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Performance Analysis aimedto Improve Efficiency by Energy Audit at Narmada Sugar Factory, Dharikheda.

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Abstract :Energy audit and process analysis of industrial machines are essential to save energy for efficient use of equipment.In energy audit, the system is well analyzed and report gives possible changes in the system. Energy audit analyze the causes of drastic losses of energy which occurs in industrial buildings due to larger thermal loads, heat losses, poor efficiency, larger specific consumptionin the different equipment. Energy audit identifies whether, where and how loses are occurring. Improvement in energy efficiency gives the advantage to industry in terms of profit may be directly or indirectly. This topic provides an explanation of the energy audit procedure for commercial or industrial buildings. In this paper,there is identification major areas where energy can be saved and have given solutions to reduce energy consumption in different mechanical systems such as Pumps, Compressors, Boilers, Belts or other systems that are used in industry.

I. Introduction

Narmada Sugar Factory is situated in the backward area of the Narmada District. The society is established in the year 1989 with the objectives of uplift of rural economy and development of tribal area of District Narmada.

They have installed one more zero mill and increased crushing capacity from 2500 MT per day to 4200 MT per day. The factory has now started to generate more power from bagasse and selling to DGVCL.

The factory houses equipment like pumps, compressors, boilers, motors, conveyer belts and other machining equipment. Among these equipment pumps, compressors, boilers and motors had the scopes of energy saving.

II. Pumps

Efficiency of the pump is given by the formula, $\eta = \frac{Q\rho g H}{P_{shaft} \times 1000}$

Q = Flow Rate in m^3/Sec, **ρ**= Density of Fluid in kg/m^3 = 1000, **g** = Gravitational Constant = 9.81, **H** = Pump Head in meter, $\mathbf{P_{shaft}}$= Shaft Power in kW.

	Boiler Feed Pump-2	Boiler Feed Pump-1
Q	0.0124	0.0041
H	660	780
P_{shaft}	104.83	45.80
ŋ (%)	76.59	68.50

Remarks:- Both Pumps are working with good efficiency. We have taken reading of the following pump. The efficiency of the same cannot be found out because there is no pressure gauge available and Pumps are very old.

Sr.no.	Pump	hp	kW
1	Dephited Juice Pump	150	-
2	Dephited Juice Pump	100	40
3	Spray Pump(13/4)	100	51
4	Spray pump(13/7)	100	20
5	Injection water pump(10/4)	220	94
6	Injection pump(9/2)	100	57
7	Clear juice pump(7/4)	70	17
8	Boiler vaccum pump(5/26)	125	75
9	Clear juice pump(5/7)	75	31
10	Clear juice pump(5/8)	75	24.16

For Improving of Pump efficiency the following points may be attended

1) The pumps may be for overhauling, alignment, applying adhesive epoxy compound on impeller and interior surface of pump body. At 50% flow pump efficiency dropped by 20 %.
2) At 0 load (no flow) pump takes significant power 30 % to 40 %.

Energy saving opportunity in Pump

1) High efficiency pump
2) Match pump to system by
   A) Impeller trimming B) Changing impeller
   C) Proper size Pump D) Variable speed drive

III. Compressors

	Capacity (CFM)
Compressor-1 Raw House	180
Compressor-2 Raw House	180
Compressor-1 Refinery	191
Compressor-2 Refinery	191
Compressor-3 Refinery	191

Remarks: Sample Load –Unload Test calculations are as given below.TheCompressor is found working with good capacity. Similar calculations were performed for other compressors, and all were found working with good capacity. Compressor-3 Refinery was powered off.

Compressor Load - Unload Test for Compressor-1 Raw House:

Cumulative Time	Loading Cycle Time	Unloading Cycle Time	Loading Cycle kW	Unloading Cycle kW
0				
60	60		27.77	
95		35		11.11
155	60		28	
195		40		11
255	60		28.15	
290		35		10.9
350	60			
Total Time	240	110		
%age Time	68.57	31.43		
Average kW			28	11
Working Days/Year			180	180
Annual kWh Consumption			82865	14939
Total kWh Consumption			97804	
Specific Consumption (kW/100 CFM)			15.5556	
Recommended Specific Consumption (kW/100 CFM)			16	

Tips for Compressor:

- Efficient flat nylon poly weave Belt may be provide in place of V- Belt.
- Efficient Electrical Motor may be used.

IV. Boilers

Total boilers = 3 Nos.

Specifications:

- Working Pressure: 32 kg/cm^2.
- Heating surface: 1575 m^2
- Steam generating capacity in Kg/hr.: 35000 kg/hr.
- Furnace area for bagasse or coal (in m^2.): 379.4 m^2.
- Super heater heating surface and degree of super heat: 120 m^2.

Boiler Efficiency $\eta = \frac{Q \times (h_g - h_f)}{q \times GCV}$

Boiler No.	Notation	1	2	3
Total Steam Produced (kg/hr)	Q	29792	29792	29792
Total Fuel Used (kg/hr)	q	13718	22409	22332
Enthalpy of Steam (kcal/kg)	h_g	745	745	745
Enthalpy of Feed Water (kcal/kg)	h_f	37	37	37
Gross Calorific Value of Fuel (kcal/kg)	GCV	2250	2250	2250
Boiler Efficiency (%)	Ƞ	68	42	42

Remarks: -Boiler no:1 is found working with good efficiency while no:2 and no:3 are working with below normal efficiency.

Tips for Boiler:

Heat Insulation: It is found that there is heat loss due to poor heat insulation at various locations of the boiler. So, Heat insulation should be attended regularly.
Combustion Control:- To monitor combustion of fuel in boiler, it is required to install Orsat testing system to monitor O_2 and CO_2 % in flue gas so that there will be no loss due to unburned fuel and excess heat carried out in flue gases through chimney.
Soot Blower: Install sonic soot blower for soot cleaning, as present system of soot cleaning by flash of superheated steam incurring heat loss.
Boiler water chemistry: It is suggested to take regular test at interval 2 hour. The raw cold water should be treated to achieve zero hardness. Silica below 1 PPM & TDS below 100ppm before adding the cold water to the high pressure boiler.

V. Belts

The V-Belts consume extra power due to transmission loss, improper alignment, loose/tight and groove gap slippage. Now Nylon poly weave Flat-Belts are introduced in India to reduce these transmission losses. Therefore it is proposed to replace all V-Belts with pulleys by flat poly weave nylon belts with pulleys and reduce transmission losses. According to practical estimating, about minimum 5% power can be saved by replacement of V-Belts.

Total Measured kW running load of V-Belt driven equipment	450
Total Nos. of V-Belt operated equipment	14
No. of working days	180
Total kWh per year	1944000
Considering diversity factor[2] – 50 % of total kWh per year	972000
Considering minimum saving of 5% due to replacement of V-Belts by Nylon polygrip Flat-Belt the annual Saving will be in kWh	48600
Average Cost	7.41
Saving (Rs.)	360126
Considering estimated cost of Rs.1000/- per kW on the average for flat pulleys, belt and labour charges, the total investment for V-Belt driven motors will be	450000
The pay back period in months	15

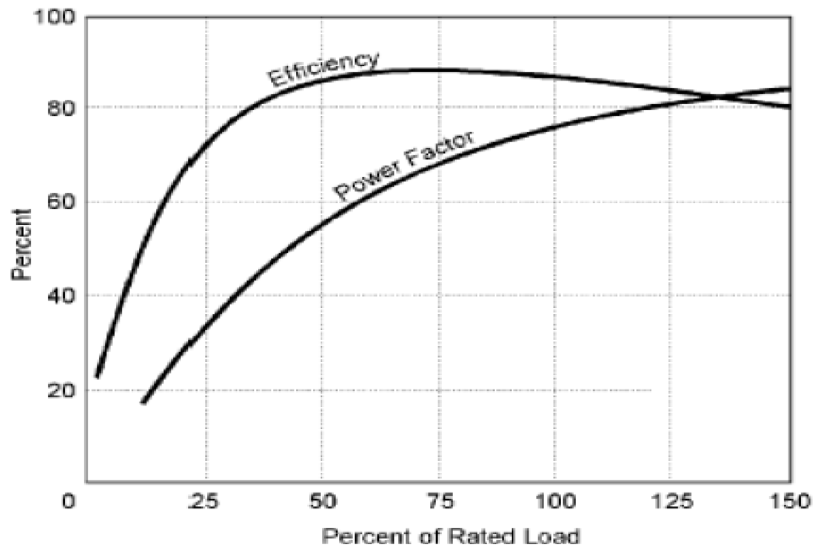
We can save total **48,600 KWH** worth **Rs.3,60,126/-** per annum with payback period 15 months, if the existing V-Belts are changed by Nylon Poly weave Flat Belts.

VI. Motors

Standard squirrel-cage induction motors are widely used as prime movers for driving machines. In general, even at ideal condition, it wastes 8-10% of the total electrical power during (electrical to mechanical) conversion.
It is always advisable to select correct capacity motors. There is a wrong notion that a lesser capacity motor is advantageous. But any under capacity will lead to overloading the motors thereby reducing considerably its speed, and machine production. So, any small advantage seen in

consumption is not true if we take the production loss also into account. Similarly an over capacity motor will also lead to excess consumption.

EFFICIENCY / POWER FACTOR Vs LOAD:



AVOIDING MOTOR BURNOUTS:

OVERLOAD RELAY is the only protecting device available in the motor control panel for motor burnout prevention. Therefore any defect in this device will lead to motor burnout.

Nominal limits of motor efficiency [1]:

It is recommended that the existing old IE1 type motors may be replaced by premium IE3 type motors to get benefit of better efficiency and to reduce the running cost of motor. From the nominal limits for standard efficiency IE1 and premium efficiency IE3[1], we can take example of 22 kW 2 pole IE 1 type motor to be replaced by premium IE 3 type motor as under.

Comparison of Power Consumption of IE 1 and Premier IE 3 motor :

	Audited Data	Proposed Data
Power Rating kW	22	22
Motor Efficiency	89.9	92.7
Per Day kWh Consumption	587.32	569.58
Average Energy Cost/Day (Approx.)	4350	4220
Working Days/Year	180	180
Annual Saving (Approx.)	23400	

VII. Conclusion

Efficiency of system can be increased by reduction in energy consumption. By reduction of energy conversion, we can get cost benefits too. Solutions for improvement in efficiency may require investment but after payback period it is beneficial to industry. Based on energy audit data certain improvement measures can be taken which can result in successful saving of energy consumption. In boiler, it is found that energy consumption is mainly reduced by replacing insulations& monitoring combustion. To monitor combustion of fuel in boiler, it is required to install Orsat testing system to monitor O_2 and CO_2 % in flue gas so that there will be no loss due to unburned fuel and excess heat carried out in flue gases through chimney.In pump, energy can be saved by changing or trimming the impeller. The over loaded motors could be changed by correct size to avoid frequent burning. For under loading motor, motor connections may be changed from delta to star.

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