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DESIGN FOR THERMAL COMFORT DURING WINTER& PSYCHOMETRY TOOL FOR HUMAN COMFORT

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Abstract:-- Central Air Conditioning is more reliable for easy operation with a lower maintenance cost. The effective design of central air conditioning can provide lower power consumption, capital cost and improve aesthetics of a building. This paper establishes the result of heating load calculation under different climatic conditions by using E-20 for a multi-story building. Heating load items such as people heat gain, lighting heat gain, infiltration and ventilation heat gain and cooling load due to walls and roofs. Using ISHRAE and CARRIER fundamental hand books and here the study of air water vapor mixture (called psychometric) for human comfort in the air conditioning system for the city Hyderabad.

Keywords: Temperature difference, thermal resistance, overll heat transfer coefficient, British Thermal Unit, Room heat load in BTUH.

1. Introduction: -

Heating, ventilation and air conditioning (HVAC) is the technology of indoor and vehicular environmental comfort. Its goal is to provide thermal comfort and acceptable indoor air quality. HVAC system design is a sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer. Refrigeration is sometimes added to the field's abbreviation as *HVAC&R* or *HVACR*, or ventilating is dropped as in *HACR.*

Energy efficiency can be improved more by installing central heating systems which allows more granular application of heat. Zones can be controlled by multiple thermostats. The HVAC industry is a worldwide enterprise, with roles including operation and maintenance, system design and construction, equipment manufacturing and sales, and in education and research. The HVAC industry was historically regulated by the manufacturers of HVAC equipment, but regulating and standards organizations such as *HARDI, ASHRAE, SMACNA, ACCA*, Uniform Mechanical Code, International Mechanical Code, and *AMCA* have been established to support the industry and encourage high standards and achievement.

The starting point in carrying out an estimate both for cooling and heating depends on the exterior climate and interior specified conditions. However, before taking up the heat load calculation, it is necessary to find fresh air requirements for each area in detail, as pressurization is an important consideration.*ISO 16813:2006* is one of the ISO building environment standards. It establishes the general principles of building environment design. It considers the need to provide a healthy indoor environment for the occupants as well as the need to protect the environment for future generations and promote collaboration among the various parties involved in building environmental design for sustainability. ISO16813 is applicable to new construction and the retrofit of existing buildings.

2. Methodology: -

- Commercial building plan of 11634.5 square feet.
- Calculation of floor, roof, wall and windows areas.
- Calculation of temperature difference (ΔT).
- Thermal resistance of wall, roof and windows.
- Overall heat transfer co – efficient.
- E-20 FORM.
- Heating load in BTUH.

3. PSYCHOMETRIC CONDITION DURING WINTER IN HYDERABAD

Dry Bulb Temperature- 55^oF
Relative Humidity-20%

As the above conditions for the citizens of Hyderabad is not comfortable. So, the air should be dehumidified and should bring the temperature at 76^oF-78^oF,
And relative humidity to 45%-55%. For this heating is required in a space.

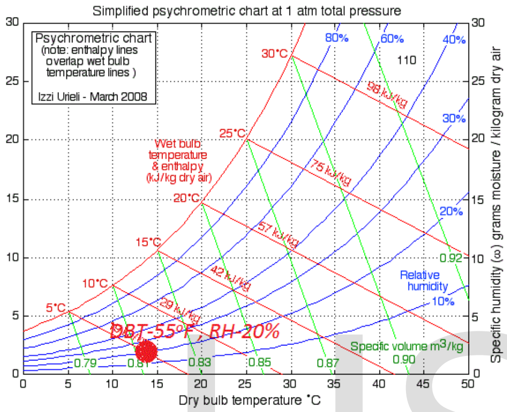


Figure: psychometric properties of air during winter

4. Design: -

As the name implies, heating load calculations are carried out to estimate the heat loss from the building in winter to arrive at required heating capacities. Normally during winter months, the peak heating load occurs before sunrise and the outdoor conditions do not vary significantly throughout the winter season. In addition, internal heat sources such as occupants or appliances are beneficial as they compensate some of the heat losses. Thus, normally, the heat load calculations are carried out assuming steady state conditions (no solar radiation and steady outdoor conditions) and neglecting internal heat sources. This is a simple but conservative approach that leads to slight overestimation of the heating capacity. For more accurate estimation of heating loads, one must take into the thermal capacity of the walls and internal heat sources, which makes the problem more complicated.

4.1 Temperature difference (ΔT)

Present Dry bulb temperature – 55^oF

Required dry bulb temperature - 78^oF
Temp diff. (ΔT) = 78-55=23^oF

4.2*Overall heat transfer co - efficient(U):*

The overall heat transfer coefficient is a measure of the overall ability of a series of conductive and convective barriers to transfer heat. It is commonly applied to the calculation of heat transfer in heat exchangers, but can be applied equally well to other problems.

- **FINDING 'U' VALUE**

U=Overall coefficient of heat transfer in BTU/(hr-sft-F)
R=Thermal resistance of material (R>U)

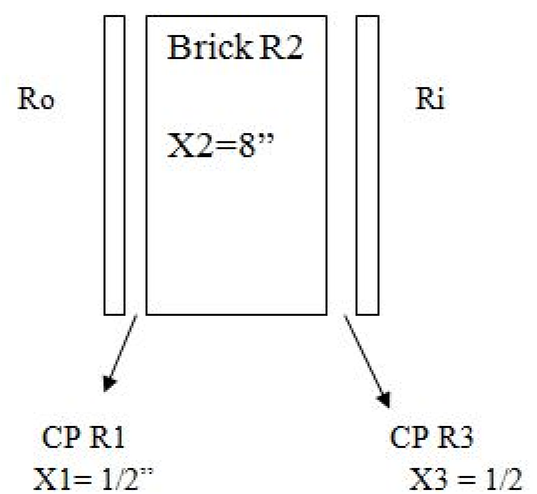
$$U=1/\sum R$$

Where, $\sum R$=Ri+X1R1+X2R2+X3R3+.......+XnRn+Ro
Ri = Resistance of inside air film = 0.68 (std. value)
Ro = Resistance of outside air film = 0.25 for summer @ 7.5 m/s wind velocity
Ro = 0.17 for winter @ 15 m/s wind velocity
Ra = Resistance of air film gap = 0.91

NOTE:
1.Ro may vary as per location
2. Ra is standard value irrespective of thickness of the air gap.
3.R1, R2, R3...Rn is the resistance of the material
4.X= thickness of material
5.value of R for different material are taken from resistance table of data book.

4.2.1 'U' VALUE OF BUILDING

1) 9" COMMON WALL:



$$\sum R = R_O + X_1R_1+X_2R_2+X_3R_3+R_i$$
$$=0.25+(0.5x0.12)+(8x0.2)+(0.5x0.12)+0.68$$
$$=2.65$$
$$U = 1/\sum R = 1/2.65 = 0.37 \text{ Btu/(hr-ft}^2\text{-F)}$$

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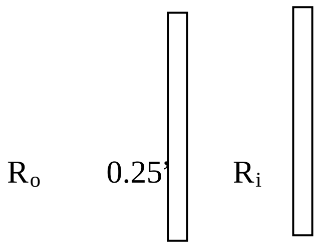
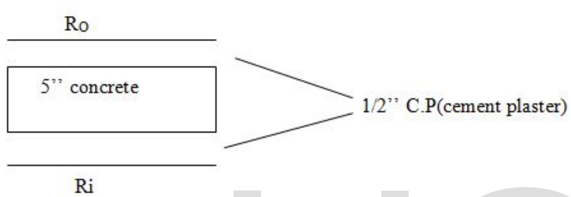
4.2.2 0.25” GLASS:-



$\sum R=0.25+(0.25x1.25) +0.68$
$=1.24$
$U =1/\sum R$
$=1/1.24=0.8$ Btu/(hr-ft^2-F)

4.2.3 6” ROOF



$\sum R = 0.25+(0.5x0.12)+(5x0.08)+(0.5x0.12)+0.68$
$= 1.45$
$U = 1/\sum R$
$= 1/1.45 = 0.69$ Btu/(hr-ft^2-F)

The calculated Overall heat transfer coefficient for wall, glass and windows are as follows:
9” common wall - 0.37
0.25” glass – 0.8
6” roof – 0.69

4.3 Heating load calculation of room 101

HEATING LOAD CALCULATIONS								
Project: - Mini						Location: - Hyderabad		
Engrs.:-						Calc.by: -		
Room No.		101				Room Name: -	CEO Cabin	
Plan Size								
Heat transfer		U	x	A	x	TD	=	BTU/hr.
Walls	N		x		x		=	
	S	0.37	x	156	x	23	=	1327
	E		x		x		=	
	W	0.37	x	120	x	23	=	1021
Windows	N		x		x		=	
	S	0.75	x	74	x	23	=	1276
	E		x		x		=	
	W		x		x		=	
Doors			x		x		=	
			x		x		=	
Roof/Ceiling		0.1	x	375	x	23	=	862.5
Partition			x		x		=	
Heat Transfer Loss								
Infiltration		1.1 x	U x		Parameter x	TD =		
Window		1.1 x	0.37 x		78 x	23 =		663
Door		1.1 x	x		x	=		
Infiltration Heat Loss		663						
Room sub-Heating Load		5149 BTU/hr						
Safety Factor 10%		514						
Room Heating Load		5663 BTU/hr						

4.4 Heating load calculation of overall space:

HEATING LOAD CALCULATIONS								
Project:- Mini						Location: - Hyderabad		
Engrs.:-						Calc.by:-		
Room No.						Room Name: -	Overall Building	
Plan Size		11891 sft						
Heat transfer		U	x	A	x	TD	=	BTU/hr.
Walls	N	0.37	x	465	x	23	=	3957
	S	0.37	x	444	x	23	=	3778
	E	0.37	x	462	x	23	=	3931
	W	0.37	x	880	x	23	=	7488
Windows	N	0.75	x	633	x	23	=	10919
	S	0.75	x	674	x	23	=	11626
	E	0.75	x	1056	x	23	=	18216
	W	0.75	x	267	x	23	=	4605
Doors			x		x		=	
			x		x		=	
Roof/Ceiling		0.1	x	11634.5	x	23	=	26759
Partition		0.4	x	1145	x	23	=	10534
Heat Transfer Loss								
Infiltration		1.1 x	U x		Parameter x	TD =		
Window (total)		1.1 x	0.37 x		754 x	23 =		7058
Door		1.1 x	x		x	=		
Infiltration Heat Loss		7058						
Room sub-Heating Load		108871 BTU/hr						
Safety Factor 10%		10887.1 BTU/hr						
Room Heating load		119758 BTU/hr						

The heating load calculation of the project is calculated

The BTU per hour for space *101* is 5663.

12000 BTU per hour is equal to 1ton of refrigeration.

Therefore, the calculated tonnage for the room no. 101 is

(5663)/12000 = 0.47 Tr.

The BTU per hour for overall space is 119758

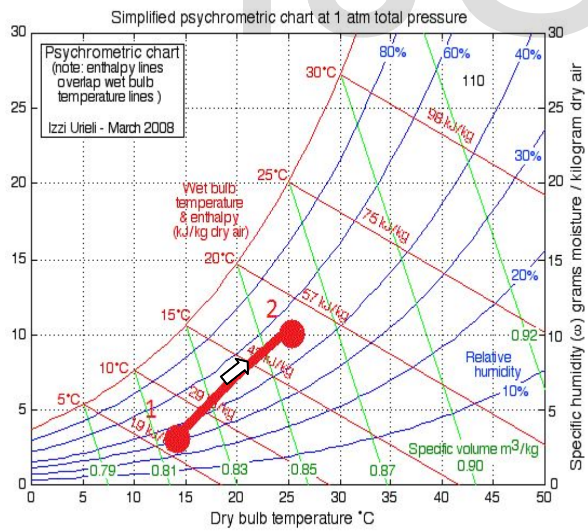
Therefore, the calculated tonnage for the overall space is

(119758)/12000 = 9.97 Tr

5. ***Psychometric condition after designing heating load calculation***

At point 1: Condition before heating load calculation
Dry bulb Temperature: 55^{o}F (14^{o}c)
Humidity ratio: 20%
At point 2: Condition after heating load calculation
Dry bulb Temperature: 76^{o}F (25^{o}c)
Humidity ratio: 50% - 60%

Figure: psychometric condition before and after heating load calculation



6. ***Conclusion***:

Using E-20 as per ISHRAE standards provides effective comfort solution for the commercial building during winter, for that building heat absorption to be 119785 BTUH.

7. ***References:***

1) *Milne, M, et al., " Climate Consultant 40 Develops Design Guidelines for Each Unique Climate,"proceedings of the American Solar Society. Buffalo New York, 2009.*
2) *Givoni, b., Man Climate and Architecture, Van Nostrand Reinhold, 1981.*
3) *Givoni, B., Climate Considerations in building and Urban Design. John Wiley and Sons, New York, 1998.*
4) *Driscoll, M. P., Psychology of learning for Instruction. Pearson Education, Florida State University, 2005.*