2.3.6 Thermal comfort 1

Key terms

Term	Definition
Conduction	Heat transfer through physical contact.
Convection	Heat transfer through fluids, such as gases, including air, and liquids.
Radiation	Heat transfer by methods such as microwaves, infrared radiation, visible light, and electromagnetic radiation.

Thermal conduction – this is the transfer of internal heat within a solid material because of a temperature difference across it. Heat will tend to transfer from a higher temperature to a lower temperature. In a heated building in winter, there is likely to be a temperature difference between the inside and outside, resulting in heat loss to the outside by conduction and causing higher operating costs, higher carbon emissions and discomfort to the occupiers.

Convective heat – the transfer of convective heat in buildings results from the movement of air of different temperatures. It can be used to maintain internal comfort, either through heat exchange between the air and the internal surfaces of a building, or heat exchange with sources of heating or cooling.

Convection can be noticeable above hot radiators where warm air rises, or next to windows where there may be a cold downdraught. It can be used in passive building design to naturally ventilate buildings, using the stack effect, which involves drawing in cool outside air at low level, and warming the air using sources of heat within the building (such as people, equipment, heating and solar gain). The warmed air then rises through the building to vent out at a higher level.

Radiant heat – this transmits in straight lines, warming surfaces that are 'visible' to the source. These surfaces in turn re-radiate heat and warm the air adjacent to them by convection. This allows heat from a radiant source to distribute through a space.

Radiant heating systems include underfloor heating, wall heating systems, gas fired heated tubes, local electric heaters, and open fires. Some radiant heating systems also heat by convection, e.g., hot water radiators radiate heat directly to their surroundings, but also draw air through heated elements resulting in convective heating.

Environmental factors that affect thermal comfort

Air temperature – in most circumstances, a room temperature in the region of 20^{0}C will feel comfortable.

Radiant temperature – radiant heat may be present if there are heat sources in an environment and this will have a greater influence than air temperature on how occupants lose or gain heat to the environment.

Air velocity – stagnant air in indoor environments that are artificially heated may cause people to feel 'stuffy' and lead to a build-up in odour. Moving air in warm conditions can increase heat loss through convection and therefore produce a cooling effect without any change in air temperature. A small air movement in a cooler environment may be perceived as a draught and detract from perceived comfort levels.

Relative humidity – this is the ratio between the actual level of water vapour in the air and the maximum level of water vapour that the air can hold at that air temperature. Relative humidity between 40% and 70% does not have a major impact on thermal comfort. High humidity environments have a lot of vapour in the air, which prevents the cooling caused by evaporation of sweat.

Physical factors that effect thermal comfort

Clothing insulation – thermal comfort is very much dependent on the insulating effect of clothing on the wearer, as too much or too little clothing may be a primary cause of heat stress, even if the environment is not considered warm or cold. It is important to identify how clothing contributes to thermal comfort. Employers may regularly evaluate the level of protection provided by existing PPE and consider newer types of PPE that may improve their employees' level of thermal comfort.

Work rate/metabolic heat – physical work and exercise produces heat. The more heat we produce, the more heat needs to be lost to prevent overheating. The impact of metabolic rate on thermal comfort is critical and other physical factors such as size and weight, age, fitness level and sex can all have an impact on thermal comfort, even if other factors such as air temperature, humidity and air velocity are all constant.

The control of heat flow in buildings

Design considerations should include the following:

Levels of insulation – materials that are used to prevent heat gain or heat loss through the building envelope.

Limiting thermal bridges – these occur when a direct connection between the inside and outside of the building envelope is formed through material that is more thermally conductive than the surrounding construction.

Controlling air leakage – leakage when outside air enters a building or conditioned air leaves a building.

Orientation and solar radiation – this causes thermal gain within a building envelope, particularly through glazing. The gains may be unwanted or may be used as part of a passive energy system.

Possible interior heat – gains that can be generated by using electrical equipment and artificial light sources.