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Energy and Water Saving Initiative at DBSIL, Nigohi

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ABSTRACT

In the present ms, we have explained how DBSIL has with the increasing global focus on energy efficiency and sustainability. This study aimed to investigate and implement energy-saving initiatives at DBSIL, Nigohi. The sugar industry is a significant consumer of energy. Through a comprehensive analysis of the plant's energy usage and identification of areas of improvement, Nigohi has implemented various measures such as optimization of steam and water consumption, efficient use of bagasse, and installation of energy-efficient equipment.

Keywords : Energy efficiency, sustainability, FFEs, plate type heat exchangers, direct contact heater, zero liquid discharge, zero fresh water consumption.

INTRODUCTION

The factory set up in Nigohi currently has a capacity for 10,000 TCD of cane crushing, a 120 KLPD distillery and 28 MW of co-generation. The unit also carries a sulphurless refinery producing refined sugar with high quality and safe consumption for further export globally.

The sugar industry is a significant contributor to the global food economy, but it faces intense scrutiny for its environmental impact. As the world grapples with the challenges of climate change, water scarcity and sustainable development the sugar industry must adapt and transform its practices to ensure a more sustainable future.

This paper describes the journey of DBSIL-Nigohi, one of India's leading sugar producers, in reducing its environmental footprint while enhancing its productivity and profitability. By implementing innovative energy and water-saving initiatives at its Nigohi unit, DBSIL has achieved significant reductions in energy consumption, water usage and wastewater generation. This paper highlights the technologies and practices adopted by DBSIL, including the installation of falling film evaporators, utilization of waste heat and implementation of zero liquid discharge and zero fresh water consumption systems. By sharing its experiences and achievements, DBSIL aims to inspire other sugar producers to adopt sustainable practices and contribute to a more environmentally conscious and socially responsible industry.

Sugar industry need for energy saving

Sugar production involves various energy-intensive processes like juice extraction, clarification, evaporation, crystallization and centrifugation which require significant amounts of water, steam and electricity. As global energy prices continue to rise, the sugar industry faces increasing energy costs, affecting its profitability and competitiveness.

The sugar industry's energy consumption contributes to greenhouse gas emissions, which have a significant impact on climate change. Reducing energy usage can help minimize this environmental footprint. Implementing energy-saving initiatives can lead to

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significant cost reductions, improving the industry's profitability. Many energy-saving initiatives also reduce water consumption, which is essential in water-scarce regions where sugar production often takes place.

By implementing energy-saving initiatives, the sugar industry can contribute to a low-carbon economy, aligning with global efforts to combat climate change, water saving and promote sustainable development.

Energy saving initiatives

The following initiatives have been taken at DBSIL, Nigohi :

Installations of FFEs: The 1st and 2nd effects of the evaporator have been upgraded to FFE (3 nos - 7000 m^2 each) from semi-kestners. These evaporators have some of the same advantages as the kestner evaporator, namely the use of long tubes and more compact vessels. However, they require uniform and adequate wetting of the tubes and so need the complication of juice re-circulation and a distribution system feeding equal quantities of juice to every tube (Rein, 2007). Due to no hydrostatic head and elimination of BPE, the FFEs run on 4-5 deg lesser temperature difference than the conventional robert type bodies, resulting in higher vapour temperature across the effects which helps us in shifting the part of the vapour bleedings to later effects and due to higher temperature the vapour consumption at various stages get reduced which finally affects the steam consumption (Figure 1).

Figure 1 : FFEs and wide gap clear juice PHEs

Utilization of waste heat through various innovative measures: Complete raw juice heating is done through utilisation of waste heat. 1st RJ heating is done through VLJH on VCP, then 2nd RJ heating is done through VLJH on the last effect and final raw juice heating upto 72^{o}C is done through condensate juice heaters in counter current flow.

Change of evaporator configuration: The evaporator configuration was changed from a five-effect (quintuple) to a six-effect evaporator to utilise later effect vapours as per the Rillieux principle (Hugot, 1986; Table 1).

Installation of vertical continuous pan: To ensure complete raw massecuite boiling on 4th vapour and maximum exhaustion. It consists of 4-5 compartments i.e., pans placed over each other with massecuite bypass, overflow, liquidation system and other. It utilizes 4th effect vapour for operation and contributes to steam saving.

Installation of direct contact heater (DCHs): In DCHs, juice is heated with direct contact of vapours where the total heat of vapors (latent heat + sensible heat) is utilized for the heating and therefore, these types of heaters operate on a temperature difference of 2-3 ^{o}C. At DBSIL, DCH are installed at various heating like - 2nd and 3rd heating of defecated juice heating on 4th and 5th effect vapours, raw melt heating on 4th heating and molasses conditioning, etc.

Installation of wide gap plate type heat exchangers: For clear juice heating in three stages, which works at a lower temperature difference and improve efficiency. These type of PHEs avoid choking and thus become more efficient.

Installation of honeycomb pan: Pan with honey comb calendria is being installed to utilise low pressure vapour for B m/c boiling

Modification of pan mechanical circulators: To meet proper massecuite circulation rate which required for lower temperature vapour.

Implementing cutting-edge technologies and equipment in successive steps: by the use of this initiative at DBSIL-Nigohi, we have successfully reduced the steam consumption from 45-46% to 36-37% (full refinery on C m/c boiling).

In 2017-18, DBSIL Nigohi changed the manufacturing process from double sulphitaion to DMP process, even though with the increase in total massecuite upto 22% on cane, the steam consumption increased only 1.68%. This was due to the steam-saving project, which included the installation of FFEs, VCPs, and melt concentrators. In 2020-21, the DMP process was changed to DMP+IER process which further reduced the steam consumption due to lower R1-Hy molasses re-circulation. Further in 2023-24, 2nd phase of the steam saving project was carried out in which FFEs on 1st and 2nd effect, change of evaporator configuration, shifting of all vapour bleeding to later effects were done. The reduction in steam % cane is approx. - 9.0 -9.50% on cane (Table 2).

Sugar industry's need for water saving

Sugar production requires significant amounts of water for various processes like juice extraction, clarification, washing and boiler operation. Many sugar-producing regions face water scarcity, and the industry competes with other users for this limited resource. Excessive water usage can lead to water pollution, harm aquatic ecosystems, and deplete groundwater resources. Reducing water consumption can lower energy costs associated with pumping, treating, and transporting water. The sugar industry has a social responsibility

Table 1 : Evaporator configuration 2022-23 vs 2023-24

Effect	2022-23		2023-24	
	Type	Heating Surface (m^2)	Type	Heating Surface (m^2)
1st effect	SK	7000	FFE	7000
2nd effect	FFE	6000	FFE	7000
3rd effect	FFE	6000	FFE	7000
4th effect	Robert	2700	FFE	6000
5th effect	Robert	1500	Robert	2700
6th effect	-	-	Robert	1500
Total H.S (m^2)	**23200**		**31200**	

Table 2 : Steam and power consumption data

Season	Operation Profile		M/c% Cane	Steam% Cane	Power/MT Cane BH	Power/ MT Cane MH
2016-17	C-Hy	Double Sulphitation	53.47	43.39	9.27	16.98
2017-18	C-Hy	DMP + steam saving (1st phase)	75.62	45.07	11.49	18.09
2018-19	C-Hy	DMP + steam saving (1st phase)	76.62	46.34	12.34	16.56
2019-20	B-Hy, C-Hy	DMP + steam saving (1st phase)	67.91	44.95	11.41	15.86
2020-21	B-Hy, C-Hy	IER	66.45	41.60	10.43	16.07
2021-22	C-Hy + Syp, B.Hy + Syp	IER	71.10	39.19	10.40	15.48
2022-23	C-Hy + Syp, B.Hy + Syp	IER	67.76	39.04	10.88	15.82
2023-24	C-Hy + Thk Juice, C-Hy	IER + Steam saving (2nd phase)	73.69	36.44	13.36	16.40

to conserve water, ensuring sufficient supply for local communities and future generations.

Water conservation helps mitigate climate change by reducing energy consumption and promoting sustainable practices. Water-saving initiatives can optimize production processes, leading to increased efficiency and productivity. Conserving water reduces the amount of wastewater generated, minimizing environmental impacts. Implementing water-saving initiatives demonstrates the industry's commitment to sustainability, enhancing its reputation and social license to operate.

Water saving initiatives

Installation of re-circulation reactor along with other accessories: This works on the anaerobic digestion process for the purpose of effluent treatment, so that ZFC can be achieved (Figure 2).

ZLD (Zero liquid discharge): The total effluent produced from mill house, boiling house, power plant and distillery is treated at ETP using anaerobic digestor.

ZFC - Zero fresh water consumption is being followed in the factory premises. DBSIL, Nigohi is using total treated water in house and have minimized our borewell extraction to zero extraction. The treated water utilization scheme is given below.

At power plant -

(a) Treated water from ETP → UF System → RO System → Boiler makeup (DM water)

At Distillery -

(a) Treated water from ETP/CPU/ RO Plant → UV System → Fermentation Section

(b) UF Water from Power Plant → UV System Yeast Propagation Section

(c) UF Water from Power Plant → RO Plant → Cooling Tower Makeup

Zero groundwater withdrawal: We have successfully achieved zero groundwater withdrawal in the last 3 crushing seasons and utilised treated water for operation purpose (Table 3).

Saving ground water: By the elimination of ground water withdrawal, we saved approx. 3.66 lac m^3 of ground water by using treated water in a high-pressure boiler, distillery, green belt and farmer irrigation (Table 4).

Saving electricity: DBSIL Nigohi saved approx. 63731 kW of electricity for bore-well operation in season 2023-24 by elimination of ground water withdrawal (Table 5).

Figure 2 : Anaerobic reactor and ETP aerial view

Table 3 : Effluent treated and utilisation of treated water

S. No.	Particulars	UOM	Season 2021-22	Season 2022-23	Season 2023-24
1	Total Effluent quantity	m^3/day	2138	2198	2244
2	Outlet Treated water	m^3/day	2118	2161	2206
3	Treated water to Distillery	m^3/day	234	167	305
4	Treated water to Power Plant	m^3/day	890	1110	1040
5	Treated water for irrigation and greenbelt	m^3/day	994	883	860
6	Biogas	m^3/day	1622	1370	757

Table 4 : Total treated water utilised during season 2023-24

S.No.	Particulars	UOM	Values
1	Power-plant	m^3	172698
2	Distillery	m^3	50605
3	Green belt and Farmer Irrigation	m^3	142825
4	Total	m^3	366128

Table 5 : Power saved in borewell operation

S.No.	Particulars	UOM	Values
1	Water saved	m^3	366128
2	Bore-well operation (@150 m^3/hr)	Hr	2441
3	Bore-well power consumption @70%	kW/hr	26.11
4	Power Saved	kW	63731

Rinse water recovery system: Permeate from rinse water recovery system is used for hydro jet cleaning and as makeup water in spray pond water in place of fresh borewell water.

Hydro-jet cleaning excess water and pump gland cooling water is recycled: A greater amount of water was consumed for mechanical cleaning of evaporator and heater bodies. After the introduction of hydro jet, total effluent generation quantity decreased significantly due to decrease in water required for cleaning and cleaning duration per equipment.

Reducing additional load to ETP: BRS reject is sent to the distillery, thus reducing additional load to ETP.

Treated water: It is used in place of raw water in the boiler.

Treated water is used in the fermentation unit at the distillery after UV treatment.

Treated effluent water is used as spray pond make-up water, gardening and farmer irrigation.

CONCLUSION

The sugar industry can significantly benefit from implementing energy and water-saving initiatives, reducing its environmental footprint while enhancing profitability and sustainability. By adopting innovative technologies and efficient practices, sugar producers can minimize their energy consumption, water usage, and wastewater generation, contributing to a more sustainable future for the industry and the planet.

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