LOAD CALCULATIONS FOR DESIGN OF AN MINI AIR- CONDITIONING SYSTEM

[1]T.N. Ravi Kanth, [2]K. Shravan Kumar, [3]B. Prashanth

Assistant Professor
Department of Mechanical Engineering
MLR INSTITUTE OF TECHNOLOGY
Dundigal, Quthbullapur(M), R.R.Dist - 500043.

***ABSTRACT*: Human comfort is the key factor for the present day in the competitive world of designing and creating new appliances like ACs, Refrigerators etc.as the life style of a common man is increasing and because of the global changes in the environment. Being not suitable for Huge buildings, Electric ACs are to be replaced with Central air conditioning as it is more sustainable for smooth operation with a less maintenance cost. The effective design of central air conditioning is to provide lower power consumption, capital cost and improve aesthetics of a building.**

***KEYWORDS*: CLTD, Cooling Load, Air conditioning, Human comfortless.**

1. INTRODUCTION

In present days the environmental problem is one of the most serious problems. Energy consumption by industries and buildings are responsible for this problem. About 72% of world energy is consumed by infrastructure, industry, commercial buildings, residential houses, and markets. In a large building or complex, which is air-conditioned, about 60% of the total energy requirement in the building is allocated for the air-conditioning plant installed to use the cooling purpose.

Exact prediction of the cooling and heating load, proper sizing of the heat ventilation air-conditioning (HVAC) system and optimal control of the HVAC systems are important to minimize energy consumption. Root factors that affect cooling loads are the external climates such as outdoor temperature, solar radiation and humidity. Local climatic conditions are important parameters for the energy efficiency of buildings. Because the energy consumption in buildings depends on the climatic conditions and the performance of heating ventilating and air conditioning (HVAC) systems changes with them as well, better design in building HVAC applications that take account of the right climatic conditions will result in better comfort and more energy efficient buildings.

Calculation of thermal load of building is very essential to find exact air-conditioning equipment and air handling unit, to achieve comfort operation and good air distribution in the air-conditioned zone.

This project **Cooling load estimation for Seminar Hall** presents by using CLTD method.

.

2. OBJECTIVE

The objective of this paper is to calculate cooling load to find exact air-conditioning equipment and air handling unit, to achieve comfort operation and good air distribution in the air-conditioned zone.

3. COOLING LOAD CALCULATION

The objectives of cooling load calculation are as follows

i. To calculate peak design loads (cooling/heating)
ii. To estimate capacity or size of plant/equipment.
iii. To provide info for HVAC designs e.g. load profiles
iv. To form the basis for building energy analysis

3.1 Human comfort

Human comfort is the condition of mind, which expresses satisfaction with the thermal environment. Air conditioning of any building mainly concerns the comfort of people.

3.1.1 Heat exchange of human body with environment

A human body feels comfortable thermodynamically when the heat produced by the metabolism of human body is equal to the sum of the heat dissipated to the surrounding and the heat stored in the human body by raising the temperature of body tissues.

The phenomena of heat loss from the body can be expressed by Eqn. 1.1……………. (1.1)

Where

Q_M = metabolic heat produced within the body.
W = useful rate of working.
Q_S = heat stored in the body.
Q_E = heat loss by evaporation.
Q_R = heat loss and gain by radiation
Q_C = heat loss and gain by conduction and convection

3.1.2 Convection heat loss

The convective heat loss from the body is given by the Eqn. 1.2.

$$Q_C = UA\,(T_b - T_s) \qquad \text{……………}(1.2)$$

Where, U = heat transfer coefficient on body surface.
A = body surface area.
T_b, T_s = temperature of the body and surrounding respectively.

The heat will be gained by the body if the temperature of the surrounding is greater than the body temperature and this will increase with increase in U which is function of air velocity. Higher velocities impart more uncomfort when surrounding temperature is higher than body temperature.

3.1.3 Radiation heat loss

The radiation heat loss from body to the surrounding is given by the Eqn. 1.3.

$$Q_R = \sigma (T_b^4 - T_s^4) \ldots\ldots\ldots\ldots\ldots (1.3)$$

Where

σ is Stefan-Boltzmann constant.

Body gains the heat from surroundings when $T_s > T_b$ and loses heat to the surrounding when $T_s < T_b$

3.1.4 Evaporation heat loss

The heat loss by evaporation is given by the Eqn 1.4

$$Q_E = C_d A\,(Ps\text{-}Pv)\,hfg.C_c \ \ldots\ldots\ldots\ldots\ (1.4)$$

Where

C_d = diffusion coefficient in kg of water evaporated per unit surface area and pressure difference per hour.

P_s =saturated vapour pressure corresponding to skin temperature

P_v = vapour pressure of surrounding air.

h_{fg} =latent heat of vaporization = 2450 kj/kg.

C_c = factor which account s for type of clothing worn.

4. Design condition

The amount of cooling that has to be accomplished to keep buildings comfortable in summer and winter depends on the desired indoor conditions and on the outdoor conditions on a given day.

These conditions are, respectively, called the “indoor design condition” and the “outdoor design condition”.

For most of the comfort systems, the recommended indoor temperature and relative humidity are as follows

DBT – 22.78 °C to 26.11 °C, and RH – 50% for summer

DBT – 22.11 °C to 22.22 °C and RH – 20 to 30% for winter

The cooling load of the TIIR building is based on 25 °C dry bulb temperature and 50% relative humidity Indoor design conditions.

The outdoor design conditions are determined from published data for the specific location, based on weather bureau or airport records. The outdoor design conditions of Hyderabad is 43 °C DBT and Relative Humidity 46% for summer (month of May) and 36 °C DBT and 84 % RH for monsoon (month of July).

4.1 Overall heat transfer coefficient calculation

Commonly the building walls may consist of non-homogeneous materials for example hollow bricks, air gap and plaster. Heat transfer through these types of wall is quite complicated as it involves simultaneous heat transfer by conduction, convection and radiation as shown on Fig 3.3 in Chapter 3. All material has different kinds of thermo-physical properties; the thermo-physical properties of common building materials have been measured and presented in ASHRAE and other handbooks.

4.4 Cooling load calculation of Seminar Room

Length of the room = 23.82m

Width of the room = 9.70 m

Height of the room = 2.91 m

Area of glass (D_1) =2.42 □1.29 □ □ □ □ □m^2

Area of glass (D_2) =2.42 □1.29 □ □ □ □ □ m^2

Area of larger window (W_1) = 1.70 □1.70 □ 2.89 m^2

Area of the smaller window (W_2 to W_6)= 1.54□ 0.82 = 1.26m^2

Now,the amount of infiltrated air through windows and walls

□ $^{23.82}$ □$^{9.70}$ □$^{2.91}$□^{1} □ 11.20 m^3/min

60

Total capacity of the seminar hall= 250-300

Total number of fans = 10

Total number of light source = 12

Total number of split a.c = 5

Total number of windows = 6

Total number of glass doors = 2

Ton of refrigeration attained = 13.70 (May), 12.7 (June)

Conclusion

Hence, the total refrigeration attained for the month of May is 13.70 tons, and for the month of June is 12.7 tons. With this a desired layout can be made for designing an air-conditioning system for the Seminar Hall in order to save power and produce more refrigerating effect.

REFERENCES:

[1] Cooling load calculation manual prepared by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., U.S. Department of Housing and Urban Development.

[2] ASHRAE, Handbook of Fundamentals, Ch. 28. American Society of Heating, Refrigerating and Air-Conditioning Engineers, U.S.A. (1997).

[3] A Bhatia, HVAC Made Easy: A Guide of Heating and Cooling Load Estimation, PDH online course M196 (4PDH).

[4] Handbook of Air Conditioning System Design /Carrier Air Conditioning Co. by Carrier Air Conditioning Pty. Ltd.

[5] Andersson,B., Wayne P. and Ronald K., " The impact of building orientation on residential heating and cooling" , Energy and Buildings,1985; 8; 205-224.

[6] Al-Rabghi,O. and Khalid A. "Utilizing transfer function method for hourly cooling load calculations" Energy Conversion and Management,1997; 38; 319-332.

[7] Shariah,A., Bassam S., Akram R. and Brhan T.," Effects of absorptance of external surfaces on heating and cooling loads of residential buildings in Jordan" Energy Conversion and Management,1998; 39; 273-284.

[8] Kulkarni K., P.K. Sahoo and Mishra M., “Optimization of cooling load for a lecture theatre in a composite climate in India” Energy and Buildings, 2011; 43; 1573-1579.

[9] Suziyana M. D., Nina S. N., Yusof T. M. and. Basirul A. A. S., “Analysis of Heat Gain in Computer Laboratory and Excellent Centre by using CLTD/CLF/SCL Method” Procedia

[10] Engineering, 2013; 53; 655 – 664. Hani H. Sait, “Estimated Thermal Load and Selecting of Suitable Air-Conditioning Systems for a Three Story Educational Building” Procedia Computer Science, 2013; 19; 636 – 645.