

REFRIGERATION & AIR CONDITIONING



○ TOPICS

1. Calculation of cooling load TETD due to sunlight & shaded roofs & walls using table
2. Load due to air filtration
3. Load due to ventilation

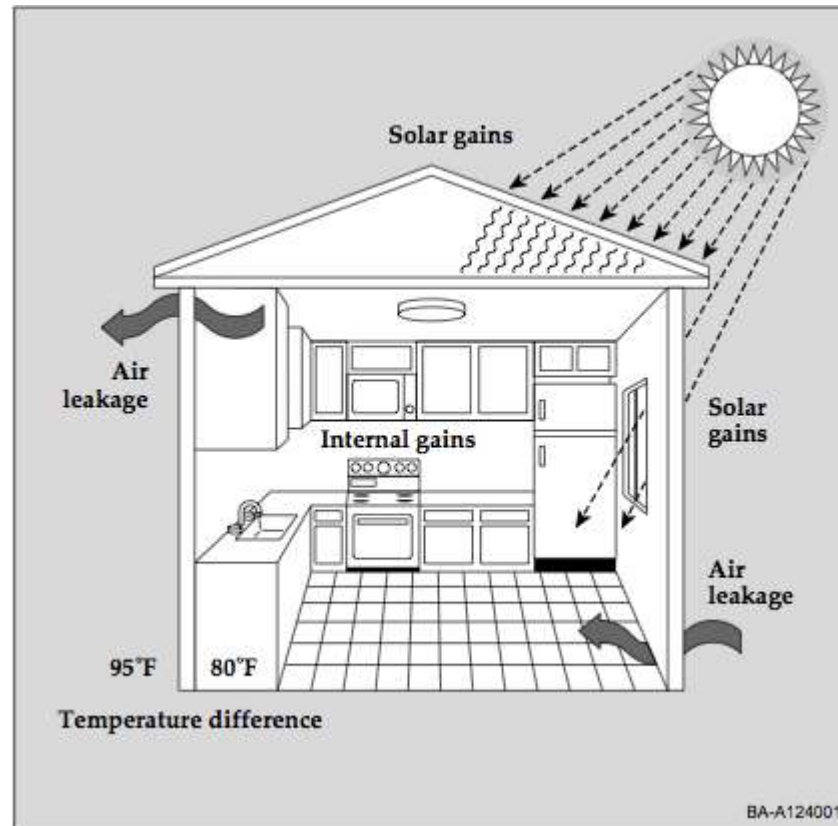


1. TOTAL EQUIVALENT TEMPERATURE DIFFERENTIAL (TETD)

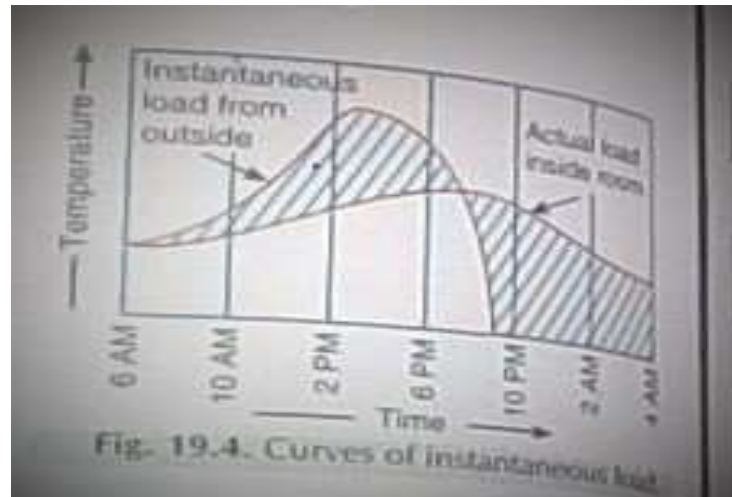
- The transmission of heat walls exposed to the outdoors and roof is not steady (i.e. the flow of heat is periodic) due to variation in the outside air temperature and the solar radiation intensity over a period of 24 hours.
- A little consideration will show that temp. of wall rises with the rise in outside air temperature and the heat is stored in the wall which has a considerable storage capacity. The storage capacity depends upon (1) the mass of the building material, (2) the specific heat of the building material.
- Thus the heat transferred to the air conditioned room is reduced due to the high storage of the wall .



- The stored heat in the wall is given off when the outside air temperature falls. Since the outside air temperature changes continuously over a cycle of 24 hours, there for instantaneous heat gain from outside is not equal to the instantaneous heat gain inside the room, the difference being stored or rejected by the wall.



- The heat stored by the wall is given off later in the evening.
- thus peak of incoming heat rate is delayed by the storage effect of walls & it is also reduced. Fig shows the curve of instantaneous load coming from outside and the actual load felt inside.
- The area under the two curve is equal . the shaded area above the actual load shows the heat stored and below the actual load show the heat released by the walls and other structure.



- A convenient method of taking into account the storage effect or flywheel effect and the solar radiation is to use an equivalent temperature differential.
- The equivalent temperature differential for roof are given in table.19.6 And those applying to walls is given by table19.7

The heat gain through outside walls and roofs is given by

$$Q = UA t_e$$

Where,

U= overall heat transmission coefficient of roof or wall,

A= Area of roof or wall, and

t_e =Equivalent temperature differential.

t_e



Table 19.6. Total equivalent temperature differentials for calculating heat gain through sunlit and shaded roofs.

Description of roof construction ¹	Sun-time								
	A.M.			P.M.					
	8	10	12	2	4	6	8	10	12

Light construction roofs-exposed to sun

2.5 cm wood ¹ or 2.5 cm wood + 2.5 cm or 5 cm insulation or 5 cm wood	12	38	54	62	50	26	10	4	0
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Medium construction roofs-exposed to sun

5 cm concrete or 5 cm concrete + 2.5 cm or 5 cm insulation or 5 cm wood	6	30	48	58	50	32	14	6	2
5 cm gypsum or 5 cm gypsum + 2.5 cm insulation 2.5 cm wood ¹ 5 cm wood ² or 5 cm concrete or 5 cm gypsum	0	20	40	52	54	42	20	10	6

+ 10 cm rock wool
in furred ceiling

¹ Includes 9 mm felt on top with ...



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10 cm concrete or 10 cm concrete + 5 cm insulation	0	20	38	50	52	40	22	12	6
15 cm concrete 15 cm concrete + 5 cm insulation	4	6	24	38	46	44	32	18	12
Light construction roof with 2.5 cm water Heavy construction roof with 2.5 cm water Any roof with 15 cm water	0	4	16	22	18	14	10	2	0
Light construction Heavy construction	-2	-2	-4	10	14	16	14	10	6
Light construction Medium construction Heavy construction	-4	0	5	12	14	12	8	2	0

Heavy construction roofs-exposed to sun

Roofs covered with water-exposed to sun

Roofs with roof sprays-exposed to sun

Roofs in shade

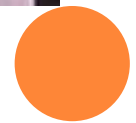


Table 19.7.

Total equivalent temperature differentials for calculating heat gain through sun lit and shaded walls.

North Latitude Wall Facing	Sun-Time																South Latitude Wall Facing
	A.M.								P.M.								
	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12		
	Exterior colour of wall : D-dark, L-light																
	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	

Frame

NE	22	13	24	12	14	10	12	10	14	14	14	14	10	10	6	4	2	2	SE
E	30	14	36	18	32	16	12	12	14	14	14	14	10	10	6	6	2	2	E
SE	13	6	26	16	28	18	24	16	16	14	14	14	10	10	6	4	2	2	NE
S	-4	-4	4	6	22	12	30	20	26	20	16	14	10	10	6	6	2	2	N
SW	-4	-4	0	-2	6	4	26	22	40	28	42	28	24	20	6	4	2	2	NW
W	-4	-4	0	6	6	6	20	12	40	28	48	34	22	22	8	8	2	2	W
WW	-4	-4	0	-2	6	4	12	10	24	20	40	26	34	24	6	4	2	2	SW
V	-4	-4	-2	-2	4	4	10	10	14	14	2	12	8	8	4	4	0	2	S

(shade)

20 cm hollow tile or 20 cm cinder block

NE	0	0	0	0	20	10	16	10	10	6	12	10	14	12	12	10	8	8	SE
E	4	2	12	4	24	12	26	14	20	12	12	10	14	12	14	10	10	8	E
SE	2	0	2	0	16	8	20	12	20	14	14	12	14	12	12	10	8	6	SE
S	0	0	0	0	2	0	12	6	24	14	26	16	20	14	12	10	8	9	N
SW	2	0	2	0	2	0	6	4	12	10	26	18	30	20	26	18	8	6	NW
W	4	2	4	2	4	2	6	4	10	8	18	14	30	22	32	22	18	11	W
NW	0	0	0	0	2	0	4	2	8	6	12	10	22	18	30	22	10	14	SW
N (shade)	-2	-2	-2	-2	-2	-2	0	0	6	6	10	11	10	10	10	10	6	6	S (shade)

20 cm brick or 30 cm hollow tile or 30 cm cinder block

NE	2	2	2	2	10	2	16	8	14	8	10	6	10	8	10	10	10	8	SE
E	8	6	8	6	14	8	18	10	18	10	14	8	14	10	14	10	12	10	E
SE	8	4	6	4	6	4	14	10	18	12	16	12	12	10	12	10	12	10	SE
S	4	2	4	2	4	2	4	2	10	6	16	10	16	12	12	10	12	8	N
SW	8	4	6	4	6	14	8	4	10	6	12	8	20	12	24	16	20	14	NW
W	8	4	6	4	6	6	8	6	10	6	14	8	20	16	24	16	24	16	W
NW	2	2	2	2	2	2	4	2	6	4	8	6	10	8	16	14	18	14	SW
N (shade)	0	0	0	0	0	0	0	0	2	2	6	6	8	8	8	8	6	6	S (shade)



2.LOAD DUE TO AIR INFILTRATION

- The air entering to conditioned space through window cracks & opening of door is known as air infiltration.
- Air infiltration is caused by pressure difference on two sides of the window and doors & it depends upon the wind velocity & its direction & difference in densities due to temperature difference between inside & outside air.



- The amount of infiltrated air can be estimated by
 - (1) crack length method
 - (2) air change method
- Generally, the crack method is used where high accuracy is required. In the most of cases, the air change method is used for calculating the quantity of infiltrated air.
- The infiltrated air through windows & walls is given by this method as

$$\text{Infiltrated air} = \frac{L \times W \times H \times A_c}{60} \text{ m}^3/\text{min}$$

Where,

L= room length in meters,

W=room width in meters,

H= room height in meters, and

A_c = air change per hours



- The total room infiltration air for entire building is taken one half of the calculated value because infiltrating takes place on the windward side of a building.
- The number of air changes per hour for variety of room types and exposures are shown in table (A).

Types of room or building	Number of air changes per hour
Rooms with no window or outside doors	0.5 to 0.75
Rooms, one walls exposed	1
Rooms, two walls exposed	1.5
Rooms, three walls exposed	2
Rooms ,four walls exposed	2
Entrance halls	2 to 3
Reception halls	2
Bath rooms	2

3.LOAD DUE TO VENTILATION

- Ventilation air is that portion of supplied air which is outdoor air plus any recirculated air that has been treated for the purpose of maintaining acceptable indoor air quantity.
- Ventilation is the process of supplying and removing air by natural or mechanical means to and from any space.
- Ventilation minimize odour, concentration of smoke, carbon dioxide and other undesirable gases so that freshness of air could be maintained.
- The quality of out side of air used for ventilation should provide at least one-half air change per hour in building with normal ceiling heights.
- The outside air adds sensible as well as latent heat.



Table (A), shows minimum and recommended values of fresh air per person for different application of the space.

Application (1)	Smoking (2)	Outside air in m^3/min /person	
		Recommended (3)	Minimum (4)
Apartment	Some	0.6	0.45
Banking space	Occasional	0.3	0.23
Barber shop	Considerable	0.45	0.3
Beauty Parlour	Occasional	0.3	0.23
Cocktail bars	Heavy	0.9	0.75
Department stores	None	0.23	0.15
Drug stores	Considerable	0.3	0.23
Factories	None	0.3	0.23
Funeral parlours	None	0.3	0.23
Hospitals, private rooms	None	0.9	0.75
Hospital, wards	none	0.6	0.45
Hotel rooms	Heavy	0.9	0.75

Thank you

