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Energy management of mirc electronics ltd

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ABSTRACT

India is a developing nation. Its per capita energy consumption is very low. The principal objective of the energy audit was to explore the potential for reducing power & fuel bill (about Rs 6.5 Crore per year) of the factory. Technical study of the plant was undertaken with observation, measurements, discussion with concerned persons. The study indicated that utilities (chiller & air compressors) consume about 75% of electricity and furnace oil is used for boiler. The major utilities as mentioned are chillers, air compressors and boiler. Out the above, chillers & HVAC need complete revamping since the chillers are very old with reciprocating refrigerant compressor. Industries have switched over to screw compressor or centrifugal compressors since their overall performance is better than that of reciprocating compressors. Nowadays, package type chillers are available with good temperature control system. However revamping of chillers yields good annual saving. In order to bring about power & fuel bill reduction without major investment, the measures like certain automated control actions are mainly recommended, with simple pay back of less than 18 months.

Keywords— **Energy audit, Chiller, boiler, Air compressor**

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I.INTRODUCTION

Energy Audit

Energy audit is the first step forward systematic efforts for conservation of energy like financial audit. It involves and collection of energy related data on regular basis. It tells how and where the energy is being consumed and it also tells how efficiently and effectively the energy is being used. It is not only study to identify various weak areas but also tells the tool to take corrective actions and monitor the performance. Energy audit provides with the tool to bench mark your consumption against your best figure.

Energy audit is a powerful tool for exposure operational and equipment improvements that will reduce energy costs, lead to higher performance and save energy. Sometimes, the energy audit is also called an “energy assessment” or “energy study”. Energy audits can be done as a stand-alone effort but may be conducted as part of a larger analysis across an owner’s entire group. The purpose of an energy audit is to find out how, when, where and why energy is used.

The energy auditors do the audit process. The first thing energy auditor needs to be aware of end user expectations and then audit starts with an analysis of historical and current utility data. This sets the stage for an onsite inspection. The most important outcome of an energy audit is a list of recommended energy efficiency measures (EEMs). Energy audit serves the purpose of identifying energy usage within a facility, process or equipment, and then identifies opportunities for conservation, called energy conservation measures (ECMs). Audit provides the most accurate picture of energy savings opportunities. Energy audits can be targeted to specific systems i.e. boiler, turbine, generator and any motor etc.The study indicated that utilities (chiller & air compressors) consume about 75 % of electricity and furnace oil is used for

boiler. The major utilities as mentioned are chillers, air compressors and boiler

Company Profile:

MIRC Electronics Ltd, Wada manufactures ONIDA brand TV. The power & fuel bill of the unit was to the tune of Rs 6.5 Crore.

Annual Electricity Bill : Rs 4.6 Crore

Annual Fuel (FO + HSD) : Rs 2.0 Crore

Scope of Work: The scope of work is to study the followings with a view of energy conservation.

1 Chilled water plant & HVAC
2 Electricity Sub meters
3 Air Compressors
4 Boiler & steam utilization
5 Water Pumps

II.PROBLEM STATEMENT

The principal objective of the energy audit was to explore the potential for reducing power & fuel bill (about Rs 6.5 Cr per year) of the factory. Technical study of the plant Out the above, chillers & HVAC need complete revamping since the chillers are very old with reciprocating refrigerant compressors. In the present days, industries do not use reciprocating compressors. Industries have switched over to screw compressor or centrifugal compressors since their overall performance is better than that of reciprocating compressors. Nowadays, package type chillers are available with good temperature control system. In the present chillers & AHUs the control is manual, the new AHUs available have a auto operated three way valve which control temperature.

However, the revamping of all chillers will certainly yield saving but would call for investment to the tune of more than 1 Cr. Air compressors and boilers are in order in the sense that air compressor, screw types are operated and boiler performance was also satisfactory. In order to bring about power & fuel bill reduction without major investment, the measures like certainautomated control actions are mainly recommended, with simple pay back of less than 18 months.

III.METHODOLOGY

To maintain a clear focus on the objective of improving overall energy utilization, the team typically performs an energy audit in ten sequential tasks. This approach is taken to insure adequate dialog between energy auditors & client at key junctures during the exercise.

Step 1 - Interview with Key Facility Personnel

During the initial audit, a meeting was scheduled between the auditor and all key operating personnel to start the project. The meeting agenda focuses on: audit objectives and scope of work, facility rules and regulations, roles and responsibilities of project team members, and description of scheduled project activities.

Step 2 - Facility Tour

After the initial meeting, a tour of the facility is arranged to observe the various operations first hand, focusing on the major energy consuming systems identified during the interview, including the architectural, lighting and power, mechanical, and process energy systems.

Step 3 - Document Review

During the initial visit and subsequent meetings, available facility documentation are reviewed with facility representatives. This documentation includes all available architectural and engineering plans, facility operation and maintenance procedures and logs, and utility bills for the previous years.

Step 4 - Facility Inspection

After a thorough review of the construction and operating documentation, the major energy consuming processes in facility are further investigated. Where appropriate, field measurements are collected to substantiate operating parameters.

Step 5 - Staff Interviews

Subsequent to the facility inspection, the audit team meets again with the facility staff to review preliminary findings and the recommendations being considered. Given that the objective of the audit is to identify projects that have high value to the customer, management input at this juncture helps

establish the priorities that form the foundation of the energy audit.

Step 6 - Utility Analysis

The utility analysis is a detailed review of energy bills from the previous 12 to 36 months. If possible, energy data is obtained and reviewed prior to visiting the facility to insure that the site visit focuses on the most critical areas. Billing data reviewed includes energy usage, energy demand and utility rate structure. The utility data is normalized for changes in climate and facility operation and used as a baseline to compute projected energy savings for evaluated ECM's.

Step 7 - Identify/Evaluate Feasible ECMs

Typically, an energy audit will uncover both major

facility modifications requiring detailed economic analysis and minor operation modifications offering simple and/or quick paybacks. A list of major ECMs is developed for each of the major energy consuming systems. Based upon a final review of all information and data gathered about the facility, and based on the reactions obtained from the facility personnel at the conclusion of the field survey review, a finalized list of ECMs is developed and reviewed with the facility manager

Step 8 - Economic Analysis

Data collected during the audit is processed and analyzed back in offices. We build models and simulations with software to reproduce field observations and develop a baseline against which to measure the energy savings potential of ECMs identified.

Step 9 - Prepare a Report Summarizing Audit Findings

The results of the findings and recommendations are summarized in a final report. The report includes a description of the facilities and their operation, a discussion of all major energy consuming systems, a description of all recommended ECMs with their specific energy impact, implementation costs, benefits and payback. The report incorporates a summary of all the activities and effort performed throughout the project with specific conclusions and recommendations.

Step 10 - Review Recommendations with Facility Management
A formal presentation of the final recommendations are presented to facility management to supply them with sufficient data on benefits and costs to make a decision on which ECMs to be implemented.

IV.DATA COLLECTION AND OBSERVATIONS

Electricity Consuption
Number of transformers: 4
Number of transformers charged: 3 (1000 kVA + 1000 kVA + 2000 kVA)
Incoming: 22 kV

SR. NO	MONTH	MSEB UNITS.	DG UNITS.	Total UNITS.
1	APRIL 13	576516	21768	598284
2	MAY 13	609368	30144	639512
3	JUNE 13	577448	64840	642288
4	JULY 13	665260	66920	732180
5	AUG 13	758244	68856	827100
6	SEPT 13	710352	86992	797344
7	OCT 13	689568	77864	767432
8	NOV 13	415500	2968	418468
9	DEC 13	177944	584	178528
10	JAN 14	445788	5776	451564
11	FEB 14	451184	6712	457896
12	MAR 14			0
	TOTAL	6077172	433424	6510596

Table no 1 12 months electricity bill

Title	Volt	Amp	PF	kW
PCC1	245	625	0.93	420
PCC2	242	520	0.72	252
AUTO INSERT	240	80	1	60
PDB	235	75	0.78	39.6
PCC3 [FDRG]	236	175	0.9	110
FDR8	233	76	0.8	43
FDR5	230	340	0.78	180
FDR1	232	40to 160		150
TOTALOFPCC3				483
PCC1+PCC2 AND PCC3				1255
LIGHTING PCC2	233	70		45

TOTAL 1300

Table no 2 Instantanous power consumption

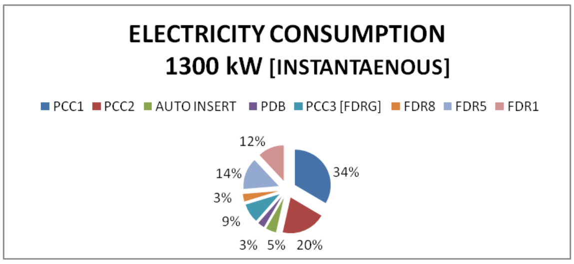

Figure 1 Instantaenous Power consumption

Considering moderate utility operation of 20 hours/day, the average consumption of utilities works out to 16140 kWh. Thus consumption of Utilities is 75 %.

UTILITY	DEPT	KW	TOTAL
air compressor	pcc2	95	
	molding	90	
	EPS	95	
	pcc1	52	
			332
chillers	pcc2	175	
	skd 2	82.6	
	skd 1	100	
	pumps	28	
			385.6
lighting			90
			807.6

Table no. 3 Utility consumption

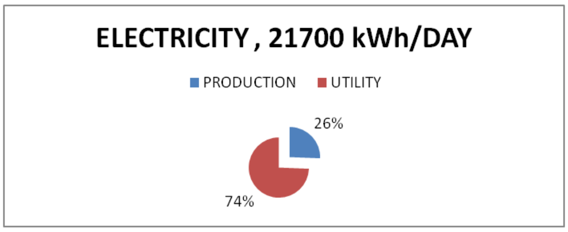

Figure 2 Distributon of electricity

BOILER EFFICIENCY (INFERRED EFFICENCY)		
Method of Assessment fuel fired boiler		
Step : 1 : Select Boiler of which efficiency is to be measured		
Step : 2 : Note stack temperature		
Step : 3 : Note oxygen content in stack		
Site Measurements - Efficiency Measurement		
	Values	**unit**
Stack Temp at outlet of boiler	**205.00**	°C
Oxygen Content in stack at outlet	**3.50**	%
Fuel (FO) consumed	***180.00***	*lit/h*
Excess air	**18.82**	%
Quantity of air supplied for above fuel consumption	***2844***	*kg/h*
Quantity of Flue gas	**3024**	kg/h
Dry Flue gas loss	**130656**	kcal/h
Heat loss due to evaporation of water formed by combustion of Hydrogen	**98696**	kcal/h
Total Stack gas loss	**229352**	kcal/h
Blow down loss	**17442**	kcal/h
Surface loss	**17442**	kcal/h
Total Losses	**264236**	kcal/h
% total loss	**15.15**	
Boiler efficiency(inferred efficency)	**84.85**	

Table 2 Boiler efficiency calculation

<u>Note- Boiler efficiency is satisfactory.</u>

The condensate coming from machine is contaminated, however the heat recovery from the condensate was being done by collecting the contaminated condensate in a tank and boiler feed water was passed through a coil immersed in the tank. Thus boiler feed was being heated to about 60-65°C.[2]

The inferred boiler efficiency calculations are given in the table 2.

V.COST OF STEAM: CALCULATIONS FOR BOILER

Cost of steam with boiler efficiency of 84 % is worked out below.

Furnace Oil price: Rs 42 per liter
Average steam/Fuel ratio: 13.6 kg of steam per liter of FO
Thus cost of steam: Rs 42/13.6 kg = Rs 3 /kg

<u>It was discussed to work out the cost of steam if bagasse briquettes are being used for steam generation</u>

The cost of bagasse: Rs 6000 / MT
GCV of bagasse briquettes: 4500 kCal/kg

Boiler efficiency: 80 %

To generate 1 kg of steam heat required = 604 kCal/kg
Heat input for the steam generation: 604 /0.8 = 755 kCal/kg

Quantity of bagasse briquettes = 755 kCal/ 4500 kCal/kg = 0.18 kg
Cost of 0.18 kg bagasse: Rs 1 /-
Cost of steam: Rs 1 /kg
Thus cost of steam or cost of fuel for steam generation would reduce to one third.

Annual furnace oil consumption: 300 MT
Annual cost on furnace oil : Rs 1, 26, 00,000 /-
Annual cost of bagasse briquettes : Rs 42, 00,000/-
For same quantum of steam generation

Annual savings : Rs 84, 00,000/-

In order to use bagasse briquettes, either a new boiler of same capacity would be required, the cost of which would be in order of Rs 30-50 Lakh or use the same boiler for which a additional bagasse briquettes fired furnace needs to be installed.

(2) Air Compressor

Air Compressors (PCC2)
No of air compressors installed : 3 No
(GA 30 x 2 0 + (GA 55 x 1)
Make : Atlas Copco , Type : Screw

Details of GA 30 :
FAD = 93 l/s = 200 CFM at pressure of 7.5 bar(g)
Motor : 30 kW

Details of GA 55 :
FAD = 158 l/s = 330 CFM at pressure of 10 bar(g)
Motor : 55kW

FAD of the air compressors was measured by measuring the air velocity at suction pipe and the cross section of suction pipe

FAD GA 30 (measured) :214 CFM [5.5 -6 Bar(g)]
Power drawn : 33 kW
kW /100 CFM (FAD) = 15.4

FAD GA 55 (measured) : 440 CFM [5.5 -6 Bar(g)]
Power drawn : 61.2 kW
kW /100 CFM (FAD) = 13.9

The performance of air compressor was satisfactory.

Air Compressors In Pcc3

Number of air compressors : 2
Comp No 1 & Comp No 2 (located in one room)

Ratings : Make IR , Type Screw , Rated CFM : 195 ,
Motor : 30 kW

Measurements :

⇨ Compressor No 1 :
CFM delivered (measured) : 210 (FAD)
Power drawn (ON load) : V = 235 . Amp = 54 ,PF = 0.78, kW = 29.1
Power drawn (UN load) : V = 235 . Amp = 23 , PF = 0.74, kW = 12.3
kW/ 100 CFM (FAD) = 13.85 [SATISFACTORY]

⇨ Compressor No 2 :

CFM delivered (measured) : 223(FAD)
Power drawn (ON load) : V = 235 . Amp = 57 , PF = 0.94, kW = 35.8
Power drawn (UN load) : V = 235 . Amp = 35 , PF = 0.75, kW = 18.6
kW/ 100 CFM (FAD) = 16 [SATISFACTORY]

It was seen that both these compressors operates in "un-load" mode for nearly 40 % of time (date 29 May 2014, time 2-2.30PM) .

" Un –load " operation is wastage of energy , it is recommended to have different pressure setting for these compressor . One compressor should be operated for base load requirement and other compressor should be operated for peak load . The compressor which is supposed to cater to peak load requirement would switch off after operating in "un-load " mode for certain length of time (say one minute) . This circuit can be incorporated in operation of air compressor. This circuit has been employed in many other factories.

The savings on account of the aforementioned circuit is worked out below

Power drawn at "Unload : mode : 18.1 kW

"un load" mode period : 40 % of time , consider only 30 % for working out saving

Thus " un-load " mode operations in a year : 2160 hour/year
Electricity savings : 2160 h/year x 18.1 kW = 39,096 kWh/year
Monetary savings : Rs 273672/- say Rs 2,50,000/- .
Incorporating the circuit will cost about Rs 25,000/-.
Further arresting the leakages would further really yield saving on account of areesting leakage and would minimize the operation of air compressor which is meant for peak load requirement.

Air Compressors For Eps

Number of Air Compressors installed : 3 no (GA55 + GA 30 + GA 30)

Normally one number of GA 30 & one number of GA 55 are in operation .

⇨ Compressor No GA 30 :
CFM delivered (measured) : 200 (FAD)
Power drawn (ON load) : V = 235 . Amp = 57 ,PF = 0.78, kW = 34.2
kW/ 100 CFM (FAD) = 17.1 [SATISFACTORY]

⇨ Compressor No GA 55 :
Details of GA 55 : FAD = 158 l/s = 330 CFM at pressure of 10 bar(g)
Motor : 55kW
CFM delivered (measured) : 416 (FAD)
Power drawn (ON load) : V = 235 . Amp = 98 ,PF = 0.78, kW = 61
kW/ 100 CFM (FAD) = 14.56 [SATISFACTORY]

Both the above air compressors were seen operating in "on-load " all the time .
It is recommended that a pneumatically operated isolation valve be installed at the inlet of compressed air line. If the EPS machine is not operating , the isolation valve would shut off compressed air supply to the machine. It is difficult to quantify the monetary savings on account of this recommendation , nevertheless the investment would have pay back less than a year. Excessive air leakages were observed in EPS machines.

(3) Compressed Air Leakage
Compressed air leakage frequently occur at the air receivers relief valves, pipe and hose joints, shut off valves, quick release couplings, tools and equipments. Leakage test can be carried out in the following way.

The test was carried out when none of the machine/instrument or unit was using compressed air. Air supply at user end is closed and valves on all the distribution network line were kept open. Then the compressor was allowed to run until system reaches to full line pressure and compressor unloads. Due to air leakage in the system, pressure drops down and compressor comes to "On Load" mode again.

The time period for which compressor is "On Load" and "Un Load" were recorded.

	Compressor	On load time /kW	Unload time /kW	% leak ON ONE COMP	Annual saving in lakh if leakage reduced to 20 %
PCC3	GA 30	20 [31 kW]	5 [7.5 kW]	80	7.0
EPS	GA 30	Comp did not unload , meaning this comp was working to augment leakage only Monetary loss :			
EPS Air supply to all	GA 30	90 [31 kW]	240 [7.5kW]	28	16.0

machines was closed					
EPS Air supply to one machine was restored	GA 30	120	120	50 %	
EPS	GA 55	20 [60 kW]	20 [18 kW]	50	
PCC2	GA 55	60 [60 kW]	15 [18 kW]	80	13.0
PCC1	GA 30	240	30	90	8.32

Table 3 %leakage calculation

$$\% \text{ Leakage} = \frac{\text{On Load Time}}{\text{On Load Time + Un Load Time}} \times 100 \quad [1]$$

The test was conducted on Air compressor

" ON-LOAD" pressure : 7.0 kg/sqcm(g)
" UN-LOAD" pressure : 6.6 kg/sqcm(g)
Total saving on account of minimizing leakage : Rs 44 lakh/per year

Chilled Water Plant in PCC2

Centrralised chilled water plant is located in PCC2 to generate chilled water which circulated across various AHUs to generate air conditioning effect manufacturing sections .

The performance of chilled water is assessed as under.
No of chilled water plants : 3 no , Capacity : 90 TR / each
chilled water generated by these chilled is circulated through a common header
Compressor type : reciprocating
The time of operation of the chillers is mentioned below

8 AM – 5 PM ⇨ Two chillers are in operation

5 PM – 8 AM ⇨ One chiller is in operation

Chilled water entering evaporator : 13°C
Chilled water leaving evaporator : 11°C
Discharge Pressure of refrigerant :180 PSIG
Suction Pressure of refrigerant : 50 PSIG
Condenser water entering evaporator : 30°C
Two chillers were
Condenser water leaving evaporator : 32.6 °C
in operation

The refrigeration load on AHU was measured , as indicated in the Table below

AHU	VOL FLOW	MASS FLOW	RA	ENTH, RA	SA	ENTH, SA	DIFF, ENTH	DIFF, TOTAL EN
	CUM/H	KG/H	DBT/WBT	KCAL/K				
NO 7 AUTO	24200	27588	26.5/20.5	14				
NO 8 AUTO	30240	34473.6	26.5/20.5	14				
NO5 BR	8710	9929.4	2/19.5	13.2				
NO 2,BR	18030	20554.2	25/19.5	13.2				
NO 6	16335	18621.9	25/20.5	14				
NO 4	17000	19380	27/23	16.24				
NO 3	7400	8436	27/23	16.24				

Table no 4 AHU at the PCC2 load calculations
Total load is **172 kW.**

Power drawn by Chiller during day time (8 AM – 5 PM) ; 136 kW
Hence , specific energy consumption : 136 kW / 172 TR = **0.79 kW/TR**

Power drawn by Chiller during evening & night time (5 PM- 8 AM) ; 67 kW
Refrigeration load during evening & night time : 50 TR
Hence , specific energy consumption : 67 kW / 50 TR = **1.34 kW/TR**

If specific energy is reduced to 0.8 kW/TR from present value of 1.34 kW/TR , the savings are worked out below .

Refrigeration load during evening & night time : 50 TR
With proposed specific energy consumption of 0.8 kW/TR , kW drawn = 40 kW

Thus **saving 27 kW** , the monetary savings : **Rs 6.8 lakh per year.**

Making the un -loading automation system work in chiller would generate the above savings.

VI.CONCLUSION

The consideration of annual consumed electricity by Electricity bill and the actual consumption of energy is differ by accountable units. So the energy saving is significant in the various areas of the utility department mainly.

As per studied area till date, it is focused on the reciprocating compressor and screw compressor energy consumption.
We can obtion up to **Rs. 46,50,000/-** per year.

And also in boiler unit **Rs. 84,00,000/-** per year. By providing bagas as substitute to the FO.

Also the Chilled water pump at PCC2 building yields the saving of around **Rs. 6,80,000/-** per year

So that we have calculated the savings of the energy in terms of money up to **Rs 1,37,30,000/-**per year**.**

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