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WATER CONSERVATION IN SUGAR INDUSTRY: A CASE STUDY OF LOKMANGAL SUGAR, ETHANOL AND CO-GENERATION INDUSTRIES LTD, BHANDARKAVATHE

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ABSTRACT
Sugar manufacturing process requires considerably a large amount of water. Wastewater generated also is huge. Reducing the water consumption for industrial process is challenging task. Conservation of this resource is significant in the aspect of environmental and economical sustainability. Water conservation is possible by implementing the optimum water utilization techniques. Excess condensate water generated from the process can used back in the process, reducing the cold water required for the cooling & other purpose. This excess condensate water can also be used for Turbine cooling towers as make up. A Case Study of Lokmangal Sugar Ethanol and Co-Generation Industries Ltd, Bhandarkavathe reveals that the excess condensate water available during the process of sugar manufacturing is equivalent to 216.36 m^3/day and it shows that judiciaous use of water and application of 3 R concept in sugar industry, instead of bringing water from outside source water will be available from industry.

KEYWORDS: Water conservation, sugar industry, Water balance etc.

INTRODUCTION

India is mainly an agro based country. The sugar factory is one of the most popular and second largest agro based industries and there are about 600 plus sugar industries in India playing a vital role in economic development of the country. These industries are using huge quantities of water and raw material in their production process. The raw water requirement for sugar industry is 200- 400 lit/tonne and wastewater produced is about 200-300 lit/tonne of sugarcane crushed. In the production of sugar bye-products such as, Press mud (3.5-4%), Bagasse (28-32%) and Molasses (3-4%) are produced. The darker side of growth of the sugar industries in the country is environmental deterioration i.e. water, soil and air pollution. These environmental problems are affecting the future prospects for sugar industry development in the country. The pollution prevention practices and waste treatment methods require particular circumstance for success. Treatment processes are to be altered to suit the Indian versatile climatic conditions. Maharashtra the leading state for production of sugar in India, where, few Industries have kept the pace with change in time and have not only conceptualized the necessary changes but have implemented them through their innovative ideas and stand out as the success stories in sugar industries sector.

Lokmangal Sugar Ethanol and Co-generation Industries Ltd. is established in 2008 with crushing capacity 2500 TCD and, co-generation power plant capacity of 15 MW, situated at Bhandarkavthe of Solapur district in Maharashtra is one of the such leading industry. Since, its inception the industry has adopted various policies in the fields of cane development, technical efficiency and water management with crushing capacity of 6000 TCD and power plant capacity of 31.5 MW.

Over the past few years, there has been growing awareness that many end-of-pipe solutions have not been as effective in improving the aquatic environment as it was expected. As a result, the approach is now shifting from "waste management" to "pollution prevention and waste minimization", which is also referred to as "cleaner production", (Anon, 2000). The conventional end of pipe approach to waste management which provides required treatment of waste generated at various stages of process operation does not lead to sound solution in the long run. It is so because, firstly waste treatment in many instances leads to mere transformation of pollutants from one phase to another. Secondly, it requires substantial investment and

budget to meet the operating cost, (Gunjal, *et.al.*, 2013). In contrast modern approach to waste management aims at optimizing production process and at minimizing generation of waste then managing the unavoidable waste in an environmentally acceptable and economical manner. In most of the environmental problems, cheapest and most effective way is to reduce pollution and if possible avoid production of waste. Industries can modify the production processes so that lesser quantities of wastes are generated or the waste generation can be totally eliminated. (MG Cortés, *et al.*, 2010). Recycling and reclaiming materials that otherwise might be discarded in the waste stream also reduces the environmental pollution. Both these approaches usually have economic as well as environmental benefits, (Agarwal, 2005 and Hulett, 1970).

This paper attempt to analyse the 3-R i.e. Reduce, Reuse and Recycle concept adopted by the "Lokmangal Sugar, Ethanol and Co-generation Industries Ltd. (LSECIL), Bhandarkavthe, Dist: Solapur"

MANUFACTURING PROCESS AND WATER USAGES

The sugar industry consumes large quantity of water in manufacturing process and resulting in huge wastewater generation. Water used in sugar industry is of two types, viz., cold water and condensed hot water. Conventionally, the cold water is used as make up water, injection water to the condenser, cooling water for various accessories such as mill bearing, turbine bearing, crystallizers, cold maceration, juice dilution, lime preparation, laboratory testing and factory equipment cleaning. The condensed hot water is used as boiler feed-water, juice dilution, lime and sulphate preparation, oliver wash, molasses conditioning, centrifugal, magma making, massecuite dilution, etc. The manufacturing and water circulation process of the in LSECIL is shown in the Fig.1.

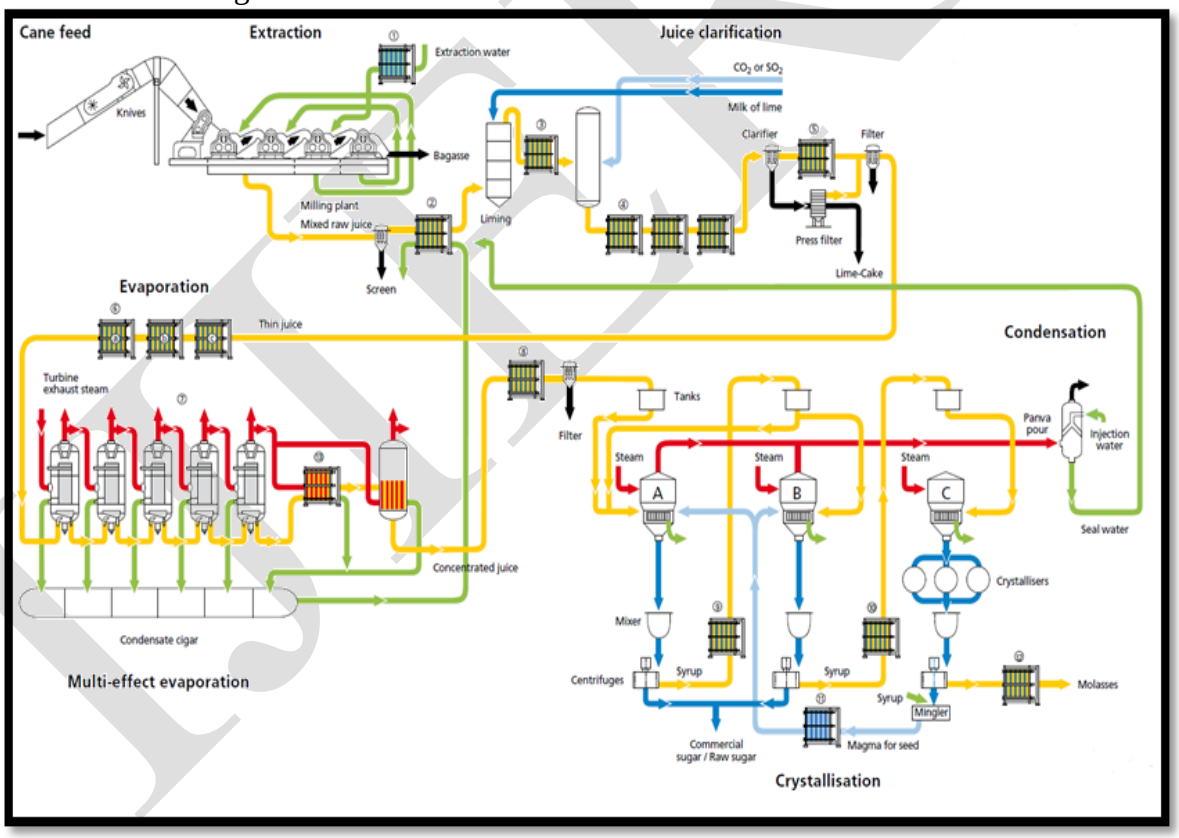

Fig 1: Manufacturing & Water Circulation Process in Sugar Industry

The water requirement of LSECIL for different unit operation is as below,

a. MILLING SECTION:

- Cold water- for mill bearing cooling (30 m^3/hr), shredder bearing cooling (20 m^3/hr) and mill gearing cooling (76 m^3/hr).
- Hot water- requires for mill imbibition ranges from 28-32% on cane. (85.8 m^3/hr)

b. CLARIFICATION OF JUICE:

- Cold water- for sulphur station (11 m^3/hr), air compressor (20 m^3/hr) and pump gland cooling (8 m^3/hr).
- Hot water- for milk of lime preparation (10.4 m^3/hr) i.e. 4 % on cane and oliver filter washing i.e. 5% on cane (13 m^3/hr).

c. EVAPORATION:

- Hot water- for molasses conditioning (5.2 m^3/hr), melter (13 m^3/hr), water movement for pan (5.2 m^3/hr), magma and seed preparation (5.2 m^3/hr) i.e. 2% on cane, makeup for C- mascuite reheating (4.5 m^3/hr) i.e. about 1.5-2 % on cane.
- Cold water- injection water for vacuum pan.

d. BOILER WATER:

- Hot water as a boiler feed water(170 m^3/hr) ,
- Cold water- boiler makeup water(13.9 m^3/hr), RO plant reject (4.17 m^3/hr)

e. WASHING & MISCELLANEOUS USE:

- Water required for washing of centrifugal (2.6 m^3/hr), floor, laboratories, etc.

WATER CONSERVATION TECHNIQUES ADOPTED BY LSECIL

The various techniques adopted by LSECIL on water conservation are enumerated as below,

a. Milling Plant - Hot condensate after cooling in two stage cooling towers is fully used instead of fresh water supplement.
b. Boiler feed water - First body evaporator condensate (exhaust condensate) is only used as boiler feed water, as other evaporator bodies does not give the condensate of the boiler feed quality.
c. Clarification House Compressors- Re-circulated the cooling waters.
d. Sulphur Burner- Water used is re-circulated and connected to spray pond.
e. Oliver Filter- Spray pond water is used to create vacuum at vacuum pump and barometric condensers. Hot water condensate is used for filter cake washing.
f. Boiling and Centrifuge Section- Hot water condensate is used for cooling. Water required to wash sugar mascuitte in centrifugal machine is condensate from evaporator bodies.
g. Preparation of seed and mixture- Hot water is used instead of fresh water.
h. Cooling water- Cooled condensate and re-circulated water is used for Mill drive, mill bearing, power house turbines, fiberisers, compressor, cooling and vertical crystallizers.
i. Excess Condensate- Sent to cooling tower for cooling.

WATER BALANCE

The hot and cold water consumption in LSECIL is shown in the form of schematic diagram in Fig.2 and 3.

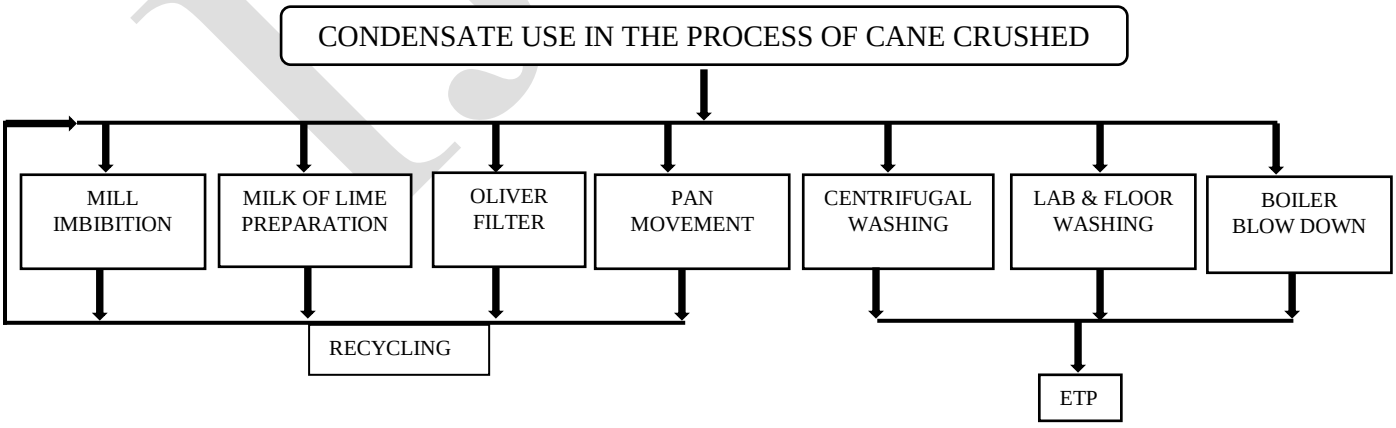

Fig 2: Hot Water Consumption in LSECIL

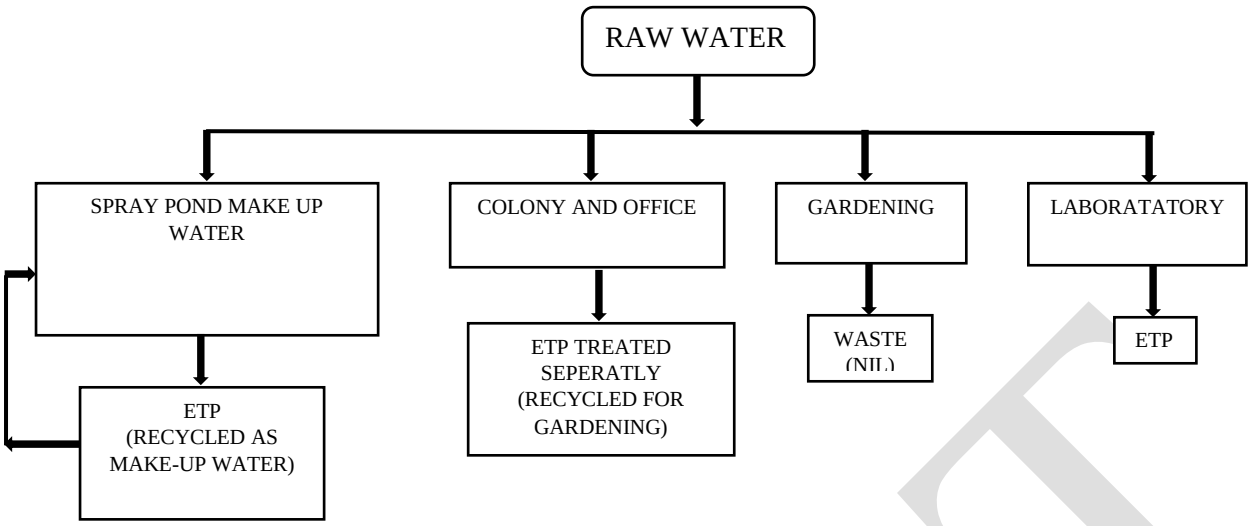

Fig 3: Cold Water Consumption in LSECIL

Based on the water balance study of LSECIL, it is feasible to completely eliminate the process water requirement (except for drinking and laboratory purpose) to be brought from outside source, in fact it can generate some excess water which can be stored and reused in the process. It is also feasible to reuse, the treated effluent water as makeup water in spray pond, sulphur burner cooling water, wet-scrubber, etc. and in which case the effluent quantity can be further reduced to 9.0% of the cane crushed.

Table 1: Case Study of LSECIL with crushing rate 260 T/hr (6000 TCD)

Hot Water

Hot water Required	**T/hr**		**Hot water available**	**T/hr**
A. Clean Condensate			A. Clean Condensate	
• Boiler (170 T/hr)	170		• Condensate from Evaporator – I	110
• Blow down and Emergencies (3% of boiler capacity)	5.1		• Surface condenser (TG)	32
• For Desuperheating (2%)	5.2		• HP heater	15
			• Dearator	9
			• Ejector (TG)	0.4
B. Hot water			B. Hot water	
• Mill Imbibition (230% on Fibre), 33% cane	85.8		• Condensate from Evaporator - II to V	85
• Movement water for Pans - 2%	5.2		• Condensate from Pans	54
• For molasses conditioners (2%)	5.2		• Condensate from Juice Heaters	36
• Melter (5 %)	13		• Oliver filter	13
• For magma & seed preparation (2 %)	5.2			
• Oliver filter	13			
• For Milk of lime preparation (4%)	10.4			
• Water at C / F washings (1%)	2.6			
• Misc - washings & losses &unacconted (1 %)	2.6			
• Make for C massecuite reheating 0.4 m3/m3	4.5			
Total hot water required	327.8		Total hot water available	354.4
			Net balance hot water	**26.6**

Cold Water

Cold Water Required	Re-circulated Water	Make up Water
• Shredder bearing cooling	20	0.2
• Mill bearing cooling	30	0.3
• Mill gear cooling (5 mill + 1 GRPF)	76	0.76
• Sulphur station	11	1.1
• B and C Massecuite cooling ,	25.5	0.255
• Air compressors	20	0.2
• Pump gland cooling	8	8
• Laboratory, washings and unaccounted losses 1%	2.6	2.6
• R.O. plant reject	4.17	4.17
Total	**197.27**	**17.585**

Cold water available	
Hot water cooled (Surplus)	26.6
	26.6

Summary of Water Balance

1	Hot water cooled (surplus)	26.6 T/hr
2	Total cold water required as make up water	17.585 T/hr
3	Excess water available	9.015 T/hr = 216.36 (m^3/day)

PROCESS MODIFICATIONS

It is a need of hour to establish co-generation unit along with sugar industry from economic sustainability point of view and also raw material required for this is available in the form of bagasse, which is a by-product of sugar industry. Following modifications are recommended,

- From the water minimization point of view, back pressure turbine shall be preferred instead of condensing turbine as a process modification.
- Cooling towers in condensing turbines requires huge amount of fresh cooling water which can be minimised to zero by installing air cooled condensers.
- Condensate polishing unit will lead to achieve "water" as a by-product of sugar industry.
- Excess condensate is get contaminated to certain extent after repetitive recycling hence it has to be treated by installing condensate polishing unit.
- Due to this process modification, the wastewater load on ETP is reduced tremendously.

DISCUSSION AND CONCLUSION

During manufacturing process of sugar from sugarcane, water comes out as a by-product, in the form of excess condensate. There is a considerable amount of water generated which has large potential of being re-used. The processes like mill imbibition, milk of lime preparation, oliver filter washing, etc. requires considerable amount of water. This requirement of water can be fulfilled from the excess condensate, thus making the industry a zero water intake industry.

CONCLUSION

The process modification like use of air cooled condenser installation of condensate polishing unit (CPU) with good housekeeping, efficient operation and maintenance of industry will lead to achieve water conservation in sugar industry. Hot condensate after cooling in two stages cooling tower can be efficiently used instead of fresh water supplement. The reduction of water consumptions by optimum use and implementation of 3-R i.e. Reduce, Reuse and Recycle will definitely lead to the water conservation in the sugar industry which is proven by the techniques suggested to Lokmangal Sugar, Ethanol and Co-generation Industries Ltd., Bhandarkavthe, Dist: Solapur.

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