Energy Conservation in Heating, Ventilationand Airconditioning

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1. INTRODUCTION

1. Energy conservation is the practice of decreasing the quantity of energy used while achieving a similar outcome. Energy conservation facilitates the replacement of non-renewable resources with renewable energy. Energy conservation is often the most economical solution to energy shortages, and is a more environmentally benign alternative to increased energy production. The ECBC has been developed by India's Bureau of Energy Efficiency, and is mandated by the Energy Conservation Act, 2001, passed by the Parliament in September 2001. The Energy Conservation Building Code (ECBC), launched on 28th June 2007, is a document that specifies the energy performance requirements for all commercial buildings that are covered by the ECBC. In HVAC terms a building having conditioned area of 1000 Sqm or more will fall under this category. (a) The designer has to consider not only the initial cost and maintenance cost equipment selected but overall life cycle cost. It is generally observed that energy saving costs and environmental concern over – weigh the adoption of latest technologies and use of optimum size equipment in compliance to ECBC 2007.. A building affects HVAC and HVAC affects the building. For designing HVAC system knowledge for considering the aspects such as orientation of building use of materials natural lighting wind direction, size of opening protection from glare and rain and a whole lot of other details need to be considered. In view of foregoing building users, architects, engineers (civil, electrical and air conditioning) need to work in tandem to implement the provisions of energy conservation in true spirit.

2. PROVISIONS IN HVAC

2. All Heating, Ventilation and Air-Conditioning equipment and systems shall comply with following mandatory provisions.

   (a) Natural ventilation shall comply with the design guidelines provided for natural.

   (b) Cooling equipment shall meet or exceed the minimum efficiency requirements as per table 1 /comply with ASHRAE 90.1-2004.

   (c) Unitary Air conditioner shall meet is 1391(part l), split air conditioner shall meet is 1391 (part Packaged Air Conditioner shall meet is 8148 and boilers shall meet is 13980 with above 75% thermal efficiency.

3. INSULATION

3. Piping and Ducting systems (Heating more than 40deg c, cooling less than 15 deg centigrade should have insulation as per table 2. Insulation exposed to weather shall be protected by aluminium sheet metal, painted canvas, or plastic cover/water resistant paint.

   a) HVAC systems should be balanced in accordance with generally accepted Engineering Standards.

   b) Air systems shall be balanced to first minimise throttling loses. Fans with power more than 1 HPshould be provide with speed regulation equipment.

   c) Hydraulic systems also should be balanced.

   d) Condensers should be located to avoid recycling of air. Soft water should be used forCentralisedCooling water system.

4. HVAC Systems should comply with ASRAE 90.1.2004.

4. ECONOMIZERS

5. Each individua1 cooling fan system that has designed supply capacity over 2500 cfm and a total mechanical cooling capacity of over 6.3 tons 22kw} shall include either air economizer or water economizer. Chilled or hot water systems shall be designed for variable fluid flow and shall be capable of reducing pump flow rates upto 500/0 of design flow or minimum flow required for proper operation of the chillers/bailers.Chilled water or condenser water systems having

pump motors greater than 5 hp shall be controlled by variable speed drives.Interlocks should be provided for the pump operation with main equipment to shut down the pump when main equipment is not operating.

5. MINIMUM ENERGY PERFORMANCE

6. Establish the minimum level of energy efficiency for the base building and systems. Projects should comply with ASHRAE standard 90.1-2004/final version of ECBC as and when released.CFC reduction in HVAC to reduce ozone depletion.Zero use of CFC refrigerants in new building HVAC &r base building systems should be followed. Specify new HV AC equipment that uses no CFC refrigerants. Plan for the comprehensive CFC phase out conversion for existing building HVAC equipments. Prevent leaks.

6. COMFORT CONDITIONS

7. Human comfort depend on thermal comfort, indoor air quality, acoustical comfort and visual comfort condition. Thermal comfort conditions have to be selected based on ET *. Effective Temperature (ET*) combines temperature and humidity into a single index, so that two environments with the same ET* should evoke the same comfort even though they have different temperatures and humidity. A room at 780 F with a low relative humidity will be just as comfortable as, a room at 700 F with a high relative humidity. ET is to be worked out from the figure. given below from ASHRAE application hand book. The low humidity in the 780 F room allows a person's natural cooling system in the form of evaporation of moisture off the kin to work more efficiently. In addition, the amount of energy required in cooling a room to 780 F is less than the energy required to cool a room to 700 F. Therefore in hot and dry climate, high temperature with low RH can be selected. The same comforts can be achieved with increase in air movement and lowering ET. This can be done by providing LAD (local air moving devices like man coolers, fans etc.). In order to accomplish effective temperature control, both dry bulb temperature and the ET is defined (by ASHRAE) as the equivalent air temperature of an isothermal environment at 50% rh in which a subject, wearing clothing standardized for the activity concerned, has the same heat stress (skin temperature t sk) and thermoregulatory strain (skin wettedness w) as in the actual environment. ASHRAE also observes " SkinWettedness is more closely related to the sense of discomfort or unpleasantness than to temperature sensation. For example, ET has come down from 29.1 to 27.8 (by about 1.3 deg C) by increasing the air movement from 0.2 m/s to 1.5 m/s.amount of moisture in the air must be know. Indoor air quality has to be improved by providing UV lighting at cooling coil section as this shall also improve coil efficiency by avoiding fungal formation. In case of high ventilation loads like conference halls, DOAS (Dedicated out side air system) or HRW (Heat Recovery Wheels) are recommended which not only improve IAQ but also reduce the overall energy consumption.

7. CONDITIONING OF OUTSIDE AIR

8. Pre cooling of outside air by using evaporative coolers and EAT system (Earth air tunnel) reduces the required plant capacity, particularly in hot and dry regions. Two stage evaporative coolers can even be used as an alternative to air conditioning where stringent RH conditions are not required. The soil temperature 4-5 mtrs below ground level will be nearly constant and maintained at average ambient temperature through out the year, which is about 28-30oC . Combining EAT with adiabatic cooler is like two stage evaporative cooler and can be used as an alternative to air conditioning for comfort applications. EAT system can be used as winter heating system in the cold climate zones. HRW (Heat Recovery Wheel) can recover and transfer sensible heat, enthalpy from return air to ambient air. As an example, Hyderabad convention centre used HRW for high ventilation loads and the plant capacity has thus been reduced to 750 TR from 105 TR.

8. OPTIMISATION OF ENERGY PERFORMANCE

9. Achieve increasing levels of energy performance above the prerequisite standard to reduce the environmental impacts associated with the excessive energy use. Base line building performance rating reference can be taken as per .ASHRAE 90.1-2004 standards. Design the building envelope and building systems to maximize energy performance. Use a computer simulation model to assess energy performance and identify the most cost effective energy efficient measures. Quantify energy performance as compared to a baseline building

9. INDOOR ENVIRONMENT QUALITY

10. Establish minimum indoor air Quality (IAQ) performance to prevent the development of indoor air quality problems in buildings, thus contributing tothe comfort and well being of the occupants.Design ventilation systems to meet or exceed the minimum outdoor air ventilation rates as prescribed in the ASHRAE standard. Balance the impacts of ventilation rates on energy use and indoor air quality to optimise for energy efficiency and occupant health. Standard ASHRAE 62.1-2004 (provide at least 30% above min. rates).

10. VARIABLE AIR VOLUME SYSTEM

11. Variable air volume (VAV) is a technique for controlling the capacity of a HVAC system. The simplest VAV system incorporates one supply duct that, when in cooling mode, distributes approximately 55 degree F supply air. Because the supply air temperature, in this simplest of VAV systems, is constant, the air flow rate must vary to meet the rising and falling heat gains or losses within the thermal zone served.

12. A VAV terminal unit[often called a VAV box, is the zone-level flow control device. It is basically a quality, calibrated air damper with an automatic actuator. The VAV terminal unit is connected to either a local or a central control system. Historically, pneumatic control was commonplace, but electronic direct digital control systems are popular especially for mid-to-large size applications. Hybrid control, for example having pneumatic actuators with digital data collection, is popular as well.

11. ADJUSTABLE FREQUENCY DRIVES

13. AFD control the speed of either an induction motor or a synchronous motor by adjusting the frequency of the power supplied to the motor. Adjustable frequency drives are also known as variable-frequency drives (VFD). when changing the frequency of the power supplied to an AC motor, the ratio of the applied voltage to the applied frequency (V/Hz) is generally maintained at a constant value between the minimum and maximum operating frequencies. Operation at a constant voltage (reduced V/Hz) above a given frequency provides reduced torque capability and constant power capability above that frequency. The frequency or speed at which constant-voltage operation begins is called the base frequency or speed. Whether to applied voltage is regulated directly or indirectly, the V/Hz tends to follow the general pattern described for the performance described. The variable-frequency drive article providesadditional information on electronic speed controls used with various types of AC motors.

12. THERMAFUSE DIFFUSERS

14. These are simple replacements for complex and costly VAVs for standalone requirements. The TF-HC has four dampers that open and close to meter airflow (warm and cold) into the room in response to room temperature. The dampers are mechanically actuated by thermal element thermostats. There are up to twelve variations of this model with various options and accessories. A simple independent control plug controls the opening of the air path to allow the air flow as desired. Normally these are factory set at the temperature required. However off late design with site adjustable set points are also in the market. However there is a difficulty in going up the ladder every time the set points need to be changed. New models are being developed with remote set point facility and those also can be connected to BMS.

13. THERMAL COMFORT

15. Establish comfort criteria as per ASHRAE STD 55-2004 that support the desired quality and occupant satisfaction with building performance. Evaluate air temperature, radiant temperature, air speed and relative humidity in an integrated fashion. The survey should indicate that more than 80% occupants are satisfied with indoor conditions.

16. Prohibit smoking in the building except in designated smoking areas and provide negative pressure of 0.1 to 0.5 mm SPWG in the smoking room.

14. CONCLUSION

17. The contents and deliberations of this paper are intended to supplement general requirements for the planning, designing and commissioning HVAC system with an noble intention to conserve energy which is the order of the day now a days. Therefore all mechanical cooling and heating systems shall be controlled by a time clock that can start and stop the system under different schedules for three different day types per week this system is applicable to cooling systems above 28 KW and heating systems above 7 KW). All heating and cooling equipment shall be temperature controlled with a temperature dead band of 3 degree centigrade. Thermostats will be interlocked to prevent simultaneous heating and cooling. Efforts should be made to develop a Measurement and Verification plan to evaluate building and energy performance. Install the necessary metering equipment to measure energy use and compare the same with baseline performance and the design aspects of the system..

REFERENCES

[1] ECBC 2007
[2] ASHRAE STD 55-2004
[3] HVAC System Design By Roger W Haines, P E Michael, E Myers, PE Leeds
[4] Book Published by BEE on HVAC System