

Thermal comfort and heat stress

Learning Objectives

At the end of 1 hr didactic session on thermal comfort and heat stress, the students should be able to:

1. Describe discomfort and details of various thermal comfort indices
2. Interpret CET chart with 100% accuracy
3. Describe comfort zones with values
4. Define heat stress and describe various heat stress indices with values
5. Describe effects of heat stress on human health with corrective measures
6. Describe prevention of heat stress

The air of occupied room

- Changes in the air in confined places:

- Chemical Changes:

- Progressive contamination

- Per capita output of $CO_2 = 0.6$ c.ft./hr

- Physical Changes

- Rise in temperature

- Increase of humidity

- Decrease in air movement

- Body odours

- Bacterial pollution

- Comfort, health and efficiency: adversely affected when vitiated air is not replaced by fresh air
- Headache, drowsiness, inability to concentrate...
- On prolonged exposure: risk of droplet infection and lowered resistance to diseases





Discomfort

- A subjective sensation which people experience in ill-ventilated and crowded rooms
- “Black hole of Kolkata”
- Changes in the physical condition of the air, leading to heat retention
- Temperature, humidity, air movement and heat radiation
- These factors determine the cooling power of the air with respect to human body

Indices of thermal comfort

1. Air temperature: inadequate index when considered in isolation
2. Air temp and humidity: better but still inadequate
3. Cooling power: 2 + air movement (Kata Thermometer - wet and dry)

4. Effective temperature: an arbitrary index which combines in a single value the effect of temp, humidity and movement of the internal air on the sensation of warmth or cold felt by the human body
- special charts and scales

5. Corrected effective temperature (CET)

includes effect of radiant heat

- ET - dry bulb thermometer

- CET - globe thermometer

➤ *McArdle's Maximum Allowable Sweat Rate: P_4SR*

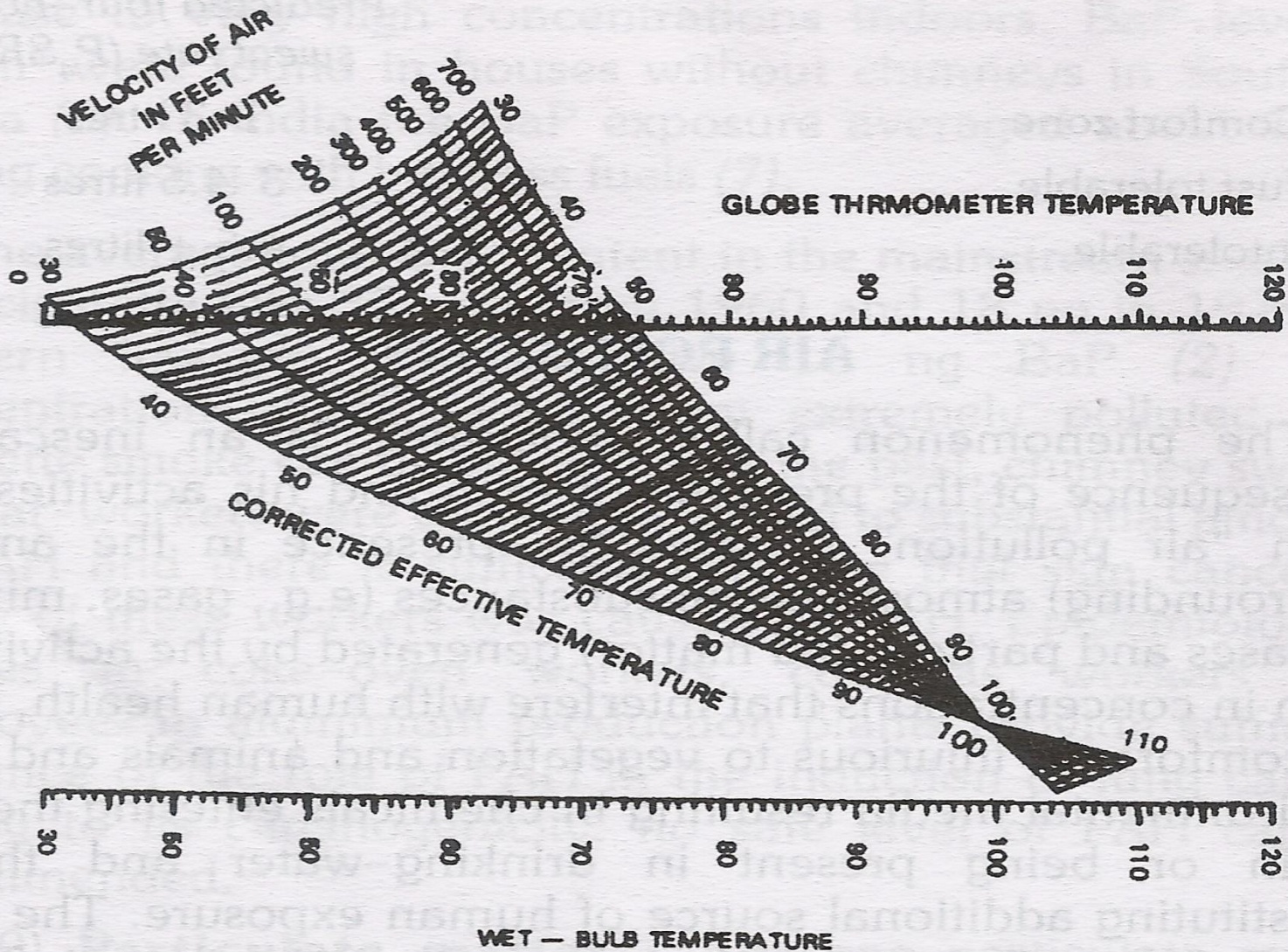


FIG. 1
Effective temperature chart

Comfort Zones

- Comfort: Complex subjective experience, depending on physical, physiological and psychological factors which are difficult to determine
- So, considering only the environmental factors, the comfortable thermal conditions are those under which a person can maintain normal balance between production and loss of heat, at normal body temp and without sweating

Comfort Zones evaluated in India

No.	Type of Zone	CET (Deg C)
1	Pleasant and cool	20
2	Comfortable and cool	20-25
3	Comfortable	25-27
4	Hot and uncomfortable	27-28
5	Extremely hot	28+
6	Intolerably hot	30+

Comfort Zones evaluated in India

No.	Type of Zone	P ₄ SR (litres)
1	Comfort zone	1-3
2	Just tolerable	3-4.5
3	Intolerable	4.5+

Heat Stress

- The burden or load of heat that must be dissipated if the body is to remain in thermal equilibrium
- Metabolic rate, air temperature, humidity, air movement and radiant temperature
- Amount of heat gained by the body must be equaled by the amount of heat lost from it

Heat stress indices

- **Equatorial comfort index:** temp of still and saturated air
- **P_4SR**
- **Heat stress index:**
 - percentage of heat storage capacity of an average man
 - Takes into consideration the metabolic rate and the principal channels of heat exchange between human body and environment
 - Nomograms

Heat Stress Index - values

No.	Level of stress and strain	Percentage
1	No thermal Stress	0
2	Moderate to mild heat strain	10-30
3	Severe heat strain	40-60
4	Very severe heat strain	70-90
5	Upper limit of heat tolerance	100

Effects of Heat Stress

- Heat Stroke:

- Failure of heat regulating mechanism in hypothalamus
- Very high temp; up to 110°F
- Delirium, convulsions, partial or complete loss of consciousness
- Dry and hot skin
- Sweating may be absent or diminished
- Acidotic breathing
- CFR high (40) even if brought quickly to medical attention

- **Heat Stroke:**

- **Treatment:**

- Rapid cooling, ice water bath till rectal temp falls below 102°F
 - Continuous monitoring of rectal temp for efficacy of hypothermia treatment and also to guard against clinically significant hypothermia if cooling is continued too long.
 - Correction of hypovolemia, hyperkalaemia, hypocalcaemia, bleeding diathesis, other complications of hyperthermia
 - Other supportive including CBR for several days

- **Heat hyperpyrexia:**

- Temp above 106°F
- May proceed to heat stroke

- **Heat exhaustion:**

- Inadequate replacement of water and salts lost in perspiration
- Typically occurs after several days of high temperature
- Body temp normal or slightly elevated; but not more than 102°F
- Dizziness, weakness, fatigue
- Tachycardia, weak pulse, BP and Urine Output decrease

- Heat exhaustion:

- Treatment:

- Removal to cool place
 - Drinking fluids containing salt
 - ORS
 - Some may need hospitalization and i. v. fluids
 - Recovery is fast

- **Heat cramps:**

- Intracellular over hydration and diminished chlorides in the tissues
- Heavy muscular work in high temp and humidity
- Painful and spasmodic contractions of the skeletal muscles esp. legs and arms
- Shift to cool place; plenty of fluids

- **Heat syncope:**

- Milder form: person standing in the sun becomes pale, his blood pressure falls and he collapses suddenly
- Pooling of blood in dilated vessels
- Make patient to lie down, with head slightly down

- **Prickly heat:**

- Hyperactivity of acrine sweat glands
- Blocking of the sweat ducts by epithelial debris due to excessive heat and sweating and poor personal hygiene
- Secondary infection may lead to furunculosis

Preventive measures

- Replacement of the water content lost by body
 - Heavy work under direct sunlight: as much as 1 litre per hour; others involved in sedentary work require half the amount
 - No need for extra salt except unacclimatized persons
- Regulation of work: intervals, regular periods of rest, treatment as soon as signs and symptoms start appearing

- Clothing
- Protective devices
- Work environment: proper ventilation and air conditioning
- Effects of cold stress

