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RECENT TRENDS IN MODES OF HEAT DISSIPATION FROM HUMAN BODY

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ABSTRACT

The human solace relies on physiological and mental conditions. The human body can be considering as warm machine with twenty percent warm productivity. The staying Eighty percent heat must be arranged off from the body to the surroundings generally amassing of warmth results and causes uneasiness. Then again, if the warmth dispersal from the body is higher than that at which it is delivered, the temperature of the body gradually falls bringing about inconvenience. Human solace is that state of psyches, which communicates fulfillment with warm environment Human body, works best at a particular temperature, like some other machine; be that as it may it can't endure wild scope of varieties in their natural temperature such as machines.

The path in which individual's body keeps up itself in agreeable harmony will be by its programmed utilization of one or a greater amount of the three methods of warmth exchange. A human body feels good when the warmth delivered by Metabolism of human body is equivalent to aggregate of the warmth disseminated to the surroundings and the warmth put away in human body by raising the temperature of body tissues.

The human body maintains its thermal equilibrium with the environment by means of three methods of warmth exchange i.e. Evaporation, Radiation and convection. The heat dissipation by evaporation it is depends upon the vapor pressure difference between the skin surface and the surrounding air, it is always positive. When the surrounding air temperature is equal to the skin temperature and air is saturated or when it is higher than the skin temperature and the air is saturated at this condition the heat dissipation by evaporation is becomes zero.

Heat dissipation or gain by Radiation from the body to the surroundings depends upon the mean radiant temperature. When mean radiant temperature is lower than dry bulb temperature of air in room, the heat dissipation or gain by radiation is positive. If the mean radiant temperature is higher than dry bulb temperature of air in the room, the heat dissipation or gain by the radiation is negative.

When the temperature of surrounding is higher than the temperature of body, then heat dissipation by convection will be negative. Other hand, if the temperature of surrounding is lower than temperature of body, then heat dissipation by convection will be positive.

When Heat dissipation by evaporation, Radiation and Convection are high and positive and Summation of three modes of dissipation is greater than heat to be dissipated to the atmosphere, then the heat stored in body will be negative.

Keywords: Dissipation, Evaporation, Radiation, Convection, Mode, Heat etc.

INTRODUCTION:

In the thermodynamics of human body the comfort depends upon physiological psychological conditions it is difficult to define human comfort. Today's body inhabitants almost every patch of land available to him/her. The body cannot choose the climate, he can only adopt himself. For the correct adaptation it is necessary to make concentration on three modes of heat dissipation viz. Evaporation (H_{evap}) Radiation ($H_{rad.}$) and Convection (H_{Conv}).

MODES OF HEAT DISSIPATION FROM THE BODY WITH ENVIRONMENT

Convective heat loss from the body is given by equation,

$H_{con.} = UA (T_b - T_a)$ ----- in Watt

Where,

U= Heat transfer coefficient on body surface,

A = Body surface Area (1.8 m^2) for normal body,

T_b = Mean body surface Temperature,

T_a= Temperature of surrounding.

The heat will be gained by the body if the temperature of surroundings (T_a) is greater than Mean body surface temperature (T_b) and this will increase with increase in heat transfer coefficient on body surface (U) which is a

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function of air velocity. Higher velocities impact more uncomforted when surrounding temperature is higher than the body temperature.

When the temperature of surrounding is higher than the temperature of body then the heat loss by the convection from the body to surrounding, then H_{con}will be negative i.e. heat will be gained by the body.

Other hand, if the temperature of surrounding is lower than the temperature of body, then H_{con}will be positive i.e. Heat will be lost by the body.

Since the body film coefficient of the heat transfer increase in air velocity, therefore higher air velocity reproduce uncomfort when $T_a > T_b$. Higher air velocity are recommended when $T_a < T_{b.}$

For Example,

When the Dry Bulb Temperature (DBT) is 50°C with air velocity of 20 km/Hr the convective heat gain by an unclothed body is about 1800 KJ/Hr which is equals to the metabolic heat produced during heavy work. When surrounding temperature is less than the the temperature, then the high velocities of air are recommended as $H_{con.}$ Increases with increase in velocity.

The radiation heat loss from the body to the surroundings is given by the equations,

$H_{rad.} = \sigma A (T_b^4 - T_a^4)$ Watt

Where,

σ = Stefan–Boltzmann constant,

$\sigma = 5.670367\times10^{-8}\ W\ m^{-2}\ K^{-4}$

A = Body surface Area (1.8 m^2) for normal body,

Body gains the heat from the surroundings when temperature of surroundings (T_a) is greater than Mean body surface Temperature (T_b). Other hand loss of heat to the surrounding when temperature of surroundings (T_a) is Less than Mean body surface Temperature (T_b). All bodies emit radiation in the form of Electro Magnetic Waves, the intensity and wave length of each depend on their temperature. The hotter body, the higher will be the intensity of radiation and shorter its wave length. Mostly all radiation except sun radiation is essentially long wave type. The effect of short wave radiation on the human body is quite different from that of the long wave once. The long wave radiations are practically all absorbed by the skin irrespective of its colour. The absorption of the short wave depends on colour of skin and clothing.

For Example,

White colour clothing and fair skin reflect the short wave radiation to the maximum extent, whilst various shades of skin and colours of clothing absorb these radiations in different degrees. As the indoor conditions are concerned, the colour of skin and clothing does not play important role most of the radiation are long wave radiations. It becomes a determining factor when the body is exposed to the short wave (direct sun) radiations.

It is the average surface temperature of the surrounding bodies when properly weighted and various from place to place inside the room. When the mean radiant temperature lowered than Dry Bulb Temperature (DBT) of air ($Ta < T_{b.}$) in the room. The heat loss or gain by the radiation ($H_{rad.}$) is positive i.e. the body will undergo radiant heat loss.

Other hand, if the Mean Radiant Temperature (MRT) higher the Dry Bulb Temperature (DBT) of air ($Ta > T_{b.}$) in the room, the heat loss or gain by the radiation ($H_{rad.}$) is negative i.e. the body will undergo radiant heat gain.

The Evaporation heat loss from the body to the surroundings is given by the equations,

$H_{evap.} = K_d A h_{fg} K_c (P_{vs} - P_v)$

Where,

K_d = Diffusion coefficient in kg of water evaporated/m^2 Hr/(N) pressure difference

A = Body surface Area (1.8 m^2) for normal body,

h_{fg}= Latent heat of vaporization (It can be taken as 2450 KJ/Kg),

K_c = It is the factor which accounts for the type of clothing,

P_{vs}= Saturation vapour pressure corresponding to skin temperature,

P_v=Vapour pressure of surrounding air.

Heat loss by evaporation ($H_{evap.}$) is become zero when Saturation vapour pressure corresponding to skin temperature (P_{vs}) is equals to Vapour pressure of surrounding air (P_v) i.e. $P_{vs} = P_v$

That means the surrounding temperature is equals to skin temperature and air is saturated or which it is a higher than the body temperature and saturated.

Heat loss by evaporation ($H_{evap.}$) never becomes negative even Saturation vapour pressure corresponding to skin temperature (P_{vs}) is less than Vapour pressure of surrounding air (P_v)

i.e. $P_{vs} < P_v$

Because Diffusion coefficient in kg of water evaporated/m^2 Hr/(N) pressure difference (K_d) becomes zero under such conditions.
Therefore, The Evaporation heat loss from the body to the surroundings ($H_{evap.}$) is always positive

HEAT RELEASE RATE BY HUMAN BODY AND MODE OF HEAT DISSIPATION

The different mode of heat dissipation i.e.$H_{con.}$,H_{rad} and $H_{evap.}$ Are mostly depends on environmental conditions are listed below:

a) Dry Bulb Temperature (DBT) in °C
b) Relative Humidity (RH)
c) Air Velocity

The rate of increase in heat loss by Evaporation (Latent Heat) is more pronounced than the heat by convection (Sensible Heat) with increase in metabolic rate.The main purpose of comfort air-
Conditioning system is to control the above mentioned factors of conditioned air in such a way that the sum heat dissipation ($\mathbf{H}_{con.}$+H_{rad}+ H_{evap}) must balance $H_m$for making $H_s$zero.

Where,
$H'_m = (H_m – W_e)$
$H= H_{rad}+H_{con}$

The heats H_{rad}andH_{con} are grouped together as both present gain or loss in sensible heat. The metabolic rates (H'_m) depends upon the activity of person.

Degree of Activity	Typical Applications	Total heat dissipated per person (KJ/Hr)	Sensible Heat (KJ/Hr)	Latent Heat (KJ/Hr)	O_2 Consumed (Lits./Hr)
Heated at rest	Theatre	370	210	160	0.24
Heated with light work	Offices,Hotels	420	210	210	0.30
Moderatively active	Offices,Hotels	480	210	270	-
Handling with light work	Dept. Stores	480	210	270	-
King slowly	Banks	520	210	310	-
T bench work	Factory (Small)	800	230	570	0.7 – 1.1
Derate Dancing	Dancing Hall	900	250	650	2.5 – 3.1
Moderatively Heavy work	Factory (Heavy)	1050	310	740	-
Heavy work max. activity possible	Blowing Factory	1550	480	1070	3.4 – 5.2

Table No. 1 : Shows Rate of Heat Gain from occupants in Air-Conditioned Spaces**.**

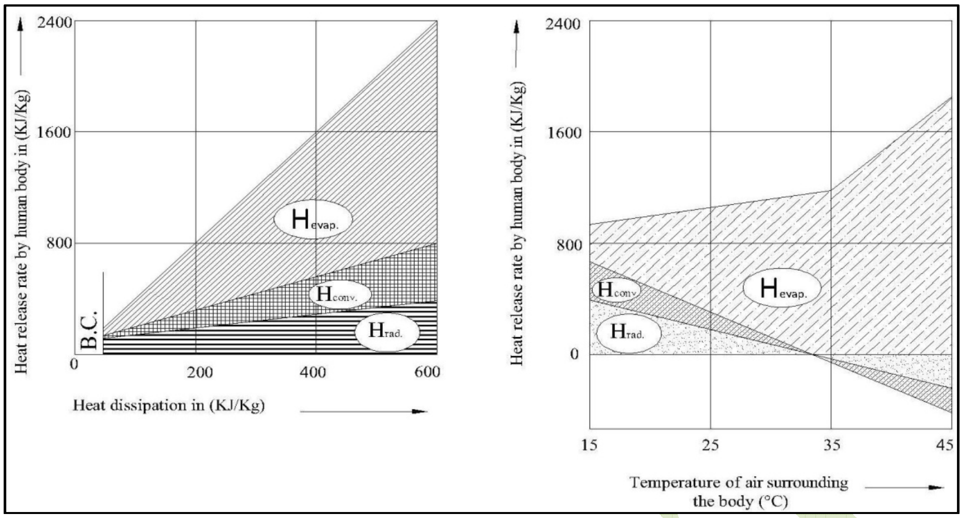

Figure (a) Figure (b)

Fig. (a) And Fig. (b) Shows proportional Heat release rate from human body by different mode of heat dissipation.

HEAT AND MOISTURE LOSSES FROM THE HUMAN BODY

Heat is given off from the human body as either sensible or latent heat or both. In order to design any air conditioning system for spaces which human body is to occupy it is necessary to know the rates at which these two forms of heat are given off under differentconditions of air temperature and bodily activity.
Fig. (a) Shows the Graph between sensible heat loss by radiation and convection for an average body and the Dry Bulb Temperature for different types of activity.
Fig. (b) shows the Graph between Latent heat loss by evaporation for an average
body and Dry Bulb Temperature for different types of activities.
Fig. (C) shows the Total heat loss from the human body under varying effective temperatures.
From Curve D, which applies to body at rest, we see that from about
19°C to 32°CEffective temperature the heat loss is constant. At the lower effective temperatures, the heat dissipation increases which results in feeling of coolness. At higher effective temperature, the ability to loss heat rapidly decreases resulting sever discomfort. The Curves A, B, C and D shows in Figs', b,c and d represent as follows:
Cure A- body working at rate of 90 KN-m/Hr
Curve B - body working at rate of 45 KN-m/Hr
Curve C - body working at rate of 22.5 KN-m/Hr

Curve D - body at Rest.

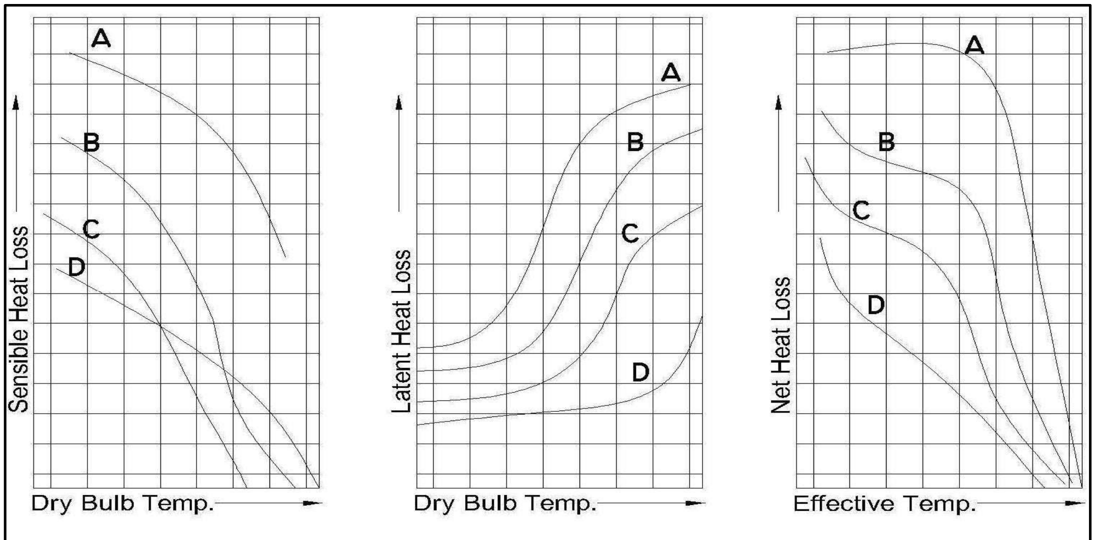

Figure (a) Figure (b) Figure (c)

RESULT AND DISCUSSION

In this paper the Phenomenon is represented by the following equation,
$H_m - W_e = H_{evap.} \pm H_{Conv.} \pm H_{rad.} \pm H_s$
Where,
H_m = Metabolic heat produced within the body
W_e = Useful rate of work
$H_{evap.}$ = Evaporative heat loss from the body
$H_{Conv.}$ = Convective heat loss from the body
$H_{rad.}$ = Radiated heat loss from the body
H_s = Heat Stored in the body and
$H_m - W_e$ = Heat to be dissipated to the surrounding
It may be noted that,
Heat stored in the body is positive when temperature of body rises and it may be negative when temperature of body falls below Equilibrium temperature (36.5 C)
The metabolic heat produced depends upon rate of food energy consumption in the body For Example,
A fasting person or a weak body or a sick person will have less metabolic heat production.

CONCLUSION

In this paper the net modes of heat dissipation from the body to the surrounding can be estimated by three modes viz. Convection, Radiation and Evaporation at any degree of activity for mentioned typical applications with respective of Dry Bulb Temperature (DBT) at a required Metabolic Heat Production.

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BIOGRAPHIES

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