Journal on Science Engineering & Technology
Vo1ume 1, No. 04, December 2014

Optimization of Energy Saving Technology on Air-Conditioning Systems

V.I. Firoz and M. Parameswaran

Abstract--- The increasing consumption of energy in buildings on heating, ventilating and air-conditioning (HVAC) systems has initiated a great deal of research aiming at energy savings. There is a pressing need to accelerate the development of advanced clean energy technologies in order to address the global challenges of energy security, climate change and sustainable development.

The optimization process consists of systematically investigating the operation of HVAC system and implementing improvements specifically designed to reduce energy usage while maintaining or improving occupant comfort. Oftentimes these improvements have very quick paybacks. In addition, the utility has incentives to make the paybacks even more attractive. In almost all government institutions electrical energy is not used in a sensible way. In the present energy crisis scenario there is a great need for energy conservation or optimization by all means possible. In fact, HVAC systems can account for about half of the energy used in a building. By optimizing the building's HVAC system, it will save 10-20 percent or more of the building's energy costs

Firstly this project defines what are the meanings, categories and features of energy saving technology optimization on heating, ventilating and air conditioning systems. Secondly, it analysis how to optimize energy saving technology on heating, ventilating and air conditioning system for existing auditorium in Govt. Engineering College Thrissur.

V.I. Firoz, M Tech, Student, Manufacturing Systems Management, GEC, Thrissur, Kerala, India. E-mail: firozvi005@gmail.com
M. Parameswaran, Professor, Production Department, GEC, Thrissur, Kerala, India

I. INTRODUCTION

Energy management of heating ventilating and air-conditioning (HVAC) systems is a primary concern in building projects, since the energy consumption in electricity has the highest percentage in HVAC among all building services installations and electric appliances. Without sacrifice of thermal comfort, to reset the suitable operating parameters, such as the chilled water temperature and supply air temperature would have energy saving with immediate effect. For the typical building projects, it is not difficult to acquire the reference settings for efficient operation. However, for some special projects, due to the specific design and control of the HVAC system, conventional settings may not be necessarily energy-efficient in daily operation.

This project is interested in the feasibility of implementing such a system. The GEC Thrissur incurs a costly electricity bill, which imposes a significant financial burden. Concerned that the costs of electricity would only rise in the future, the thesis looks into some kind of energy optimisation techniques in the field of heating ventilating and air-conditioning system for the existing auditorium in the college.

Heating Ventilation and Air Conditioning (HVAC) system are used to maintain a comfortable indoor environment (that is indoor temperature, humidity, and air cleanliness) where this was cannot be achieved by naturally. There are several types of HVAC systems used in buildings. These includes single zone and multiple zone type when classified according to the number thermal zone created or constant volume or variable air volume when categorised according to the air flow mode. The use of a particular

ISSN: 2349-6657 @ JSET

HVAC depends on building type, thermal requirements as well as location and purpose for which it is designed. It is therefore necessary studies focussing on energy use in HVAC systems to be building specific; this would ensure increased applicability to the already existing buildings.

Electricity is used for building operations, the largest uses are lighting and air conditioning. Building energy can be saved and pollution decreased while utility expenditures are minimized if energy conservation measures are incorporated into the design, maintenance and operation of a facility. Air cooling Provision in building is undergoing a period of rapid expansion. Building cooling load components are; direct solar radiation, transmission load, ventilation/infiltration load and internal load. Calculating all these loads individually and adding them up gives the estimate of total cooling load. The load, thus calculated, constitutes total sensible load.

II. Optimization of Energy Saving Technology on Central Air-Conditioning for Existing Buildings

A. History

The invention of ventilation cannot be ascribed to a certain date. The first attempt was probably made when man brought fire into his abode and discovered the need to have an opening in the roof to let out the smoke as well as to supply air to keep the fire burning. Because the fire warmed the space to a more comfortable temperature, thermal comfort was initially linked to ventilation.

Also the need for appropriate air cleanness in ancient Egypt let man discover the beneficial aspects of ventilation. The Egyptians observed that stone carvers working indoors had a higher incidence of respiratory distress than those working outdoors. They attributed this to a higher level of dust in the indoor workspaces. These observations resulted in the improvement of air circulation within the work areas by the provision of additional openings in the walls.

The need for indoor fires disappeared temporarily with the Romans' invention of under floor heating where hot combustion products were ducted from 'stoves' around the periphery of the buildings, through the floor tiles to a smokestack. There are still remains of the baths with the fragments of floors under which there are hot air ducts. Such technical solutions for central heating were signs of wealth and the higher status of the owner and were often present in the bawdy houses of the 1st century B.C.

In the middle ages, people began to realize that air in a building could somehow transmit disease among people in crowded rooms. Homes and small buildings were heated with open fires in fireplaces. Smoke often spilled into the room and poisoned the air. King Charles I of England in 1600 decreed that no building should be built with a ceiling height of less than 10 ft (3 m), and that windows had to be higher than they were wide. The objective was to improve smoke removal.

B. Building Design and Energy

Different interrelated issues influence building design, and combinations of these different issues determine the choice of building components. The energy issue can play a significant role in the building design process. As climate modifiers, buildings are usually designed to shelter occupants and achieve thermal comfort in the occupied space backed up by mechanical heating and air-conditioning systems as necessary. Significant energy savings can be realized in buildings if they are properly designed and operated. Energy awareness and energy management are important measures during the life of the building. Therefore, building designers can contribute to solving the energy problem if judicious early design decisions are made regarding the selection and integration of building sub-systems.

Meanings the optimization on the existing buildings central air-conditioning energy saving technologies has been debugged continuously among various systems. This is especially on devices between the facilities system and the automatic control system; the systems between all equipments as well as equipments and the serving objects in order to achieve the best match. Technology optimization is through scientific management methods, there is no need to extra investment but can achieve the purpose of energy conservation; this is known as energy-saving management. Compared with the transformation of energy conservation, energy efficiency goals can be achieved through scientific management methods, a minimal investment but with good effect

a. Categories

There are two methods on the optimization on the existing buildings central air-conditioning energy saving technologies: First, load tracking type dynamic runtime management refers to the adjustment of the operating strategy based on building load changes, on fresh air as demand control, number of refrigerators controlled of control and night ventilation, etc.; Second, the cost of track-type dynamic runtime management, refers to the adjustment of the operating strategy according to changes in energy prices. Also this is to control air conditioning running under the peak and valley price difference, and maximize the use of its own.

b. Features

There are six advantages on optimization of energy saving on central air-conditioning when compared with the energy saving technological transformation. First, this does not need to invest additional technological transformation costs, reduce the barrier on the additional costs of existing buildings needed to put into the renovation funds by the owners or occupants. Second, this does not need to have the new technology selection decisions assessment. This can avoid existing buildings multiple stakeholders discuss on what technical advice aground the energy conservation efforts. Third, this does not need technological innovation and investment in financing as well as the time for discussion.

Fourth, the use of optimization techniques to energy saving is easy to implement, unlike saving technological transformation requires owners' or tenants' support, and awareness. The implementation can simply run by the property company. Fifth, the use of optimization techniques and energy conservation, if property management companies are positive on this, this can immediately see the quick effect. Sixth, the optimized use of technology must require property company technicians and their optimization. This helps to improve both the overall construction equipment operation and management level. Of course, compared with the adoption of new technologies there have two disadvantages. First, the use of energy saving of optimization techniques, dynamic implementation plan must be developed in accordance with the characteristics and needs of both the construction equipment operation. This requires higher personnel skill from the management of existing buildings of the property company. Second, because of higher personnel skill, costs of the management of existing buildings management of property companies are higher.

C. Building Energy Management System (BEMS)

Building Energy Management System (BEMS) is believed to have high contribution for solving control problems since it depends on continuous management to achieve high operational performance. Energy management and control functions can be broadly classified into three groups: basic, intermediate, and advanced. Basic and intermediate functions seek measuring and control energy in simple way. It varies from using sensors, energy metering, alarm settings, scheduling and load shifting. It follows a simple process, from data collected by sensors, which gives signals for controllers that takes decision according to the signal given. Advanced functions could be identified as "intelligent" energy management systems. A number of studies presented these types of intelligent systems and its potential in efficient building control. This type of BEMS has the ability to track the energy use from different building components, automated fault detection and diagnoses. On the other hand, a simulation model fed with forecast data could be encapsulated within the BEMS where it performs a whole-building control evaluation and optimization according to a given control algorithm. This process is called simulation assisted control. This process proceeds by creating a building model that acts as the real building, where new control configuration analysis takes place. Then optimize the parameters that could achieve the best control configuration. Implement the results using a control algorithm. This model should be connected to a forecast data. This helps in prediction for the best control strategies. The system simulation models that belong to this category are expected to predict system performance accurately.

D. *Increase the Cooling Recycling Efficiency*

It has been use 7-12 ℃ as the central air-conditioning system standard refrigeration conditions. When the end side does not need too much cooling, electromagnetic valves will shut down automatically. The indoor temperature will be regulated under the control of the volume adjuster. However, the central air conditioning's quality adjuster monitors the indoor temperature by controlling the temperature of chilled water. During the transition of season, the demand coldness from the end side reduced by raising the indoor temperature for 2℃. Under the change condition on the cooling procedure, this can raise the chilling water's temperature. Such method can inhibit or reduce the excessive consumption of cold while improving the efficiency of the refrigeration cycle.

Table 2.1: Conversion ratio between the energy and heat load

LOAD	Cop	IPLV kw/ton	kw/ton	COP	Cop %	Efficiency %
100%	6.223	0.565	0.565	6.223009	100.00%	0.00%
90%	6.190	0.529	0.568	6.190141	99.47%	0.53%
80%	6.000	0.509	0.586	6	96.42%	3.58%
70%	5.745	0.5	0.612	5.745098	92.32%	7.68%
60%	5.384	0.496	0.653	5.38438	86.52%	13.48%
50%	4.952	0.501	0.71	4.952113	79.58%	20.42%
40%	4.543	0.549	0.774	4.542636	73.00%	27.00%
30%	4.401	0.622	0.799	4.400501	70.71%	29.29%
20%		0.768				
10%		1.148				

III. Combination Wall Assembly with Least 'U' Value

Mostly in Indian condition we use walls made of brick/stone with plaster (sand aggregate) coating with a preferable thickness of 12 inch as exposed wall. Heat transmission coefficient of these kinds of walls can be obtained room ASHRAE 90.1 standards. For an assembly of brick and plaster with the specified thickness we get a value of 0.36 (Btu/ft^2 hr °F)

Heat gain through walls= U x A x (ΔT + CTD)

U= Overall heat transmission co-efficient through walls

A= area of wall surface

ΔT=equivalent temperature difference

CTD= correctional temperature difference

Here value such as A, ΔT and CTD cannot be changed to drop down the overall heat conduction to the air-conditioned space 'U' value can be decreased by trying a new wall assembly of more heat resistant materials

However we are dealing with an existing building it is not feasible to demolish an exist building. We can use an external coating over the existing wall to decrease 'U' value.

Preferable wall assembly:

Brick(12 inch thickness)

Rockwool(5 cm thickness)

Polyurethane(5 cm thickness)

U : .22 (Btu/ft2 hr °F)

IV. Exposed Glass Replacement

Heat gain through glass= U x A x ΔT

U= Overall heat transmission coefficient through glass

ΔT= Equivalent temperature difference

U=.56 for ordinary glass

Suggested glass

50-60% heat absorbing glass (triple pane)

U=.22 (Btu/ft2hr °F)

V. HEAT TRANSMISSION THROUGH ROOF

Heat gain through roof: U x A x (ΔT+CTD)

U =Heat transmission coefficient of room

A = Area of roof

ΔT = Equivalent temperature difference

CTD = correctional temperature difference

Suggested under deck insulation of 50 mm thickness thermo coal

U= .16(Btu/ft2hr °F)

VI. HEAT LOAD SUMMARY OF AUDITORIUM WITHOUT OPTIMIZATION

SL.No.	Description	Area	Occupancy	Fresh Air Cfm	Deh.Cfm	Sq.ft/TR	Selected Ton
1	HALL	9157	300	2049	19083.1	188.64	48.54
2	BALCONY	1100	15	141	3040.15	194.84	5.65
3	STAGE	1100	15	141	2049.69	261.8	4.2
	TOTAL TONNAGE						58.3

VII. HEAT LOAD SUMMARY OF AUDITORIUM WITH OPTIMIZATION

SL.No.	Description	Area	Occupancy	Fresh Air Cfm	Deh.Cfm	Sq.ft/TR	Selected Ton
1	HALL	9157	300	2049	27635	148.4	61.7
2	BALCONY	1100	15	141	4103.53	152.88	7.2
3	STAGE	1100	15	141	3210.31	186.64	5.8
	TOTAL TONNAGE						74.7

VIII. CONCLUSION

By using insulating materials like polyurethane, rock wool, triple pane glass with energy efficient lighting system, the total heat generated inside the air conditioned system is brought down to a greater extend. Reduction in load will provide a viable opportunity in bringing down the total load which will directly impact the power consumption of air conditioning system. The normal life of this insulation (polyurethane, rock wool and triple pane glass) is about 10 years.

In this project work, the different methods used for optimizing the heating ventilation and air conditioning systems were checked. The various kinds of combinations (for walls and glass) are considered for reducing the U factor value. The total tonnage of refrigeration calculated before optimization is 74.79 TR. After optimization the heat load value became decreased by 58.39 TR. That is, the total heat load reduced by 16.4 TR. However insulation cost and material replacement cost should be kept under check to ensure a profitable energy management scenario.

By following the specified heat reduction techniques total heat load is brought down by 25% of the total load. The reduction in load will commute in the form in reduction in power expenditure. The additional capitals spend for insulation and material replacement can be regained from lesser electricity bills. Combination wall assemblies of certain materials like polyurethane, rock wool and triple pane glass can produce a much better insulation.

Outside air ventilation is one of the most important scenarios that can play a great role during optimizing technique. Maintaining a proper indoor condition is very important. However a controlled extraction rate under strict control on CO_2 deduction can ensure a demand based fresh intake scenario which will prevent unwanted or excess ventilation rate at any point of time.

REFERENCES

[1] ASHRAE Handbook, Fundamentals 2009, ASHRAE, Atlanta, USA.

[2] Palmer J. D., Evaporative cooling design guideline manual for New Mexico schools and commercial buildings, NRG Eng. New Mexico, (2002).

[3] Harris C. N. Modern air conditioning practice, McGraw Hill, International Student addition, (2007).

[4] Stocker W.F. and Jones J.W. Refrigeration and air conditioning, McGraw Hill., Int. Edn., (2005).

[5] Prasad M., Refrigeration and air conditioning data book, Wiley Eastern Ltd, New Delhi, (1989).

[6] Majeed A. and P. M., Prediction of cooling characteristics during air cooling of cylindrical food products with a flowing film of cold water at the surface air film cooling, Transactions of the ASAE. 25(1)508, (2002).

[7] Thorley D. L., Partner F. I. H. V. E., Roger Preston J. and Partners, Consulting engineer’s air conditioning system design forbuildings, 256, (2002).

[8] Barrington S. F. and Mackinnon I. R., Air distribution from rectangular wooden ventilation ducts.,Transaction of ASAE., 33(3), 944-947, (1990).

[9] Ansari F.A., Mokhtar A.S., Abbas K.A. and N.M. Adam., A simple approach for building cooling load calculations.,Am. J. Environ. Scs.1(3), 209-212. (2005).

[10] Stoecker, W. F., and Jones, J. W., 1985, Refrigeration and air conditioning, Second Edition, TATA McGraw-Hill Publishing Company LTD., 1985

[11] Liu, J., Aizawa, Y., and Yoshino, H., 2002, Experimental and numerical study on simultaneous temperature and humidity distributions, ROOMVENT 2002, 169-172.

[12] Naydenov, K., Pitchurov, G., Langkilde, G., and Melikov, A. K., 2002, Performance of displacement ventilation in practice, ROOMVENT 2002, page483-486.

[13] Khalil, E. E., 2009, Thermal Management in Hospitals: Comfort, Air Quality and Energy Utilization, Proceedings ASHRAE, RAL, Kuwait, October 2009.