Efficiency Optimization & Detailed Energy Audit of Sugar Industry

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Abstract—Energy is the lifeblood of today's economy of any nation .Any threat to the availability of this resource can endanger local as well as global prosperity. Consumption trends all over the world are impressive and lead us to face problem of the sustainability of our system. The energy audit is undertaken with the aim of providing of company situation, quantifying possible energy saving and defining the measure needed to achieve valuable saving.Energy audit has becomes all the more important in view of the energy conservation Act 2001 enacted by Government of India and the proposed New provisions. The objectives of an energy audit can vary from one plant to another. However, an energy audit is usually conducted to understand how energy is used within the plant and to find opportunities for improvement and energy saving. Sometimes, energy audits are conducted to evaluate the effectiveness of an energy efficiency project or program. The result from the energy audit of a Sugar Industry located at NH 8, Valsad. The scope of eergy audit in sugar Industry should include the study of improve the power factor ,replace lights by efficient light, install VFD drive in spray pump, install of Automatic temperature controller in cooling tower system, reduce overloading of certain pump and install planatory gear drive in place of worm gear drive. some areas has found in Sugar plant for increasing plant productivity .It is also identified that Energy conservation must consider as important factor for cost reduction.

Keywords: Energy use, Energy audit, Energy efficient technology, Energy conservation, Sugar industry

I. INTRODUCTION

Indian sugar mills, both in the private and cooperative joint sectors, have acknowledged importance of implementing high efficiency grid connected cogen power plants for generating exportable surplus power. In fact, additional revenue stream by sale of exportable power to State Electricity Boards (or third party customers), has become the only way for achieving long term sustainability, given the fiercely competitive domestic and international sugar markets. The potential from about 575 operating sugar mills spread over 9 major States have been identified at 3,500 MW of surplus power by using bagasse as the renewable source of energy.

Energy Audit is important tool to a systematic approach for decision-making in the area of energy management. It tries to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management program . In any industry, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials.

II. OVERVIEW OF THE SUGAR INDUSTRY

ValsadSahkariKhandUdyogMandali is leading Sugar manufacturing Unit Registered under cooperative sector act. Capacity of Valsad sugar mill is 5000 TCD. Valsad sugar mill has dynamic Management and is constantly in improving productivity through effective energy usage.

Co-generation improves viability profitability of sugar Industries. Indian sugar mills are rapidly turning to baggase, Left over of cane after juice is executed, to generate electricity and steam. This is mainly being done to clean up the environment, Cut down power cost and earn additional revenue. According to current estimates about 3500MW power can be generated from baggase in existing 430 sugar mills in the country. Around 270MW of power has already commission and more is under construction. This Sugar Industries also installed captive generation system as economic measure. Power generation Capacity of generation is 5.5 MW by two 3 & 2.5 MW Turbine Generator. Now 2.5 MW TG is in operation.

III. SUGAR PRODUCTION PROCESS

- Cane is weighted first, and then it is converted into small pieces by passing through fiberizer where cane is turn into small thin fibrous form and then enter into mill set through carrier.
- This prepared cane is now crushed in mills .after passing through three mills hot water of temperature 60 °C to 70°C is added in fourth mill to take out as much as possible in leaving Baggase .The Baggase is used as fuel in Boiler to produce steam.
- The produced steam is used for prime mover of power turbines, mills and Fiberizer. The juice is collected at Mills is called "Mixed Juice" is pumped out to auto weighing Tank.

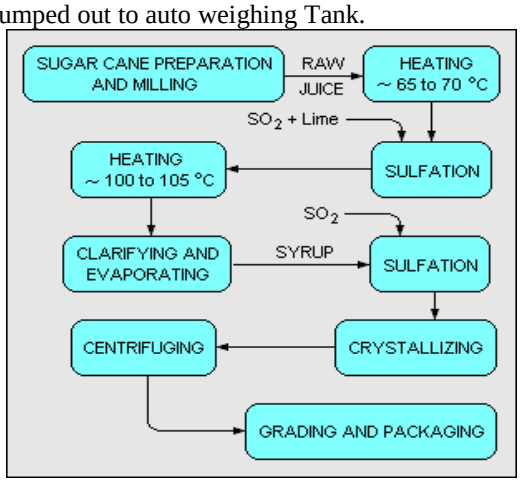

Fig. 1: Sugar Production Process

- This "Mixed Juice " is now allowed to pass Juice heater where it is being heated at 60 °C to 70°C for

clarification ,Juice is mixed with milk of lime and SO_2 gas simultaneously .Here PH of juice is maintained at 6.9 to 7.1.This juice is called sulphited juice. This sulphited juice is heated again to 100-105°C and it is pushed to settler vessels called clarifier where all Mud is settled down and clear juice is obtained on upper part of chamber.

- The muddy juice now pumped to filter where mud is taken out from the juice again sent to "Mixed Juice" and mud separated is known as "Filter Cake" which is used as manure in the syrup is again passed through SO_2 gas where PH is maintained at 4.9 to 5.1.
- Now this Sulphited syrup is sent to supply tanks of pan station .After boiling under vacuum at "pan", small grain is formed with molasses are called "Masscult"
- After dropping from pan, this Massecuite are allowed cool in crystallizer and then pumped out to centrifugal machines.
- At centrifugal machines sugar and molasses are separated Now the sugar is passed through hopper to get it free from moisture and Hot and Cold air is applied through blower.
- The separated molasses is collected in storage tanks
- This sugar is separated in separate grade by passing through grader of different mesh and finally from grader sugar filled in gunny bags and weighted and sends to go-downs.

IV. ENERGY USE IN SUGAR INDUSTRY

A. Electricity Consumption & Bill Analysis:

Mill has its own co generation at present 3 MW TG set is working to fulfill power requirement of plant. DGVCL power supply has taken with contract demand of 475 KVA.In Addition above, DG set of 500

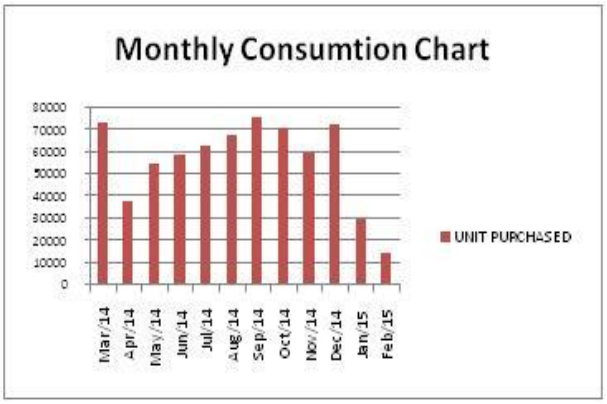

Fig. 2: Monthly Consumption Chart

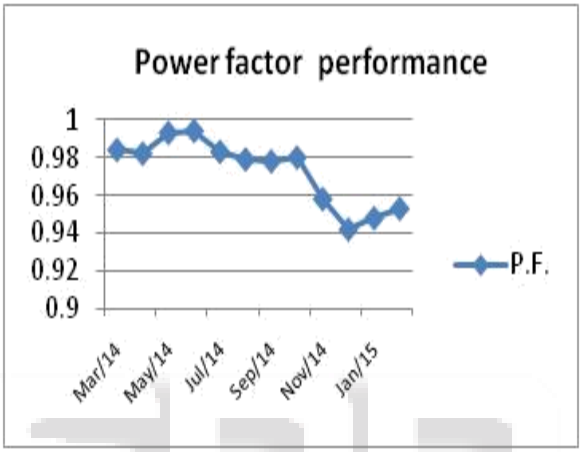

Fig. 3: Power Factor Performance

Sr.	Month	Contract Demand (KVA)	Billiing Demand (KVA)	Actual Maximam Demand (KVA)	Power consumption	KVARH	TOU	TOU CHARGES	P.F.	P.F. Rebate	Total Bill Amount
1	Mar-14	475	404	227	73524	6972	24654	8629	0.984	4956	486434
2	Apr-14	475	404	189	38340	4230	12624	4118	0.982	2432	276313
3	May-14	475	404	146	55092	2646	17664	6182	0.993	5002	391931
4	Jun-14	475	404	137	59142	2130	18696	6544	0.994	5510	417119
5	Jul-14	475	404	205	62664	4854	21528	7535	0.983	4366	440103
6	Aug-14	475	404	230	67872	7218	23088	8081	0.979	4162	469179
7	Sep-14	475	404	226	75726	7530	26022	9108	0.978	4501	518612
8	Oct-14	475	404	349	70716	6672	22902	8016	0.98	4444	482650
9	Nov-14	475	404	349	59676	10218	18756	6565	0.958	999	425492
10	Dec-14	475	496	496	73014	24276	26106	9173	0.942	0	536411
11	Jan-15	475	472	472	29922	6720	11376	3982	0.948	0	254560
12	Feb-15	475	461	461	14358	3360	6042	2115	0.953	92	157014
	Total				680046	86826	229458	80048		36464	4855818
	Avg.	475	422.083	291	56670.5	7235.5	19121.5	6670.66	0.9728	3038.66	404651.5

TABLE 1: POWER BILL DETAIL OF LAST 12 MONTHS

V. ENERGY EFFICIENCY IMPROVEMENT OPPORTUNITY IN A SUGAR INDUSTRY

This analysis of energy efficiency improvement opportunities in the sugar industry includes both Opportunities for retrofit/process optimization as well as the complete replacement of the running machinery with energy efficient technology. However, special attention is paid to retrofit measures new technologies have high upfront capital costs, and therefore the energy savings which result from the replacement of current equipment with new equipment alone in many cases may not justify the cost. Furthermore, we have tried to present measures for which we could find

quantitative values for energy savings and cost. Also, It should be noted that the energy saving and cost data provided in this paper are either typical saving/cost or plant/case specific data. The saving from and cost of the measures can vary depending on various factors such as plant and process-specific factors, the type of sugar cane and the quantity of sugar cane .

A. Improve Power Factor:

We can get power factor rebate by installing the required additional capacitor bank on DGVCL transformer.

Power factor rebate obtain during last 12 months	Rs.36463
Proposed rebate by maintaining PF at 0.999	Rs.69682
Saving due to additional rebate	Rs 33220
No of additional capacitor required to on DGVCL transformer	50 KVAR
Cost of capacitor Rs 300 per capacitor	15000
Simple Payback period in months	5.41

Table 2: Improve Power Factor of Sugar plant

B. Lighting Survey:

Lighting load consist of single tube light ,Mercury Vapour , Sodium Lamps, Bulbs etc Following table show detail of connected lighting load in the mill only. Lighting distribution provided from separate DB board.

Annual power saving Potentiality (kWH)	29937.2
Money saving potentiality Rs/Annum	119750.4
Total number of LED lights required	231
Cost of one time replacement in 8 years @ Rs 16000 /LED fitting	369600
Cost of reduction of replacement of conventional tube lights @ 2 year	92400
Actual cost of replacement will be	277200
Simple payback period (Months)	27.7

Table 3: Energy saving by using high efficiency LED Lamps

Annual power saving Potentiality (kWH)	10282
Money saving potentiality ☐/Annum	41128
Total number of CFL lights required	68
Cost of one time replacement @ ☐125 /CFL fitting	8500
Simple payback period (Months)	2.5

Table 4: Energy saving by Using high efficiency 18W CFL

C. Performance of Sugar Crystallizer:

High efficiency crystallizer drive consist of a multi stage planetary gear reducer and single helical gear transmission, all housed in a common oil & dust proof enclosure with electrical motor directly flanged on the housing .The drive has allow output shaft, which directly sits over the crystallizer shaft and is keyed to it .the drive being shaft mounted type the reaction force is taken by its torque arm & torque arm arrestor which is bolted at covenant place.

This drive are specified for the overall transmission efficiency of better than 90% . as such , substantial Power saving can obtained when the conventional worm drive system are replaced with planetary crystallizer drives , There drives are of lightweight hence it is easy to install .low running and maintenance cost oil filling is required for onesseason, easy manual operation during power failure with surrounding clean and free of oil spillage.

Recommendation: It is appreciable that management has converted some crystallizer by planetary drive and reduced the input motor from 11kV to 3 kV motor. Reduction in power consumption is 44 kWHr /crystallizer per day .it is recommended to convert remaining crystallizer also as power saving.

Crystallizer No-12 (old worm gear)-15Hp/11kW	2.37kW
CrystallizerNo-7(PlanatoryGear)-3Hp/2.2kW	.57kW
Reduction Power	1.8kW
Reduction kWH /day 1.8*24*150 per drive	6480kWH
Saving in Amount/season	Rs 25920
Investment	Rs 20000
Simple Payback period	9 Months

Table 5: Saving potentially by planetary Gear drive

D. Cooling Tower performance:

Cooling Tower Pumps: For hot water cooling, Natural draft system with spray nozzles in spray pond is necessary for sugar mills where large quantity of water is to be cooled .Hot water from mill process is collected in the big pond where water is cooled by spray nozzles .Water is circulated by pumps .These pumps are spraying hot water by spray nozzles.

Recommendation: Cooling Tower pump is working constantly day and night irrespective of heat load .It is suggested to put VFD on one spray pump motor which will control flow of water by adjusting speed of pump. Speed may be adjusted as per required set temperature for injection process. Nearly 30% saving is achieved by such controller.

Cooling Tower fans :Fans are working continuously irrespective of inlet water temperature .the performance of cooling towers depending upon ambient wet temperature which vary during day & night .And also water Temperature depend on the heat load .

Recommendation: It is suggested to install automatic temperature controller for cooling tower. The controller should be switch off the fan when the temperature goes down below the set temperature and switches on when temperature goes above the set temperature (28-30°C).

E. Performance evolution of Pumps:

Load Measurement of pump were taken for those pumps which were found working during audit time .For the purpose of evaluating operating efficiency of pump sets various parameter of head ,flow and power were taken for pumps. However for some pump it was not possible to measure flow or Head. These pumps are mentioned in the following table.

Recommendation:- Following pumps are drawing higher power than their rated power .It is suggested to reduce overloading for motor safety .Saving potentiality due to over loading of pumps are shown here under

Sr	Location	Rated Power	Meas. Power	Execess power	Annual Saving Amount
1	Bore well pump	9.3	11.5	2.2	31680

2	Injection pump 1	160	170	10	144000
3	Quad Injection Pump	75	76.5	1.5	21600
4	Injection Pump 2	75	79.4	4.4	63360

Table 7: Saving potentially By Reducing Over loading Of Pump

VI. CONCLUSION

Energy audit is important tool for identifying energy waste and accordingly corrective action can be taken which will result in saving energy, improving efficiency and reliability of machine and also gaining benefit in terms of Money. It is also increase economic viability & productivity of Plant.

During the measurement and after the analysis it is observed that Overall Power Factor of Plant during some month is lower than 0.999 level. So Install Super heavy duty capacitor at LT side to improve power factor of Sugar Plant and save Rs. 33220/Annum with 5.41 months payback period.

Retrofit the existing 400W HPMV by 150 W LED high bay / flood light Rs. 205200/Annum will be save with simple payback of 10 months.

Also Retrofit existing 60 W Bulbs by 18 W CFL which leads to save Rs 41128 annually with simple pay back of 2.5 months.

Various Pumps are Installed for juice transfer .water utility and other machinery as per requirement inplant .Pumping Power required in the sugar industries is high due to mainly injection pumps, spray cooling pumps ,Various juice pumps and boiler feed pump.

After Measurement and analysis it is found that some of pumps of industry drawing more power than their rated power .It is suggested to reducing overloading for motor safety proper maintenance . it will save Rs 260640 annually

Two spray pumps one of 250HP and other of 120 HP are operated continuously in operation for spray cooling. There is good saving potentiality of power operation in respective to cooling water temperature. It is suggested to put one VFD of the pump as power saving measure by adjusting flow pump with respect to set temperature. It will reduce annual bill by Rs 470880 / Annum with simple payback of 15 months.

In Cooling Tower, Fans are working continuously irrespective of inlet water temperature. It is necessary to install Automatic Temperature controller for CT.The controller switches off when temperature goes below the set temperature (28-30°C) and switches on when temperature goes above the set temperature (28-30°C) .Installation of Automatic Temperature Controller will save Rs 36864 with simple payback period of 3.3 months.

Conventional crystallizer worm gear drives system has combine efficiency as low as 40% . Power saving can be achieved by replacing conventional worm gear system with highly efficient planetary gear drive. It will save Rs 25920 annually with simple payback period of 9 months.

After Energy Audit, we have identified around Rs 495860.00 saving potentially which is 10.21% of total amount paid towards electricity bill of previous year.

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