Requirements of comfort air-conditioning

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Comfort feeling of human being depends on the following;

- Supply of O_2 and removal of CO_2
- Removal of body heat dissipated by the occupants
- Removal of body moisture dissipated by the occupants
- Provision of sufficient air movement and air distribution in occupant space
- Maintenance of purity of air by removing odour and dust.

Oxygen supply;

Each person requires $0.65m^3$ of O_2/ hour under normal conditions and produce $0.2m^3$ CO_2 so that the rise in concentration of CO_2 is an index of O_2 consumption.

Heat removal;

- Human body is considered as an engine that converts thermal energy to mechanical energy with a thermal efficiency of 20%.

- If a space of 6 m^3 is provided to each person and if there is no transfer of heat and air, then the space temperature will rise about 0.15^oC for each kJ of heat added to the space and rise in temperature of 48^oC /hour would result as man body dissipates 320kJ of heat/hour.

- The ventilation provides circulation of air to avoid excessive rise in temperature of air conditioned space and establish an atmosphere in which occupants can live and work satisfactorily.

Moisture removal

- Moisture loss from a body is 50g/hour when the man is at rest.
- The body ability to dispose of heat by evaporation to atmosphere decreases as the air humidity increases.
- High humidity of air reduces the apparent freshness of air in an enclosed space in addition to the difficulty in disposing of body heat.
- Ventilation system should be capable to maintain the RH below 70%.

Air motion

- Increased air velocity increases heat transfer.
- The effect of increased velocity is to increase the body heat loss and reduce feeling of discomfort when the ambient air is at temperature lower than body surface temperature.
- The sensible heat transfer will be in opposite direction if the air temperature exceeds that of body temperature.
- So the effect of increased velocity to increase the already existing discomfort.
- The increased velocity reduces the thickness of layer of the unsaturated vapour near the body surface and helps for evaporation.
- The heat loss by evaporation is usually greater than the heating effect by convection when the dew point temperature is below 30 ^{o}C. Therefore, the increased velocity of air is advantage.

- The heat transfer will be towards the body when the air is at high temperature and at high relative humidity so increased velocity will create discomfort.

- Air velocity in the AC space should not be more than 6-9 m/min at $20^{o}C$, and 9-15 m/min at $22^{o}C$.

- Air motion with out air distribution is responsible for local cooling sensation called draft.

- Velocities less than 8 m/min associated with temperature differential of $1^{o}C$ do not result in noticeable draft.

- Velocities greater than 12 m/min with a temperature differential of 1.5 ^{o}C will result in uncomfortable draft conditions.

Purity of air

- Quality air with regard to odour, dust, toxic gases and bacteria is considered to be purity of air.
- Evaporation on surface of body add odour to ac room situated near chemical, cloth and paper industries.
- Many sources contribute different odour to ac room.
- Smoke is objectionable due it bad effects on nose, eye and heart.
- Removal of toxic gases is essential because it contributes to irritation.
- Control of bacteria is important and is done by sterilisation.

Biological requirement of air supplied

- Indoor environment is affected by the growth of bacteria, fungi, mold, viruses and collective microorganism(mildew).
- Condensate of the drain pan of ac is the main breeding source for such microorganisms.
- A Canadian company has developed a non corrosive EPA registered product called “Ecolo Watercied” that kills and prevents the growth of microorganisms.
- Indoor conditions are worse than outdoor conditions since the population density per unit area is higher.
- Most of the contagious pathogens are hailing from human beings through nosocomical infections which tend to be endogenous and non contagious pathogens are hailing from surroundings.

Prime factors that affect outdoor conditions;

- Climate factors
- Edaphic factors
- Biotic factors

Prime factors that affect indoor conditions;

- **Human population and density**

Working area, degree of ventilation, hygienic conditions of occupants, health conditions of occupants and degree of tolerance against pathogens, proximity distance of people from the microbial source.

- **Indoor parameters**

- Indoor air temperature, mean radian temperature, indoor relative humidity, outdoor ventilation provided, air cleaning, air path and movement, sound level, pressure difference between space and surroundings.

- Among different varities of microbes including bacteria, viurs, algae and actinomycetes, the Aspergillus spp and Pencillium spp are the majority of community in the social structure with respect to indoor environment.

- Indoor conditions are very much favorable for them to reproduce and develop.

- Microbial formation is measured in terms of colony forming units.

- **Spores** are the single-celled reproductive unit of non flowering plants, bacteria, fungi, and algae.

- Many, such as fungi and bacteria, reproduce without mating at all.

- Instead, they produce hardy structures known as spores that are often adapted for dispersal from the main plant or fungus. Spores can last a very long time in some nasty conditions.

- During a normal day in single storied building the spore level could range from 10-100% of outdoor environment leading to 200CFU/m^3.
- The range is 10-31% of the outdoor spore level in a multistoried building.
- Colony forming unit (CFU)-measure the population density of microbes.
- Aspergillus spp and Pencillium spp are popular if the medium germination is an air conditioner, the level is 20CFU/m^3.
- 50 and 80 CFU/m^3 for mechanical and natural ventilation respectively when the CFU/m^3 is 100 for outdoor.
- Many contagious respiratory pathogens transmit by direct contact through the exchange of infections droplets or particles called formites. Eyes and nasal passages are vulnerable to formite transmissions.

- Certain infection of skin/eye, noscomical infection of open wounds and burns occur by air borne route.

- In case of Ocular infection, some reddish colour starts developing in the white portion of the eye and this mainly due to the spread of air borne pathogens and their characteristics. The same air borne pathogens some times may cause nasal infection also called spores or sporelets.

- Transmission occurs due to Immunity, duration of exposure, concentration of infectious agents, breathing rate of the occupants, route of infection.

References

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