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Identifying benchmark parameters for HVAC load optimization in Green buildings

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Abstract –

Heating, ventilation and air conditioning (HVAC) systems any building is an important key parameter to assess the energy performance of the building. To achieve this, it is necessary to have adaptable control systems that could deal with the parameters required to control the indoor climatic conditions.

In this paper, an analysis has been made to minimize energy consumption of HVAC system while maintaining the thermal comfort of a building with uncertain occupancy level. A building has been analyzed in an Engineering college campus by using ECOnirman tool with saving reports on energy conservation.

Key Words: HVAC, Simulation, Thermal Comfort, RETSCREEN, Green buildings

1. INTRODUCTION

Green building, this name implies a official or residential or commercial buildings which will produce benefits in terms of economy, durability, thermal and moisture comfort by maintaining better indoor and outdoor surrounding air quality.

Our main objective behind designing and installing of green building is to adopt or set up efficient building elements and its principle is to save our natural resources (like coal, water), reducing more energy consumption, reducing waste by using biomass or many other techniques, lowering carbon emission and crating non-hazardous space which will result bearable environmental quality and will make the building's owner money saver right from complete installation.

Here in this green building we are going to design quite sustainable location which will encompass air ducts for clean air flow, window installation for sustaining throughout day light, passive solar control, best kind of insulation and heat exchanger for better climate control . So these all will lower the energy consumption and water and will be more comfort for inhabitants.

Here to achieve energy efficiency we are including HVAC system with variable speed drives on fan and motors, low consumptive bulb (T-8, T-5) with better light and low heat transmittance operated with electronic ballast will save energy up 40%. Also by going through renewable source of energy like earth air tunnel with geothermal pump, wind, solar or fuel based, we will achieve maximum energy efficiency.

To achieve material efficiency with its durability, we will incorporate the use composite materials like reinforced concrete cement (RCC) for building's wall and roof, using bio based materials, use of toughest wood and lumber materials and by estimating recyclability of material for enhancing waste and hazardous management or control.

In this green building to maintain good indoor air quality and healthy building we will avoid the elements or material who releases VOCs contaminant and smoke, instead we are rooting towards the use of adhesive sealants finishing material (avoiding VOCs), good biodegradable cleaning elements and use of natural ventilation and operable windows.

As far as comparison is concerned green buildings differed over base buildings in many ways like installing green buildings will enable us to save energy and water consumption, saving natural resources, require low space with good designing technique, incorporate environmental friendly materials, provide healthy and thermally comfortable life by removing moisture and by maintaining better indoor air quality without any toxic, hazardous and pollution creating. Green building will even also reduce operational and maintenance cost.

So summarily it will yield benefits like environmental benefits, economical benefits, social benefits and will make the people more productive, grooming or say rooting towards green buildings.

IGBC if broadly speaking is one of renowned organisation has launched a IGBC new green building rating program and tools to address the many emerging green buildings which is being installed in our country and this will enable the people or say country to install green building even in diverse climatic zones and will produce positive

results in many desired terms. It aims to impart green building revolution and privilege the India as on of the global leaders in green building by 2015.

Building energy analysis includes energy audit tools and techniques or say energy saver program to estimate total energy consumption on heating, ventilating, cooling and lighting of proposed buildings and compares it with conventional buildings and finally compute total saving percentage which ranges from 15% to 35%.

Now we put a light on different electrical loads used in any buildings like, resistive loads, inductive loads and capacitive loads. As we know resistive load (bulb with resistive filament) causes more energy to drop but contribute optimal power factor. On the contrary inductive and capacitive loads store energy in the form of magnetic field and electrostatic field respectively and at the same time result comparatively low power factor which also affect transmission and distribution by producing reactive power but at least this severe result can be managed by reactive power compensation technique. So we have to use more efficient one and even if it is not effective then we will adopt some energy consumption controlled techniques.

Thermal mass, when it is used accompanied with passive solar design techniques and natural ventilation, can effectively remove the requirement for air conditioning. In such type of buildings, temperatures need no to be changed except for small amounts of heating on severe cold days or during overcast periods. Such types of buildings encompass single houses, medium density inhabitants, commercial buildings and some small scale educational and industrial buildings. The indoor conditions in such buildings are dominated by the influence of the climate. Mass is very useful in structures which require air conditioning. This can be achieved by night-time cooling of the mass to reduce the day-time heating loads in summer, or to even out the heat loadings in winter and eliminate the need for cooling during winter. And as we know all types of processes in any buildings require electrical energy and to fulfil this need is not energy efficient way. So instead in some of the processes like heating, cooking and tradition of sanitary hot water, we can adopt natural gas with bio mass too.

ECBC having full form energy conservation building code is a green building development tool in terms of cost and energy saver programs and also provides many more advantageous discussed earlier. It has its own standard rating of each element used in green buildings and allows the user simulator to add new data input about proposed buildings. In this ECBC simulator tool there are many building's elements and equipments which parameters needs to be changed according to proposed building like:- building envelope, HVAC, solar water heating system, all types of lightning load and what is the area where proposed building is going to be constructed. Its significance is that by using this tool we can compare the energy estimation of proposed building with standard building and finally saving energy up to 15% to 35% and further to achieve many more desired needs.

2. Procedure for Benchmark parameters

Modelling is the computerized simulation of a building or complex that concentrates on energy consumption, utility bills and life cycle costs of several energy related items or equipments such as air conditioning, lights and hot water. It is also used to calculate the payback of green energy solutions like solar panels and photovoltaic, wind turbine energy generation. In the same way as discussed above make a comparison analysis between new proposed green building and its standard rated building in terms of energy. The model results will be in the form of a percentage savings in annual energy use and its costs of the designed building when compared to the base building. . The most common models estimate energy use, energy expense, and carbon dioxide emissions. Models also can analyse other Characteristics such as the effectiveness of natural ventilation strategies and daylight penetration. In this way, energy modelling can help in the design process of proposed green building.

Weather and geographical parameter is also a considerable factor which must be taken into simulation to see the difference between average annual energy consumption per year and energy consumption when we put seasonal case and particular geographical case parameter. Here we must think about variation in parameter like temperature, pressure according to climate or weather. For this geographical analysis , we must take many points into attention , which are:- Latitude, Altitude, Topography, screening, sky- view factor and sky roof versus wall ratio, these are important factors which parameters must be taken into simulation to compute exact annual energy consumption and saving of a particular proposed green building at particular geographical location.

Now we put our one sight also toward Building materials which offers specific benefits. Such as:-Reducing maintenance or replacement costs on the life of the building. Energy conservation, Lower costs associated with changing space configurations and Greater design flexibility. To assess these building's products or materials properly, we will have to make our approach on followings points which are:- Research , evaluation and selection of materials.

Modelling of the building wall is also an essential factor which describes about one parameter cooling and two compartments. Both are related with flow of heat caused by temperature difference. This analysis is done based on Newton's law of cooling techniques and formulae. In one parameter cooling amount of heat flux calculated between surrounding and exterior wall of the building and heat

conductivity of the wall surface is calculated. In two compartments cooling heat flux of the wall which is common of both the room and compartment is calculated. In this way we get familiar with heat conductivity of wall surface and about heat loss and heat gained by room.

To take proper precaution to avoid temperature in the room caused by flow of heat flux, first we search or aim to detect the effect of a source which is causing heat generation. By this way we get dominant over that cause of heat flux and try to maintain minimum heat flux and maintain better thermal comfort with in the room.

Model-Based Design is a process that enables faster, more cost-effective evolvement of dynamic based systems, control systems, signal processing, and communications systems. The model is an executable specification that we can check and refine continually throughout the development process. It allows us to improve efficiency by continually checking error and then correct it, by automatically generating embedded software code, by putting input data only according to our requirement. This method is procedurally clear and leads to a space description of a Building which is implemented by using MATLAB or SIMULINK, RETSCREEN, BEopt 2.0 etc., This model is tested using experimental data from a building which has high thermal capacity.

As far as importance of insulation is concerned it may be like acoustic insulation, fire insulation and impact insulation, it means after all it is used for thermal comfort. Insulation products vary in terms of colour, surface finish and texture, core composition and for important performance. So their attentive factors to choose best kind of insulation and no doubt we are going through accordingly.

Better insulation performance implies a extreme prohibitance of heat flux between two bodies. So to get optimal performance of insulation we are going through insulation having high "R" value (for better thermal comfort) and at the same time In construction terms, a U-value (unit watt/k-m2, reciprocal of R- value) may be calculated and attributed to a single thickness of any material and it is more common to calculate it as a product resulting from the composition of different materials in any given form of construction or single material. The lower u –value will have better insulation and lower thermal transmittance. Even window glass is also chosen based on U-value.

One thing to be considered that installation and performance of insulation, these two make different sense in a way that many installation can be either temporary or permanent depend on its performance. As installation are site-specific means they are designed to exist only in the space for which they were created, some insulation performance depends on degree of water and degree of contamination these can affect insulation performance. Moreover performance will depends on lab test result and then we check that what are the terms and conditions which we need to follow so that insulation installation will be up to longer duration otherwise installation duration may become temporary because of worst performance.

So in this way choosing a right kind of insulation will have longer sustainable life; it will save far more energy and will reduce carbon emission.

Thermal insulation in buildings is an important factor to achieve thermal comfort for its occupants. Insulation reduces unwanted heat loss or gain and can decrease the energy demands of heating and cooling systems. It does not necessarily deal with issues of a more need of ventilation and may or may not affect the level of sound insulation. Cellulose, glass wool, rock wool, polystyrene, urethane foam, vermiculite, partite, wood fibre, plant fibre etc are the example of different insulation. Its work is like in summer it will prohibit heat flux to come into indoor building and in winter season it doesn't le the heat flux to go outside. In winter season Losses can be reduced by good weatherization, bulk insulation, and minimizing the amount of non-isolative glazing. In the same way in summer season heat flux is prohibited by sufficient shading from the sun, light coloured roofing, heat reflective paints and special coated glazing which can reduce thermal transmittance up to 10%. In this way thermal insulation will provide better thermal comfort and will maintain better indoor environment. This thermal insulation be again chosen based on "R" value (unit k-m2/watt).

3. SIMULATION RESULTS

A building communicates with the environment through its external faces such as walls, windows, projections, and roofs, termed as the building envelope. The envelope acts as a thermal shell, so little bits uncared will lead to leakage in energy. So before HVAC installation above mentioned facts must be equipped or fulfilled in a ideal way. Here the main role of efficient HVAC is to remove warmed humid air, reducing dust particulate and removing stale air and maintain fresh inside air quality by avoiding moisture, toxicity substance and many serious disease problems. In green building before HVAC installation we must calculate first density of occupants, area of floor, estimating air leakage and amount of heat gained or loss in or from the room.

ECOnirman Prescriptive Tool is an online tool for assessing conformance with the ECBC using the Prescriptive method. It enables building developers and designers to test their building design against the prescriptive requirements of the code. It is a web-based conformance tool that can be made available to the users over the Internet with minimal software requirements or building science expertise. It can be used with minimal learning involved. Being a web-based

tool, it allows design teams to collaborate remotely. The tool requires inputs from the user to arrive at conformance results for different buildings components. A report that may be submitted to demonstrate conformance with the ECBC, can be generated. Key features of the tool are:

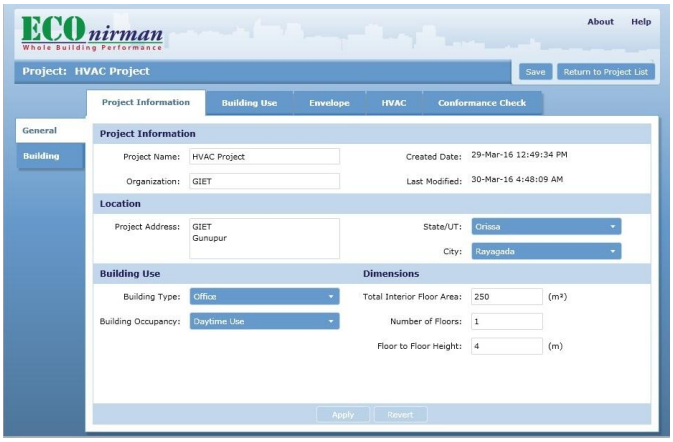

Fig. 3.1 ECOnirman tool main window

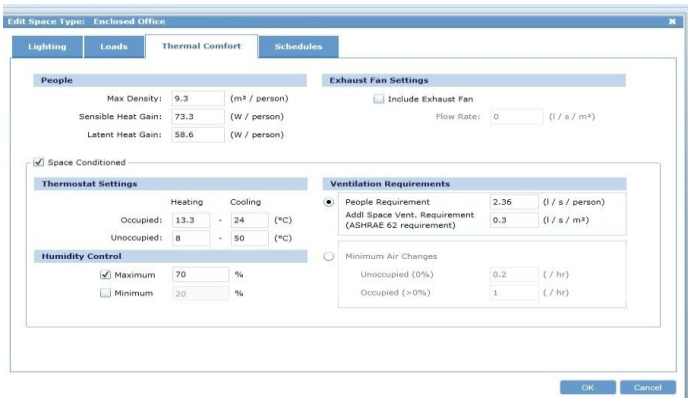

Fig. 3.2: Benchmark values for HVAC systems

4. CONCLUSIONS

Out of all HVAC system services HVAC are the most energy consuming devices which is accounted as 10–20% of final energy use in developed countries. Consequently, setting HVAC minimum energy efficiency requirements is a noted factor for the success of green building energy conservation. So HVAC component and its desired parameter must be in such a way that i could not provide us only energy saving and cost saving but also could focus towards achieving good thermal comfort and healthy environment in all required aspects. An example of better HVAC system based on our simulation effort is in such a way that we have chosen central plant air system having cooling coil source as central plant and supply fan used in it having static pressure of 500.7 pa and return fan static pressure 70pa.and one outside air economizing integrated type. In the same air system where one sensible wheel outside air heat recovery system is being used.

In this paper, a thermal model for one building has been analyzed in an Engineering college campus by using ECOnirman tool with saving reports on energy conservation.

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