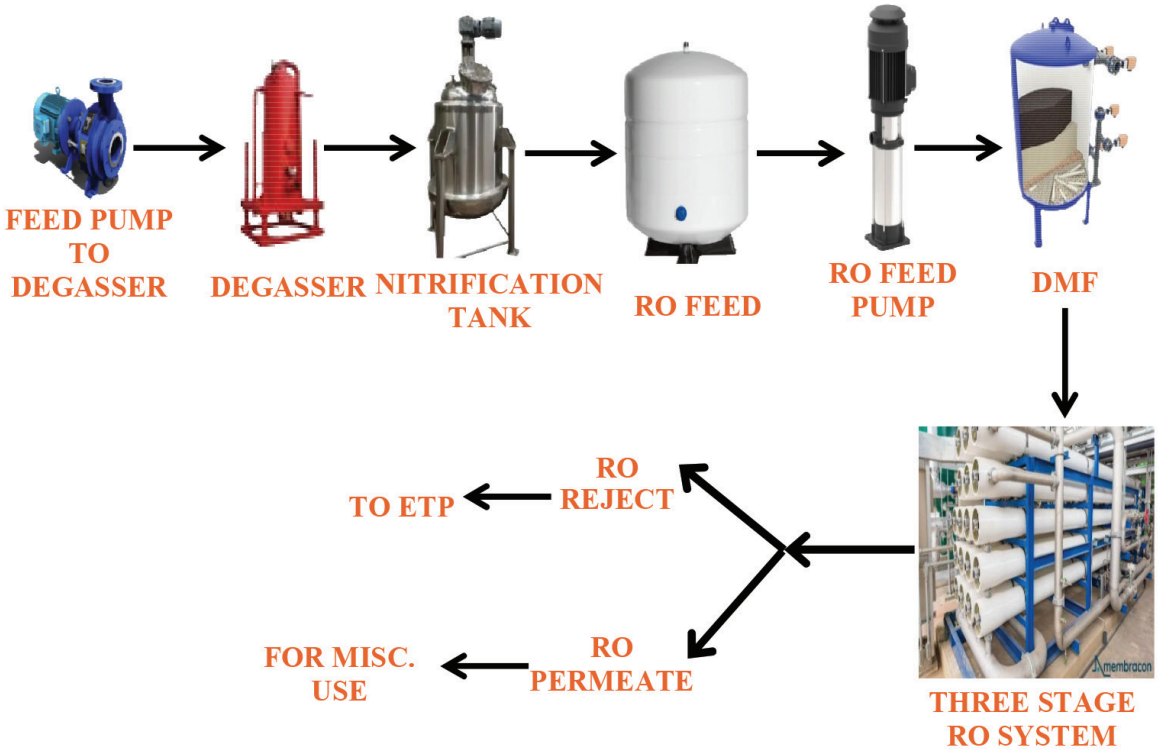

Figure 3 : CPU for sugar unit

CONCLUSION

From water deficient to water surplus, sugar factories can convert themselves into an entity requiring no fresh water for their processing needs instead coping up with the needs of integrated co-generation and alcohol units or for other purposes. The need of the hour is to implement innovative technologies and carrying out reuse of water from various stream after due treatment.

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