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Energy Conservation Tools for Pumping System of HVAC

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Abstract:
Now a days Heat ventilation and air conditioning is very important for all commercial buildings. Pumping system is a second major energy consumer in Heating, Ventilation and Air conditioning (HVAC) system. Pumping system has been working between chilled water generator and air handling units. This study presents status of a Pumping system power consumption of IT building in Delhi region. The analysis has shown that pumping system power consumption vary if cooling requirement changes which will impact on energy consumption of pumping power. It has been proposed that automation system will be helpful to conserve significant energy for pumping system.

Keywords: *HVAC systems, Energy Efficiency, Energy Conservation, Automation System*

1 INTRODUCTION

Main function of a building is to provide the thermal comfort indoor environment. Building load is not only heat load of the building from outdoor environment, it also includes indoor load like occupants, machines/equipment etc. Different methods are used for creating thermal comfort [1-4]. For providing the cooling to the commercial buildings central air-conditional system are commonly used; chiller machine is used for the generation of chilled water, second and most important prime mover is pumping system which is working as a distribution of chilled water to the air handling units, the chilled water is absorbing heat from the air handling units (AHU's) coil and pumped back to the evaporator coil where again heated water is chilled by chiller and completes the cycle[5-11].

In case of buildings heating load fluctuates whereas at the same time chilled water supply has been constant. Therefore, main objective of paper is to control the chilled water as per requirement with the use of variable flow system for pumps with variable frequency drives (VFD's) for energy conservation and efficiency [14-15]. An office building normally operates 10 to 12 hours/per day. A systemic diagram of a chiller plant and pumping chilled water distribution system to AHU's is depicted in figure 1.

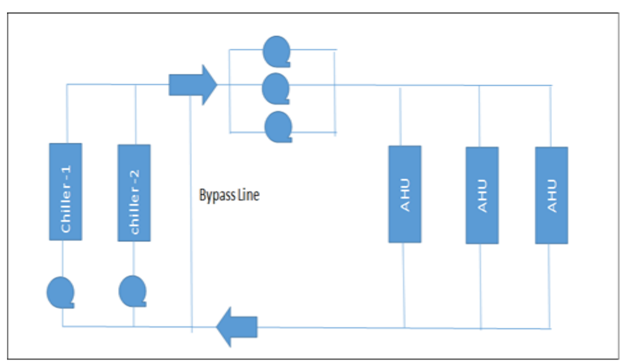

Figure 1: Systemic diagram of chiller plant and pumping chilled water distribution system to AHU's

The selected building is having 921,157 square feet and air conditioned area is 240,173 square feet. Variable frequency drive (VFD) have been installed

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on pumping system and to find out the impact on cooling load and energy.

2 EXISTING HVAC SYSTEM ANALYSIS

The building is having numbers of AHU's to cater the cooling load of the building & connected with 08 chillers. Specifications and operating parameters of chillers and pumps are as given in table 1-3.

Table 1: Specifications of chillers and pumps

System Description	Load	kW
No of Chiller (04 working/04 Standby)	550 TR	
Primary Pump (04 working/04 Standby)	297m3/hrs.	22kW
Secondary Pump (02 working/02 Standby)	506 m3/ hrs.	37 kW
Condenser Pump (04 working/04 Standby)	495 m3/ hrs.	55 kW
No of AHU's	93 No's	

Existing Operating Parameters:

Chilled water Temperature

Table 2: Details of chilled water In/Out temperature

Unit	Temperature (ºC)
Chilled water Supply Temperature	7.5
Chilled Water Return Temperature	12.2
Temperature Difference of Chilled Water	4.7

Condenser Water Temperature:

Table 3: Details of condenser water In/Out temperature

Unit	Temperature (ºC)
Condenser water Supply Temperature	32.0
Condenser Water Return Temperature	34.2
Temperature Difference of Condenser Water	2.2

Yearly consumption of electrical energy of two pumps prior installation of VFD is given in Tables 4 and 5, it is considered to be as a base data for efficient use of energy. General operation hours are 20 per day.

Actual Electrical Consumption and Running Pattern for all chilled water supply Pumps

Table 4: Yearly kWh consumption on fixed load by pump no. 1

Month	No of Days	Run Hr	kW(Pump-1)	Baseline kWh(Pump-1)
November	30	20	30.8	18,496
December	31	20	30.8	19,113
January	31	20	30.8	19,113
February	28	20	30.8	17,263
March	31	20	30.8	19,113
April	30	20	30.8	18,496
May	31	20	30.8	19,113
June	30	20	30.8	18,496
July	31	20	30.8	19,113
August	31	20	30.8	19,113
September	30	20	30.8	18,496
October	31	20	30.8	19,113
	365	20		225,036

Table 5: Yearly kWh consumption on fixed load by pump no. 2

Month	No of Days	Run Hr	kW(Pump-2)	Baseline kWh(Pump-2)
November	30	20	31.5	18,881
December	31	20	31.5	19,511
January	31	20	31.5	19,511
February	28	20	31.5	17,623

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March	31	20	31.5	19,511
April	30	20	31.5	18,881
May	31	20	31.5	19,511
June	30	20	31.5	18,881
July	31	20	31.5	19,511
August	31	20	31.5	19,511
September	30	20	31.5	18,881
October	31	20	31.5	19,511
	365	20		229,724

3 RESULTS AND DISCUSSION

Improvement analysis on pumping system after installation of speed control device on secondary chilled water pumps on bases on building load variation

Now after installation of speed control device and taking feedback of cooling load through pressure sensors cooling load on pumps no 1 was varying and energy consumption is shown in table 6.

Table 6: Yearly kWh consumption with variable load with VFD's

Month	No of Days	Run Hr	kW(Pump-1)	After Implementation kWh
November	30	20	30.8	5,015
December	31	20	30.8	9,580
January	31	20	30.8	10,953
February	28	20	30.8	9,175
March	31	20	30.8	9,184
April	30	20	30.8	10,642
May	31	20	30.8	6,343
June	30	20	30.8	12,289
July	31	20	30.8	10,488
August	31	20	30.8	8,201
September	30	20	30.8	8,609
October	31	20	30.8	11,311
	365	20		111,790

Similarly after installation of speed control device and taking feedback of cooling load through pressure sensors cooling load on pumps no 2 energy consumption and is shown in table 7.

Table 7: Yearly kWh consumption with variable load with VFD's

Month	No of Days	Run Hr	kW(Pump-2)	After Implementation kWh
November	30	20	31.5	2,507
December	31	20	31.5	4,790
January	31	20	31.5	5,476
February	28	20	31.5	4,587
March	31	20	31.5	4,591
April	30	20	31.5	5,320
May	31	20	31.5	3,171
June	30	20	31.5	6,144
July	31	20	31.5	5,243
August	31	20	31.5	4,100
September	30	20	31.5	4,304
October	31	20	31.5	5,655
	365	20		55,895

Consolidated Energy saving after installation of speed control device and taking feedback of cooling load through pressure sensors cooling load on pumps and

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is shown in table 8 & plotted in figure 2. Energy savings in percentage for given months is plotted in figure 3.

Table 8: Yearly kWh Energy consumption pattern before & after

Month	Baseline kWh(Pump-1)	After Implementation kWh
November	37,378	7,523
December	38,623	14,370
January	38,623	16,429
February	34,886	13,762
March	38,623	13,776
April	37,378	15,963
May	38,623	9,515
June	37,378	18,434
July	38,623	15,732
August	38,623	12,301
September	37,378	12,914
October	38,623	16,966
	454,760	167,684

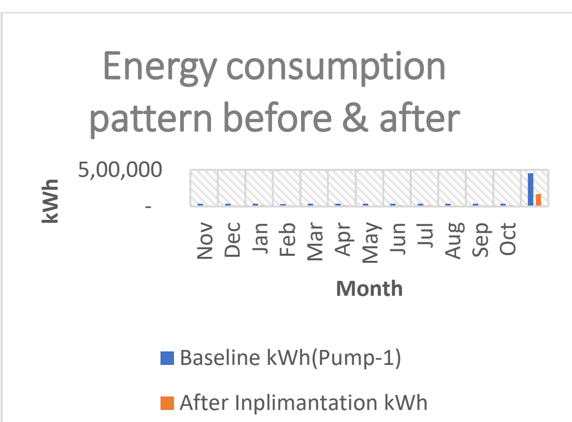

Figure 2: Energy saving Auto variation through VFD as per requirement

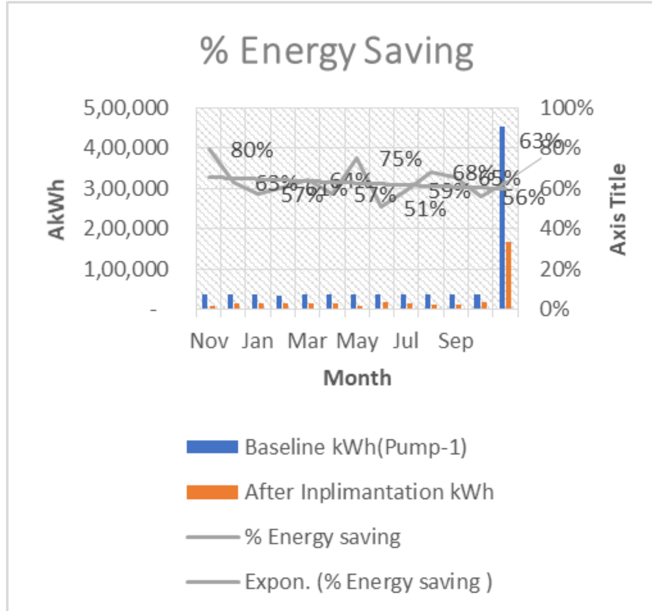

Figure 3: Energy saving (%)

4 CONCLUSION

An IT industry has been studied and after introducing automation through VFD's on Pumps energy consumption dropped by 51 % to 80 % because of demand variation. Average savings in pumping power system was recorded 63%. It is pertinent to mention that significant energy efficiency of chiller system can be increased by using speed control of pumps.

REFERENCES

1. Sklyarov, D.E., Kustov, E.F. and Lozenko, V.K. (2015) Energy Efficiency and Conservation Economies. iBusiness, 7, 98-109. http://dx.doi.org/10.4236/ib.2015.7, 2012.
2. V.V. Tyagi, D. Buddhi, Richa Kothari and S.K. Tyagi, Phase change material (PCM) based thermal management system for cool energy storage application in building: An experimental study, Energy and Building, 51, 2012.
3. Hari Kumar Singh and D. Buddhi, Experimental Investigations of PCM Based Thermal Battery for Temperature Management of Building in Hot and

May-June 2020
ISSN: 0193-4120 Page No. 10777 - 10781

Dry Climate of India, International Journal of Applied Engineering Research, 13(17), 2018.
4. Ch.V.Rajkumar* et al., International Journal of Innovative Technology and Research, 1(2), February - March 2013
5. I.M. Shapiro, Energy Audits, Improvements in Small Office Buildings, ASHRAE Journal, 54(100, 2012.
6. R. Saidur, S. Mekhilef, M.B. Ali, A. Safari, H.A. Mohammed, Applications of Variable Speed Drive (VSD) in Electrical Motors Energy Savings, Renewable and Sustainable Energy Reviews, 16(1), 2012.
7. Wemhoff, M. Frank, Predictions of Energy Savings in HVAC Systems by Lumped Models, Energy and Buildings, 42(10), 2010.
8. S. Soyguder, Intelligent System Based on Wavelet Decomposition and Neural Network for Predicting of Fan Speed for Energy saving in HVAC System, Energy and Buildings, 43(40), 2011.
9. Zlatanović, K. Gligorević, S. Ivanović, N. Rudonja, Energy-saving Estimation Model for Hypermarket HVAC Systems Applications, Energy and Buildings, 43(12), 2011.
10. F. Ascione, L. Bellia, A. Capozzoli, F. Minichiello, Energy Saving Strategies in ir-conditioning for Museums, Applied Thermal Engineering, 29(4), 2009.
11. Y. Yu, M. Liu, H. Li, D. Yu, V. Loftness, Synergization of Air Handling Units for High Energy Efficiency in Office Buildings: Implementation Methodology and Performance Evaluation, Energy and Buildings, 54, 2012.
12. L. Kajtár, M. Kassai, L. Bánhidi, Computerised Simulation of the Energy Consumption of Air Handling Units, Energy and Buildings, 45, 2012.
13. Neelesh Patel and D Buddhi, Improvement of System Efficiency and Optimization with Automation and Controls of a selected HVAC System, THINK INDIA JOURNAL, 22(7), 2019.
14. Neelesh Patel and D Buddhi, Analysis of Energy Consumption Patterns to identify the Energy Conservation Tools for an Office Building, Journal of the Gujarat Research Society, 21(10s), 2019.
15. Devendra Pal Singh and D. Buddhi, Design, Modeling Analysis and Performance Evaluation of a Single Phase Variable Frequency Drive for Induction Motor: An Energy Conservation Approach International Journal of Science, Engineering and Technology, 4(2), 2016.