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Energy Audit And Energy Conservation Potential For Water Treatment Plant

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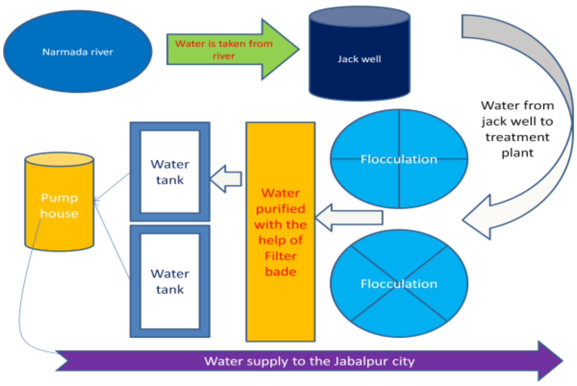
Abstract : *This paper present energy audit process on water treatment plant located at Lalpur, Jabalpur Madhya Pradesh. This plant has established in 1986 and supplying 97 MLD (million liters per day) water to Jabalpur City. Generally Water treatment plants are highly energy and cost intensive. To achieve effective and efficient energy management scheme, energy audit analysis was employed on water treatment plant.This paper Provides customers with recommendations which will increase the comfort, health, safety and prolong the durability of the property. Before appointing Energy Auditor conduct our own visual walkthrough and make a list, so when we bring in an auditor we are prepared. Become more aware! , check savings calculations by determining whether more savings have been identified than are actually achievable. Some analysts use the average cost of electricity to calculate energy savings.*

Keywords: - *Water treatment plant, energy audit, energy saving, cost analysis, Overall Equipment Effectiveness.*

I. Introduction:

Energy means is the capacity of a system to do work. We use energy to do work and make all movements, Energy can be found in a number of different forms. It can be chemical energy, electrical energy, heat (thermal energy), light (radiant energy), mechanical energy etc. The most general definition of an audit is an evaluation of a person, organization, system, process, project or product. Audits are performed to ascertain the validity and reliability of information, and provide an assessment of a system's internal control.

An energy audit was performed on the Water Treatment Plant (WTP) located at Gwarai Ghat Road Lalpur in Jabalpur. This report provides the energy use pattern, the measures considered and the recommendations for energy saving, more effective equipment use for water purification/water distributed to Jabalpur area. Water treatment plant has been highly energy and cost intensive. Continues running of the plant i.e. 8760 operating hours per year produce 35405 ML (million liters) water. To achieve effective and efficient energy management scheme, thermal energy audit analysis was employed on water treatment plant. The flow chart of water treatment process is as follows:-



Many types of equipment used just like a pump, motor, color, lighting, water etc. lalpur plant 97 MLD water supplies per day, these water taken from Narmada River. 3 hours cycle is required to purify water. The Water Flow from Jack Wall to Raw Water Pump House through gravity. 10 pumps (215h.p) are Establish in the pump house, however 6 Pumps are required 24 hr running at a time & 4 pumps are stand. Every 12hr Pumps are Change from another pump. Then with the help of 6 pump water flow to the 42 mld and 55 mld section. Water is purifying in these section. After that water is pumped by 6 pumps are established in 42mld & 8 pumps are established in 55 MLD.

1.1 Conduct Auditing Process:

- Study of plant process
- Meeting
- Energy Audit Team
- Plant Data Collection
- Field Investigation and observations
- Equipment Inventory and use
- Classification of Demand and Energy
- Develop ECMs and Implementation Strategies.
- Follow-Up

II. Parameter which affects the energy audit for water treatment plant:

- Raw Water quality
- Pumping
- Lighting
- Power factor

2.1 Pumping Systems:

11 pumps (215, 225, 300 HP) are Running 24 hrs, at present the system power factor is about 0.93. But after auditing PF will maintained nearly unity by establishing capacitor Bank. One of the most critical elements to improving water system efficiency is to optimize energy consumption by the pumping systems. Optimizing the system includes improvements such as matching the pump to requirements, optimizing the distribution piping, eliminating unnecessary valves, controlling pump speed where appropriate, and institutionalizing improved O&M practices. Replace inefficient pumps with efficient. Install variable speed drives. Regular preventative inspection and maintenance, including cleaning or replacing impellers and checking lubrication of bearings. Trim impellers where pumps too large for the application but otherwise suitable. Create a system for regular monitoring of system components and performance. Install and maintain water meters; replace on a regular basis (about every 10 years). Develop metrics to track system performance and compare performance to appropriate benchmarks and targets. Monitor the pump system (such as valves, flow, pressure, rotating speed, energy used, volume pumped, and velocity in the main headers).

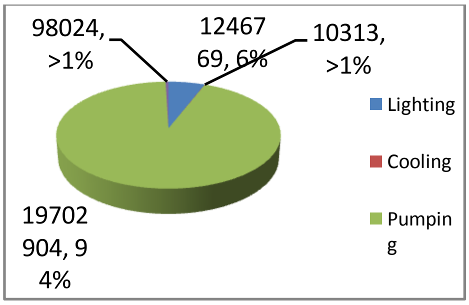


Figure 2:-.energy consumption chart

Figure 3:-: Pump House at Lalpur (Jabalpur) water treatment plant

2.2 Lighting:

Light Level or luminance, is the total luminous flux incident on a surface per unit area. The work plane is where the most important tasks in the room or space are performed. In lalpur plant total 17 MU electricity is being consumed per year. But after implementation of recommendation of energy auditing, electricity consumption will reduce by 15000 units per year. Apart from this about 153 kVA demands will be reduced by installing a Capacity Bank.

2.3 Transformer:

There are six numbers of transformers (33KV) are installed in lalpur water treatment plant and three transformer are standby out of six transformer. Transformers are extremely efficient devices; however, since the entire power consumption of the plant is through the transformers, some loss does take place. Site testing of transformers is not possible without isolation of the transformers

$$\text{Transformer efficiency} = \frac{\text{KW}}{KW + no\ load\ losses + (\%loading)^2 \times load\ losses}$$

2.4 Water:

Addition of alum and discharge of waste water from Flocculator should be regulated as per raw water quality. Fix water leaks. Test for underground water leaks. Check water overflow pipes for proper operating level. Provide proper tools for wash down especially self-closing nozzles. Eliminate continuous overflow at water tanks.

Figure 4:-Flocculator clarifiers at Lalpur (Jabalpur) water treatment plant

2.5 Flocculator clarifiers:

Effluent from the rapid mix structure flows by gravity to the flocculator clarifiers for the sedimentation process. The purpose of the flocculator clarifiers is to continue the flocculation process and produce clarified effluent, as well as to collect sludge and scum from the gravity settling basins. Specifically after the influent is mixed within the flocculator well. it migrates radically outward and enters the clarifier. Sufficient detention time is allowed to permit the solids to settle out in the clarifier during the time of flow to the outer ring of the clarifier. The effluent is removed at the tank periphery**.**

III. Bill detail of lalpur water treatment plant

1. Tariff f category-2301HV-5.1 33KV
2. Monthly fixed charges-165 RS/ KVA (total maximum demand x 165)
3. Energy charges- 3.60 (Rs per unit) (consumption x 3.6)
4. Contract demand-2500 KVA

More energy consume in lalpur water treatment plant. Because overall plant power factor 0.93 hart show monthly consumption to one year. Average energy consumes per month 1400000 kWh.

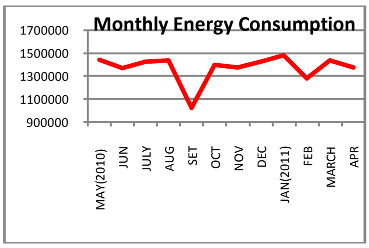


Figure 5:-overall unit consumption of lalpur water treatment plant.

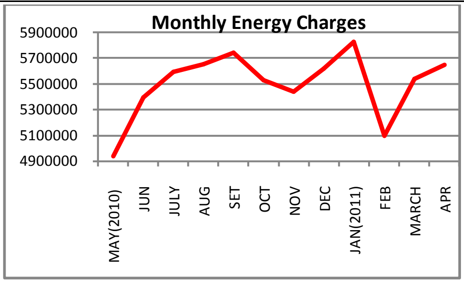


Figure 6:- annual bill detail o of lalpur water treatment plant (before auditing)

month	Consumption KWH	Demand KVA	PF	Demand reduces on the base of .93 KVA	Reduction in KVA	Saving on fix charge only demand	unit x energy charge x incentive %	save
April	1376600	2452	0.92	2280	172	28380	247788	276168
March	1436600	2416	0.92	2246	170	28050	247777	275827
Feb	1282600	2384	0.92	2217	167	27555	230868	258423
Jan	1480800	2392	0.93	2224	168	27720	266544	294264
Dec	1424900	2356	0.93	2191	165	27225	256482	283707
Nov	1373700	2374	0.93	2207	167	27555	247610	275165
Oct	1399200	2356	0.93	2191	165	27225	241856	279081
Sept	1026300	2440	0.93	2269	171	28215	258462	286677
Aug	1435400	2472	0.93	2299	173	28545	258372	286917
Jul	1423800	2388	0.93	2221	167	27555	256284	283839
Jun	1367000	2362	0.93	2196	165	27225	246060	273285
May	1440000	2456	0.93	2284	172	28380	259200	287580
TOTAL	16466900			24545		308630	3017303	3360933

Figure7:Saving due to Installation of Capacitor Bank

IV. Recommendations:

The main recommendation is to replace the recessed fluorescent lighting system in the general area and maintenance office.

- By Replacement of magnetic Ballast with electronics in existing tub light s i.e. 119 fittings having potential saving of 14700 kWh that save 51750 Rs/Year.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete mercury lamp with Compact fluorescents with electronic ballasts Consider day lighting, skylights, etc
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.

For Water & Wastewater:-

- Seal sumps to prevent seepage inward from necessitating extra sump pump operation
- Balance closed systems to minimize flows and reduce pump power requirements.
- Fix water leaks.
- Test for underground water leaks.
- Check water overflow pipes for proper operating level.

- Provide proper tools for wash down -- especially self-closing nozzles.

- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use self-closing type faucets in laboratory.

Pump and motor:-

- Power factor improvement by installing capacitor bank which increase the power factor (0.99) and gives 153.38 KVA reductions in demand at a load of 2400 KVA (Connected Load) that saves 39 lacks per annum.
- Properly size to the load for optimum efficiency. (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Balance the three-phase power supply. (An imbalanced voltage can reduce 3 - 5% in motor input power)
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.

V. Results:

TABLE OF MEASUREMENTS & CALCULATIONS OF POSSIBLE ENERGY SAVINGS IN LIGHTING LOAD

1	Room Type	pump house	pump house in down	staff room	control panal room	labrorati	compressor room	store room1,2,3	mixing room	vacquam pressur mesurement room	store room	clear water tank	tempal	mentenance office	total
2	Type Of Activity														
3	Number Of Lamps	1 Marcurry+3 Tube light	2 Marcurry	1 Tube light	1 Marcurry+1 Tube light	2 Tube light	1 Marcurry+4 Tube light	1 Tube light	2 Tube light	1 Tube light	1 Marcurry+1 Tube light	2 Tube light+2 CFL	1 Tube light	2 Tube light	
4	Length "L" in mtrs	R-4 mts	R-4 mts	1.50	6.00	4.50	15.00	3.00	3.50	2.00	5.00	15.00	1.00	2.50	
5	Width "W" in mtrs	R-4 mts	R-4 mts	2.00	3.00	3.00	3.50	2.50	3.00	2.50	4.50	3.50	1.00	3.00	
6	Room Area in Sq.mtrs	50.24	50.24	3.00	18.00	13.50	52.50	7.50	10.50	5.00	22.50	52.50	1.00	7.50	
7	Hight Of Lamp Above Working Plane in mtrs	4.00	2.50	2.25	3.25	3.25	3.25	3.25	2.50	3.00	3.50	2.00	1.50	3.00	
8	Room Index	2.00	3.20	0.38	0.62	0.55	0.87	0.42	0.65	0.37	0.68	1.42	0.33	0.45	
9	Number Of Illuminance	4.00	2.00	1.00	2.00	2.00	5.00	1.00	2.00	1.00	2.00	5.00	1.00	2.00	
10	Measurement Points	9.00	9.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	9.00	4.00	4.00	
11	Average Room Illuminance in Lux	81.11	90.00	83.00	94.00	72.25	87.50	83.00	73.25	77.00	81.20	81.22	150.00	88.25	
12	Measured Circuit Power in Watts	430	500	60	310	120	490	60	120	60	310	210	60	90	
13	Watts/Sq.Mtrs	8.56	9.95	20.00	17.22	8.89	9.33	8.00	11.43	12.00	13.78	4.00	60.00	12.00	
14	Installed Load Efficacy as Lux/Watt/Sq.mtrs	9.48	9.04	4.15	5.46	8.13	9.38	10.38	6.41	6.42	5.89	20.31	2.50	7.35	
15	Target Lighting Efficacy(for pump house) Requirement of standared or good colour rendering . CRI=40-85	42.00	42.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	33.00	36.00	33.00	36.00	
16	Installed Load Efficacy Ratio (ILER)	0.23	0.22	0.13	0.17	0.25	0.28	0.31	0.19	0.19	0.18	0.56	0.08	0.20	
17	Use Hours	18	18	18	18	18	18	18	10	10	12	20	12	20	
18	working days	365	365	365	365	365	365	365	365	365	365	365	365	365	
19	Total Number Of Similar Rooms	3	3	6	3	1	2	6	2	2	1	2	1	3	
20	Present Consumption	8475	9855	2365	6110	788	6439	2365	876	438	1358	3066	263	1971	44369
21	T5 tublight recomandate (W)	304	304	38	190	76	304	38	76	38	152	220	10	76	
22	Anticipated Lux	250	250	325	340	200	200	200	225	200	225	200	300	250	
23	Watts/Sq.Mtrs	6.05	6.05	12.67	10.56	5.63	5.79	5.07	7.24	7.60	6.76	4.19	10.00	10.13	
24	Target Lighting Efficacy	41.32	41.32	25.66	32.21	35.53	34.54	39.47	31.09	26.32	33.31	47.73	30.00	24.67	
		8.000	8	1	5	2	8	1	2	1	4	5		2	47.000
		24.000	24.000	6.000	15.000	2.000	16.000	6.000	4.000	2.000	4.000	10.000	0.000	6.000	119.000
25	Proposed Consumption	5991.84	5991.84	1497.96	3744.9	499.32	3994.56	1497.96	554.8	277.4	665.76	3212	43.8	1664.4	29637
26	(kwh) save	2483.46	3863.16	867.24	2365.20	289.08	2444.04	867.24	321.20	160.60	692.04	-146.00	219.00	306.60	14733

Note- Macurry lamps are old and the illumination is very low

VI. Conclusion:

From this paper, we have concluded, An Energy audit increases the productivity of Organization. Energy audit helps to increase output of any industry and decreases cost of Production without scarifying the efficiency. Energy audit provides batter stability to the industry or organization then the statutory audits. With the help of above observations table it is found that Lalpur Water Treatment Plant needed to improve its efficiency in terms of pumping power, transformer's function, and lighting. Energy audit is done to improve its pumping power and lighting power for improving overall performance of Lalpur water treatment power plant. During energy audit it is found that 25 halogen light of 250 watt , used, electricity bill of last on year 66019849 Rs.kr calculated finally it is concluded that electricity bill will reduced 14733kwh by the audit.

References

[1] Bureau of Energy Efficiency hand book.

[2] Gallaher KP. Free trade and the environment: Mexico, NAFTA, and Beyond. Stanford University Press; 2004. p. 125.

[3] OECD. Environmental performance review of Mexico. OECD; 1998.

[4] Mumme S. Environmental politics and policy in Mexico. Ecological policy and politics in developing countries. State University of New York Press; 1998.

[5] Carmona-Lara MdC. Ley General delEquilibrioEcologicoylaProteccio´n al Ambiente: Comentarios y Concordancias. 1st ed. UniversidadNacionalAuto´noma de Me´xico; 2003. p. 773.

[6] Greely K., Harris J., and Hatcher A., Measured Saving and Cost- Effectiveness of Conservation Retrofits in Commercial Buildings, Lawrence Berkely National Laboratory Report-27586, Berkeley, CA, 1990

[7] Fels, J., Special Issue Devoted to Measuring Energy Savings: The Socrekeeping Approach, Energy and Buildings.

[8] Thumann, A., and Mehta, P., Handbook of Energy Engineering. The Fairmont Press Inc., Librun, GA 1997

[9] Tuluca A., and Steven Winter Associates, Energy Efficient Design and Constructionfor Commercial Buildings, Mc-Graw Hills, 1997.

[10] MoncefKrarti, Energy Audit of Building system- An Engineering Approach.., CRC Press LLC 2000.

[11] Dasgupta S, Hettige H, Wheeler D. What improves environmental compliance? Evidence from Mexican industry. Journal of Environmental Economics and Management 2000; 39(1):39e66.

[12] Camper, A. K., LeChevallier, M. W., Broadway, S. C. and McFeters, G. A.(1985) Growth and persistence of pathogens on granular activated carbonfilters. *Applied and Environmental Microbiology*, 50(6), 1378-1382.

[13] Camper, A. K., LeChevallier, M. W., Broadway, S. C. and McFeters, G. A.(1986) Bacteria associated with granular activated carbon particles in drinkingwater. *Applied and Environmental Microbiology*, 52(3), 434-438.

[14] Carlson G and Silverstein J (1997) Effect of ozonation on sorption of naturalorganic matter by biofilm. Water Research 31, 10, 2467-2478

[15] Carlson KH and Amy GL (2001) Ozone and biofiltration for multipleobjectives. *Journ. AWWA* 93:1, 88-98.

[16] Carlson, K. H. and Amy, G. L. (1998) BOM removal during biofiltration.*Journal AWWA*, 90(12), 42-52.

[17] G. R. Davis, "Energy for planet earth,"Scientific American, pp. 1–10,1991.

[18] U.S. Department of Commerce,Statistical Abstract of the UnitedStates,114th ed., 1998.

[19] S. Rahman and A. D. Castro,"Environmental impacts of electricitygeneration: A global perspective," IEEETrans. Energy Conv., vol. 10

[20] Energy efficient lighting CEA,2004