ENERGY CONSERVATION STRATEGIES FOR HVAC SYSTEMS

Heating ventilation and airconditioning systems consumes nearly 50 to 60% of the total power consumption in any building and thus, offers huge potential and challenge to reduce the energy consumption by employing various innovative systems designs.

No-cost measures for reducing the energy bills. For airconditioning systems, the measures include selecting the right temperature [no overcooling or overheating], minimizing the space for airconditioning and closing of dampers / grills for areas where airconditioning is not required.

INNOVATIVE STRATEGIES:

i) Building Orientation/ Architectural features
ii) Establishing Baseline Performance Indices.
iii) Automation and Building management system.
iv) Variable Voltage and Variable Frequency Drives [VVVD].
v) Heat recovery wheel / desiccant cooling system for fresh air.
vi) Vapour Absorption Machines [VAM]
vii) Roof Top Chillers.
viii) Geothermal System.

BUILDING ORIENTATION/ ARCHITECTURAL FEATURES

The following features should be carefully considered while designing the building.

(i) Orientation
(ii) Double Glass
(iii) Insulation on roof
(iv) No Leakage (FromWindows/ Doors/ Ceiling)
(v) Long side should be having minimum heat gain.
Minimum heat gain is from NORTH
EAST
SOUTH &
WEST
(vi) Plant room and AHU locations should be such that ducting/ piping are minimum.
(vii) Fresh air intake should be sufficient to avoid “Sick Building Syndrome”
(viii) Sun shades over the glass area with proper inclination to avoid direct sunrays.
(viii) Partitions and closure of air grills of unutilized conditioned space.

ESTABLISHING BASELINE PERFORMANCE INDICES:

The following features should be carefully considered while establishing the Performance Indices"

i) Space temperatures (23-26 ℃) - Task & Non-task, Equipment Room etc.
ii) Usage time schedule – Working hours, holidays etc.
iii) Total tons at worst conditions
- At Machine End
- At User End
iv) Tons / Sqr. Meter
v) KW / Ton
vi) KWH / Day
vii) KWH / Year

AUTOMATION AND BUILDING MANAGEMENT SYSTEM:

Automation and building management systems are now increasingly used in the airconditioning systems for centralized monitoring and controlling the operations so as to ensure optimum operations of all the machines without any wastage of energy in overcooling or overheating of the areas.

Automation and Building management Systems when used in conjunction with other innovative techniques can result into substantial energy savings. Eg. the Carbon-di-oxide sensors help to maintain adequate ventilation despites varying people load. During low occupancy condition, the CO2 sensor will signal the outside air damper to reduce the ventilation rate.

Automation can help in Programmed Start & Stop of AC Machines , Ventilation Systems, Chiller ,Run time equalisation and auto adjustment of set points. The automation and the BMS builts in intelligence for instant communication between sensors and machines providing instant control and can be software driven to avoid overloading, downtime and wastage of energy.

VARIABLE VOLTAGE AND VARIABLE FREQUENCY DRIVES [VVVF] OR VARIABLE SPEED DRIVE:

In any HVAC system there is a significant variation in the load demand due to various external and internal variables. Conventional HVAC system adjusts itself to these demand variations through control of dampers, controlling valves and inlet guide vanes etc., resulting into pressure drop across these devices and loss of energy.

In the VVVFD [VARIABLE VOLTAGE AND VARIABLE FREQUENCY DRIVES] systems , the voltage and the frequency of electric supply to the induction motors for fans , pumps and compressors can be steplessly varied to control the speed of the motor in tune with the load requirements. (Cube Law)

The VVVFD system consists of an input rectifier which convert [AC to DC] , and an invertor [which converts DC to AC], connected through a controller.

The input through the drive is fixed voltage , fixed frequency supply ,which after passing through the rectifier and invertors converts into a variable frequency variable voltage supply.

The voltage to frequency [v/f] ratio is kept constant throughout the operating range of the motor to ensure that its torque producing capability is maintained without effecting its efficiency.

The performance of the VVVFD systems is dependent on the location and accuracy of the sensors which have to give feedback signals to the VVVFD systems on variations in the load demand. Besides energy saving, the VVVFD system will result in reduction in mechanical wear and tear as the motors will be running at low speed and thus, cost reduction for maintaining the same.

HEAT RECOVERY WHEEL AND DESICCANT COOLING SYSTEM FOR FRESH AIR :

The indoor air pollutants , which consists of biological contaminants, harmful chemicals , odours and dust etc. are to be constantly removed and fresh air is to be inducted into any building so as to reduce “Sick Building Syndrome” and “ Building related Illnesses”.

ASHRAE 62 – 99 Standard specifies 20CFM of outdoor air per person for proper indoor air quality. The introduction of 20CFM of outdoor air per person leads to more airconditioning loads, as this outdoor air has to be treated through the airconditioning system for temperature and humidity.

The airconditioning load due to outdoor air can be reduced by adopting desiccant cooling . [

The idea is to exchange heat between the return stale air from the conditioned space and outdoor fresh air intake. Here a wheel is rotated slowly [2 to 20 rpm].

Sensible heat is transferred as the metallic substrate picks up and store heat from the hot air steam and gives it up to the cold one which is going out.

Latent heat is transferred as the desiccant on the wheel absorbs moisture from the higher humidity incoming air stream and releases the same into the air (cold air from room) stream that has a lower humidity ratio.

In case of high humidity applications, the wheel has intensive quoting of desiccant media and this desiccant media is re-generated to its original dry state using thermal energy supplied by natural gas, electricity waste heat or the sun.

These wheels are capable of recovering 80% of the heating or cooling energy that is exhausted from the building and thus reduces the energy cost of the fresh air.

VAPOUR ABSORPTION MACHINES:

VAPOUR ADSORPTION MACHINES:

ROOF TOP CHILLERS:

Roof top chillers are now increasingly used as they can be mounted on the roof and the costly built up space inside the building can be saved.

These chillers are factory made and designed with best of components and are highly compact. Besides saving of space, there is a considerable saving of energy as the refrigerant pipes become very small.

All the components like Compressor, Compressor Motor, Evaporator, Chiller and aircooled Condenser , alongwith the micro-processor based control panel forms part of the roof top chiller.

All the protecting device and safeties are factory fitted and thus, ensure high level of reliability.

The microprocessor based panels monitors the set points precisely and thereby, save energy. The chillers are available in various ratings and generally recommended for rating above 30 ton.

Instead of reciprocating compressors, depending upon the application, the roof top chillers now are being designed with energy efficient scroll or screw compressors. One can easily achieve substantial energy saving by selection of appropriate energy efficient compressors.

GEOTHERMAL SYSTEMS:

Solar Energy Centre, Gulpahari Gurgaon constructed by TERI has used innovative scheme of providing airconditioning by harnessing in geo-thermal energy.

Basic principle is that the temperature at about 20 feet below the ground level remains constant at about 20 deg., Centigrade throughout the year.

The indoor air is thus, taken below the ground through ducts , tunnels , by using ventilation fans and the heat exchange takes place below the ground.

The system does not need extra cooling / heating as inside the space one can have a mean temperature equal to the temperature available at 20 feet below the ground.

SEA WATER SYSTEMS

CONCLUSION:

The above innovative strategies can be suitably applied for optimisation of airconditioning system and energy savings.

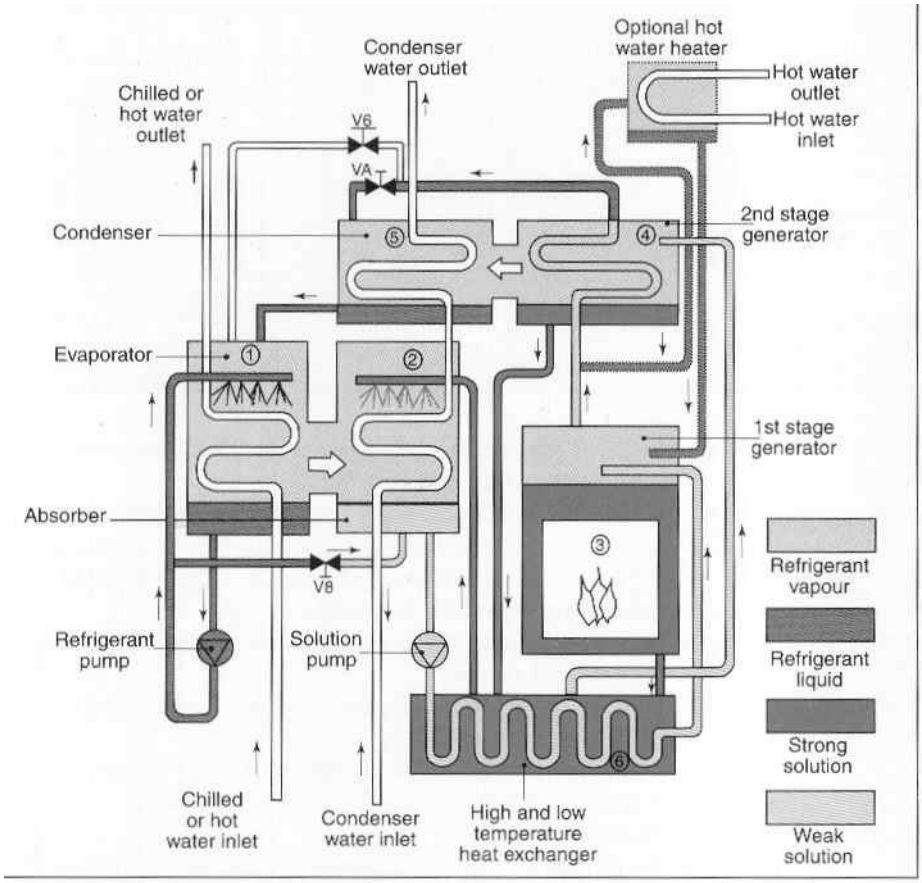

FIGURE 3: WORKING CYCLE OF VAM