A Case Study of Cooling Load Estimation of an Auditorium

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Abstract: Now a day's human comfort is the uttermost parameter because of enhancement of quality of lifestyle and rising atmospheric temperature. Electrical air conditioning equipment's are not preferred in large building because of their short life and consumptions of large amount of power. Central air conditioning provides more reliability in addition to lower maintenance of cost and energy. This also helps in improving aesthetics of a building.

This paper gives the results of cooling load evaluated in different climate conditions by using CLTD method. the programmer is often accustomed calculated cooling load from walls and roofs Calculation of cooling load from items such as infiltration and ventilation heat gain can easily be represented on MS excel programmed calculated results were compared with standard data given by ASHRAE and CARRIER fundamental hand books and results are satisfactory. The calculated results were compared with standard data given by ASHRAE and CARRIER Fundamental Hand Books, and the results are satisfactory.

Key Words: **CLTD, Cooling Load, Air conditioning, Human comfort, HVAC.**

1. INTRODUCTION

There is a big problem of ecological imbalance because of energy consumption by industries. 72% of total world energy is consumed by industries, infrastructure, commercial buildings, markets and residential houses. About 60% of the total energy requirement in the giant building is allocated for the air conditioning plant installed to use the cooling purpose by providing the exact amount of cooling and heating load, we can minimize the energy consumption. Proper sizing of heat ventilation air conditioning (HVAC) and control of HVAC system is the best method for this. Local climate conditions and external weather conditions are important parameters for the energy consumption in buildings.

Energy consumption in building is also depend upon the performance of heating ventilation and air conditioning (HVAC) system changes with reference to them, higher style in building HVAC applications that take account of the right climate conditions. This will be helpful in better comfort and also helps in energy efficient buildings.

With calculations of thermal load, we can accurately install air conditioning equipment's and air handling unit. And also helpful in provision of better human comfort and good air flow in ac zone. The project cooling load estimation for an area is grant by victimization CLTD method

2. OBJECTIVE

To minimize energy consumption with the help of cooling load calculation and maintain reconciliation between them to save energy.

To achieve human comfort operation and good air distribution in the air condition zone.

3. EFFECTIVE TEMPERATURE

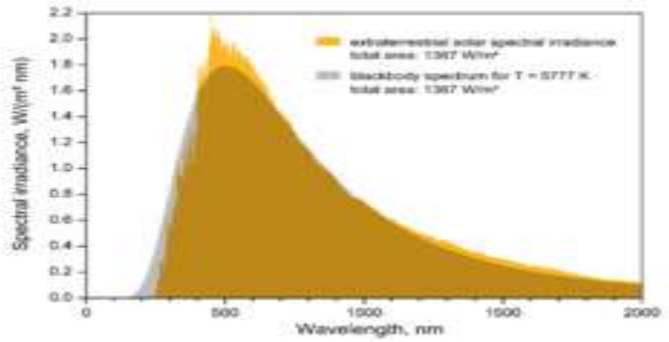
The degree of hotness and coldness felt by humans mainly depends upon the following factors: -

1. Dry bulb temperature, 2. Relative humidity, 3. Air velocity

The combined effect of these 3 is known as effective temperature, which is defined as the interpret ting which related to the combined effect of air temperature, relative humidity and air velocity on the human body.

The unrealistic application of the concept of effective temperature is represented in fig 1and is known as the 'human comfort chart'. This chart helps to analysis conditioning air into human comfort zone. Human generally feels comfortable between the temperature of 22°C to 27°C and relative humidity of 40% to 60%.

All the men and women above 40-year-old of age prefer 0.5°C higher effective temperature than the person below 40 years of the age.



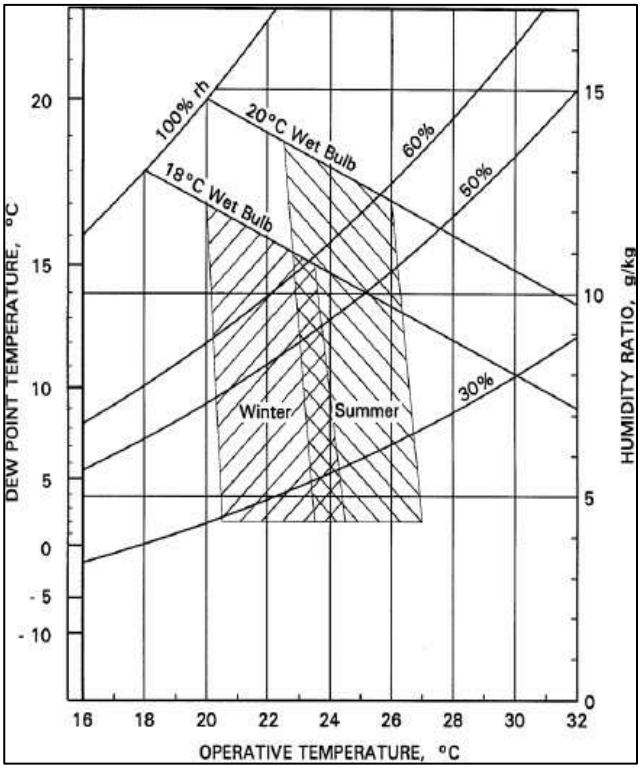


Figure-1: Human Comfort Zone.

4. HEAT TRANSFER ANALYSIS

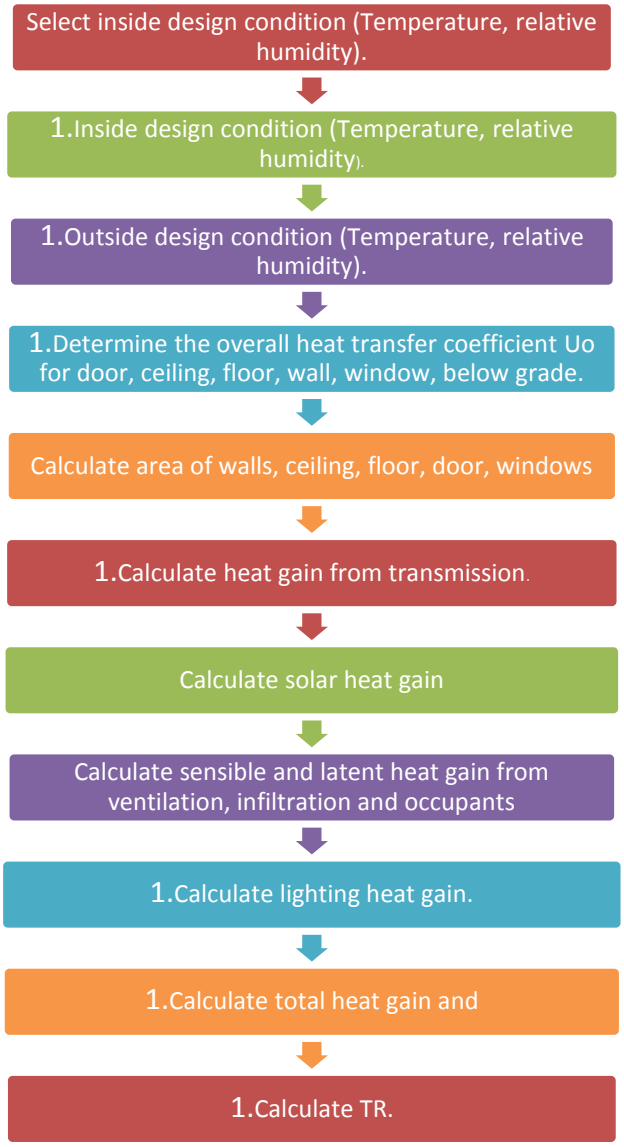
In an auditorium or space, heat is transmitted through different medium such as window, door and floor of the ground. Heat transfer takes place by 3 modes namely conduction, convection and radiation.

[Cooling load of the auditorium depend upon the following factors such as local climate, thermal characteristics of material and type of building. There also various software for cooling load calculation such as TRACE 700; ELITE or HAP 4.3 is available. These methods required a complex and lengthy data input, hence most of the designer does not use this method. They prefer compact and straightforward techniques over this software system.

An elementary method for calculating a cooling load using the transfer function method is to use single step procedure, which was given in the ASHRAE Handbook of Fundamentals of the year 2005. This technique is cooling load temperature variations (CLTD) technique and employs the utilization of human hand effort calculations for Determining the cooling load from different areas.

Human hand calculations were done for the Auditorium using the all equations mentioned in Chapter 3[6], calculation procedures and information. All equations mentioned are required for heat transfer through the Auditorium and for the inside's load in order to calculate thermal load. Then, all the equations were inserted in a particular program MS Excel for accurate and precise result. (we can do it Manually also)

The widespread step by step procedures for Determining the overall heat load are as follows: -



5. DESIGN CONDITIONS

Design of cooling required in an area depends upon the outside and inside current condition and also on the season.

The recommended comfortable temperature of Indian people according to the ASHRAE is 25° Celsius and 50% relative humidity. Our current outside condition which is known by the weather report is 43° Celsius and relative humidity is 46 %.

6. COOLING LOAD ESIMATION PRESENTED ON THE WORKSHEET

The calculations of the cooling load of Tutorial auditorium is represented on a MS EXCEL worksheet [5].

We have displayed heat gain from various sources.

Worksheet: Cooling load sheet for 30 seated Tutorial Auditorium [5].

Project: Auditorium heating load	**Area**: JIMS Engineering college	**Month**: August-September (2019)
Space: 100 persons	**City**: Greater Noida	
Length(m) 21.080 Width(m) 10.70 Height(m) 7.55 Area(m^2) 225.556 Volume(m^3) 1702.9478	Outside and Inside condition condition / DBT (deg C) / WBT (deg C) Outside 43 32 Inside 23 16 Differences 20 - No. of air changes /hr.: 0.6	Summer %RH / Kg/Kg 46 0.0248 50 0.00866 - 0.0161 Infiltered air(m^3/min): 17.029
SENSIBLE HEAT GAIN		
HEAT GAIN INFILTERATION	INTERNAL HEAT GAIN	BY WALL AND ROOFS
Sensible Infiltration 6961.4 watt	**Peoples** 6500 watts **Lights** 5000 watts **Equipment's** 10000 watts	**Wall(NE)** 3575.480 W **Ceiling** 9541.0188 W **floor** 1590.16 W
TOTAL= 43168.0588 watt	**Total (6% FOS)=45758.14233 W**	
LATENT HEAT GAIN		
HEAT GAIN INFILTERATION	INTERNAL HEAT GAIN	
Latent infiltration 13716.85 watt	Peoples 3000 watt	
TOTAL=16716.85 watt	**TOTAL(5%FOS)=17552.6925 watt**	
AUDITORIUM TOTAL HEAT	**Auditorium Sensible Heat+Auditorium Latent Heat**	**63310.83483 watt**
OUTSIDE AIR HEAT		
OUTSIDE AIR SENSIBLE HEAT	OUTSIDE AIR LATENT HEAT	
8900 Watt	**17700 Watt**	
SUB TOTAL	**89686.0576 W**	
GRAND TOTAL(5%FOS)	**94406.3765 W**	
TON(W/3500)	**25 TON**	**Taken in between (18-25)TON**
RSHF=(RSH/RTH)	**0.722**	

7.RESULTS

- Load through ceiling = 9541.0188
- Load through floor=1590.16
- Infiltrated air = 17.029 m3/min
- Auditorium sensible heat gain = 45758 W
- Auditorium latent heat = 17553 W
- Auditorium total heat= 63311 W
- Outside air sensible heat gain= 8900 W
- Outside air latent heat gain= 17700 W
- Outside air total heat= 89686.0576 W
- Grand total heat gain= 94406.3765 W
- Tons of Refrigeration =24TR

8. CONCLUSION

In this analysis an Auditorium which is situated in our college(Jims) Greater Noida was thought of for calculative cooling masses. Cooling load temperature distinction (CLTD) technique was wont to notice the cooling load for summer (month of August). Cooling load things like, people, light, infiltration and ventilation etc., can easily calculated by using Heat transfer and ASHRAE equation and tables.

As per calculation the total cooling load for the AC required Auditorium is 24 tons for summer (month of August).

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