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Effect of Energy Conservation on Environmental Loads

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Abstract: In the present paper, a theoretical investigation on energy conservation and their effect on green house gases will be discussed. The result shows the reduction of thermal (roof) load if the space between roof and false ceiling is ventilated by outside air, a certain portion of the roof load may be carried away by this air due to convective heat transfer between roof and air. Reduction in thermal load leads to reductions in the amount of environmental loads. The saving is determined between 9am to 6 pm. The other parameters are air velocities of 1.25, 1.75 and2.25 m/s; roof length in the direction flow as 10, 20 and 30m; inclination of roof at 0^0,30^0 and 45^0 at a location of 29^0 latitude.

Key words: roof heat load, environmental loads.

I. INTRODUCTION

Solar radiation is the main source of roof heat load in an air-conditioning room, which increases the cooling load requirement. If the space between roof and false ceiling is ventilated by outside air, a certain portion of the roof load may be carried away by this air due to convective heat transfer from the inside surface of the roof. This result in the reduction of heat load and due to this discharge amount of green house gases in environment reduced. The results of this study for a chosen location have been presented to show the effect of the time of the day, air velocity, angle of inclination of roof and length of the roof on the reduction of heat load and green houses gases. Such an investigation is useful to reduce the environmental pollution.

II. CALCULATION DATA DETAILS

It is a theoretical work based on assumptions and known expressions of heat transfer and solar load. Investigation about the reduction in this load at different values of parameters is carried out. The parameters are the air-velocity, length of the roof, inclination of roof and time. The location select for the research work is a Meerut (latitude: 29^0 N) in India. The other particulars and assumptions are given below.

The following particulars were chosen for the case study.
Place: Meerut, India
Latitude: 29^0 N
Month and date: July 21
Roof particulars: Thickness=25 cm; width =1m;
Made of concrete having α=1.024x10^{-6} m^2/s, k= 1.73 W/mK, a=0.8;
Parameters: velocity of air =1.25, 1.75 and 2.25 m/s;
Length of roof=10, 20 and 30m;
Inclination of roof = (0^0, 30^0, 45^0);
Orientation of inclined roof = North-South
Time = 900 hrs to 1800hrs at interval of 1hour.
Assumptions: f_o= 23 W/m^2K (at 12 km/h);
f_i= 7 W/m^2K (at 0 m/s); f_i= 11 W/m^2K (at l.25 m/s); f_i= 13 W/m^2K (at 1.75 m/s); f_i= 15 W/m^2K (at 2.25 m/s);
Re = 5 x 10^5;

Outside temperature (12 Night to 11 Night)
to={30,29.5,29,28.5,28.5,28,28,29,31.5,33,35,37,38,39,40,41, 39,39,38,36,34,33,33,31};
Room Temperature =25^0C

III. EFFECT OF VELOCITY OF AIR, LENGTH AND INCLINATION OF ROOF ON THERMAL LOAD

As the velocity increases the length of turbulent part increases and so increase the heat transfer. Therefore, moving air at higher velocity takes away the more heat and reduces the net heat load on the roof. The optimum value of velocity in this case is 2.25m/s. From the results it has been observed that at Re=5x10^5 the optimum value of length is 20m and inclination of roof at 45^0 percentage saving of load is about 10.4%.

As the length of the roof increases then percent saving first increases up to 20m length and then decreases . The heat transfer to air in turbulent portion is depends on velocity of air and length of roof. Therefore with increase in length of roof the heat transfer increases, but at the same time heat load also increases. Therefore the net saving increases up to a certain value of length and after that it decreases. The optimum value of length in this case is 20m.

The maximum roof load occurs when the roof is horizontal and heat load reduces as the inclination of roof increases (minimum at 45^0 in this study), because the solar load on roof decreases as inclination increases.

Length Inclination =45^0	Still air (1)	Heat load at velocity = 2.25m/s (2)	Heat load carried away by the air(3)	Saving [1-(2+3)] =4	% saving of load (4/1)
10 m	6778	9515	3342	605	8.9
20m	13556	19029	6693	1220	9.0
30 m	20334	28544	9917	1707	8.4

Table 1 - Approximate calculated heat load in room (Watts) (Horizontal roof)

Length Inclination = 45^0	Still air (1)	Heat load at velocity =2.25m/s (2)	Heat load carried away by the air (3)	Saving [1-(2+3)] = 4	% saving of load (4/1)
10 m	5581	7784	2735	532	9.5
20m	11162	15569	5565	1158	10.4
30 m	16743	23353	8113	1503	8.98

Table 2 - Approximate calculated heat load in room (Watts) (45^0 inclined roof-N-S))

The percentage saving of load is increased in case of inclined roof (45^0) and large velocity (2.25m/s).

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IV. RESULT AND DISCUSSION

The average COP of the air-conditioning system is supposed as 2.0, the electricity consumption of the air-conditioning system is supplied by coal burning power plant. Every unit of electricity consumption may consume 380g standard coal (380g/kWh) and at the same time may cause some environmental loads/kWh: SO_X = 9.14g, NO_X = 3.32g, CO_2=1.586 kg. The comparative data are shown in table 3. (Considering room area = 20x100 m^2)

Length = 20m Velocity= 2.25 m/s	Max. Cooling Load saving (W/m^2)	Room area (m^2)	Power required (10^4W)	Electricity kWh	Coal (10^4g/h)	CO2 (kg/h)	SOX (g/h)	NOX (g/h)
Horizontal roof	1220/20 =61	2000	6.1	61	2.32	96.75	557	202
Inclined Roof(45^0)	1158/20 =57.9	2000	5.79	57.9	2.2	91.82	529	192
Reduction	3.1	-	0.31	3.1	0.12	4.93	28	10

V. CONCLUSION

The above technique shows a considerable reduction in greenhouse gases due to reduction in thermal load in air-conditioning buildings.

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