

Air pollution

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Air

- No life without air - O₂ inhaled and CO₂ exhaled
- Reverse in plants – reversed in light.
- Human body – cooled by air
- Special senses- hearing and smell function through air transmitted stimuli
- Disease agent conveyed by air



Composition

- Mixture of gases
 - NO_2 – 78%
 - O_2 – 20%
 - CO_2 – 0.03%
 - Other :- Argon , helium, neon



Air is impured by

- Air is impure by
 - Respiration,
 - Combustion of coal, gas and oil.
 - Decomposition of organic matter
 - Trade, Traffic &
 - Manufacturing process.



Self cleansing mechanism

1. Wind- dilute and sweeps away the impurities
2. Sunlight- kill bacteria
3. Rain
4. Plant life



Air of occupied room :-

- Human occupancy and activity vitiate air and give a sense of discomfort

a) Physical Changes :-

- Rise in temperature
- Increase Humidity
- Decrease in air movement
- Bacterial pollution
- Body odours

Chemical changes

- Due to metabolic process- $\text{CO}_2 \uparrow$ & $\text{O}_2 \downarrow$



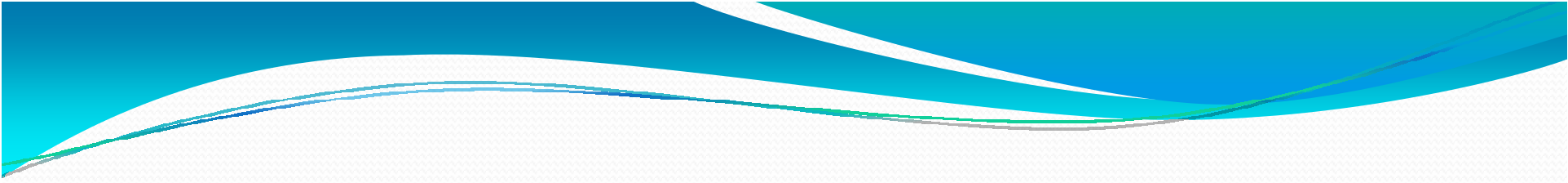
Discomfort

- Subjective sensation which people experience in ill-ventilated and crowded rooms.
- O_2 ↓ to 18% and CO_2 ↑ to 5% without adverse effect provided temperature and humidity are kept satisfactory.
- Black hole of Kolkata = 146 prisoners – 23 survived



Indices of thermal comfort

1. Air temperature- Not an adequate index
2. Air temperature and Humidity- also not satisfactory index
3. Cooling power- Air temperature , Humidity and air movement- together expressed as “Cooling power”.



4. Effective Temperature :- Arbitrary index which combine into single value the effect of temperature, humidity and movement of internal air on the sensation of warmth or cold felt by human body.



5. Corrected Effective temperature :-

- air temperature
- Air velocity
- Humidity
- Mean Radiant Heat



6. McARDLE'S Maximum Allowable Sweat rate

- 4.5 liters of sweat excreted in 4 hrs as maximum allowable sweat rate.
- Chart prepared – predicted four hour sweat rate (P4SR)- can be obtained from any combination of dry and wet bulb temperature of the air, mean radiant temperature and air velocity.



Comfort Zone

- Defined as range of ETs over which the majority of adult feel comfortable.
- Comfortable thermal condition are those under which a person can maintain normal balance between production and loss of heat at normal body temperature and without sweating.



CET deg C

- 1) Pleasant & cool - 20
- 2) Comfortable & cool - 20 – 25
- 3) Comfortable - 25 – 27
- 4) Hot & Uncomfortable - 27 – 28
- 5) Extremely hot - 28+
- 6) Intolerably hot - 30+



Predicted four
hour sweat rate (P4SR)

- | | | |
|-------------------|----|--------------|
| 1. Comfort zone | -- | 1-3 liters |
| 2. Just tolerable | -- | 3 – 4 liters |
| 3. Intolerable | -- | 4.5+ liters. |



AIR POLLUTION

- Presence of substance in ambient atmosphere in concentrate that interfere human health, safety & comfort.
- One of the present day health problem throughout the world



Basic definition

- **Primary air pollutants:** that are emitted into the atmosphere from a source such as factory chimney or exhaust pipe.
- **Secondary air pollutants:** Are those formed within the atmosphere itself. They arise from chemical reactions of primary pollutants.



Basic definition (Contd.)

- **Gaseous air pollutants:** those present as gases or vapours.
- **Particulate air pollutants:** they comprise material in solid or liquid phase suspended in atmosphere.



Sources

- **Automobiles** :- Motor vehicles are a major source of air pollution. They emit Hydrocarbon, CO , lead , NO₂, Particulate matter, smoke, fumes.
- **Industries** :- Combustion of fuel to generate power and heat produce smoke , SO₂, NO₂, ash. **Petrochemical Industries emit** Hydrogen fluoride, Hydrochloric acid & organic halides.



Sources (Contd.)

- **Domestic** :- Combustion of coal, wood , oil produce – smoke , dust, SO₂ , NO₂.
- **Tobacco Smoking** :- **Passive smoking**
- **Miscellaneous** :- Burning of refuses, incinerators, pesticide spraying, natural sources (e.g. wind borne dust, fungi, bacteria), nuclear energy programme.



Meteorological factors

- Man is most directly concerned with 8 – 10 Km of atmosphere.

Atmospheric pollution :-

- Depends upon topography, air movement and climate.
- **Topography** :- Winds help in the dispersal and dilution of pollutants. If topography is dominated by mountains or tall building, the winds become weak and calm and pollutant tend to concentrate in the breathing zone.

Meteorological factors (Contd.)

- Vertical diffusion of pollutant depends upon the **temperature gradient**.
- When there is rapid cooling of lower layers of air (temperature inversion), there is little vertical motion and the pollutant and water vapors remain trapped at the lower level and result is the “smog”, which is more frequent during winter.

Air Pollutants

- **Gases and vapours-** CO₂ , CO , Hydrogen Sulphide, Amonia, SO₂, NH₃, SO₃, NO, aldehyde, acetone, and aromatic hydrocarbons
- Fumes of lead and other chemicals with particle size 1 micron and above
- Dust suspended in the air such as grit, soot, earth, sand, Pb, Mn, Fe, Zn, pollen, fibres, etc.
- Radio active dusts and isotopes.
- Photochemical oxidants (ozone)
- Smoke



CO

- One of the most common & widely distributed.
- Product of incomplete combustion of carbon containing material i.e., automobile, industrial process , heating facilities, incinerators.



SO₂

- Combustion of sulphur containing fossil fuel, smelting of sulphur- containing ores and the other industrial process.
- Domestic fire, power generation and motor vehicles can also produce.
- SO₂ can affect the respiratory system and function of lungs, and causes irritation of eyes.



- **Lead :-**

- 80 – 90% come from combustion of leaded petrol.
- Children – up to 6 years and pregnant women at risk.

- **CO₂ :-**

- Is a natural constituent of air.
- Man generates enormous amount of it in combustion process using coal, oil and gas
- Affect global temp.



- **Hydrocarbon :-**

- incineration, combustion of coal, wood processing and use of petroleum .

- **Cadmium :-**

- The steel industry, waste incinerator, volcanic action, zinc production seem to account for the largest emission.
- Tobacco contain Cadmium.



Hydrogen Sulphide :-

- Human activities can release naturally occurring H₂S.
- Also formed during coke production, viscose rayon production, waste water treatment plant, wood pulp production using the sulphate method, sulphur extraction process and in oil refinery.
- At low concentration – unpleasant odour. Conjunctival irritation is the next subjective symptom.
- Neurological & mental symptoms <30 µg / m³



Ozone

- Ozone at ground level- not to be confused with the ozone layer in the upper atmosphere- is one of the major constituents of photochemical smog.
- It is formed by the photochemical reaction of sunlight with pollutants such as NO from vehicle, industry emissions and volatile organic compounds emitted by vehicles, solvents and industry.
- Excessive ozone- cause breathing problems, trigger asthma, reduce lung function and cause lung disease.



Oxides of nitrogen

- Coal combustion, road traffic and electricity generation
- Bronchitis, reduced lung function etc.



Polynuclear Aromatic Hydrocarbon (PAH)

- Produced by incomplete burning of carbon containing materials like, wood, garbage, coal, and oil.
- Automobile exhaust, industrial emission and smoke from burning wood, charcoal and tobacco contain high level of PAH.
- Carcinogenicity
- No safety levels



Particulate Matter

- Airborne particulate matter represents a complex mixture of organic and inorganic substances.
- Coarse particle - $> 2.5 \mu\text{m}$
- Fine Particle - $< 2.5\mu\text{m}$ - more dangerous.
- Produce by dust storm, power plants, industrial process, vehicular traffic, domestic coal burning,.



Indoor air Pollution

- **One of the 4 most critical global environmental problems**
 - ARI- pneumonia
 - COPD (Chronic lung diseases)
 - Cancer of lung
 - Adverse pregnancy outcome / Still birth
 - Chronic lung & heart dis.

Sources of indoor air pollutants

Pollutants	Sources
Respirable particles	Tobacco smoke, stove, aerosol spray
CO	Combustion equipment, stove, gas heaters
Nitrogen dioxides	Gas cooker, cigarettes
SO ₂	Coal combustion
CO ₂	Combustion, respiration
Formaldehyde	Particle board, carpet adhesives, insulation
Other organic vapors	Solvents, adhesives, resin products, aerosol spray
Ozone	Electric arcing, UV light sources, building materials



Monitoring air pollution

- Best indicators :- Sulphur dioxide, smoke , suspended particles.
- **Sulphur dioxide-**
 - major contaminant in many urban and industrial areas.
 - Estimated in all surveys



Monitoring air pollution

- **Smoke & Soiling Index :-**

- A known volume of air is filtered through a white filter paper under specified conditions and the stain is measured by photoelectric meter.

- **Grit & dust Measurement :-**

- Deposit gauges collect grit, dust and other solids.



Monitoring air pollution

- **Coefficient of Haze** – amount of Smoke or other aerosol. A factor used mainly in USA.
- **Air Pollution index :-**
 - Arbitrary index which takes into account one or more pollutants
 - In USA – 10 times SO_2 conc. + twice CO conc. + twice coefficient of Haze.
 - Alarm >12 – 50 or more.



Air pollution monitoring in India

- Natural Air Quality Monitoring Programme sponsored by Central Pollution Control Board (CPCB) since 1990
- Generate database of major ten cities.
- Trend Analysis suggested that Suspended Particulate Matter (SPM) exceeds CPCB standard in all cities.



Effect of Air Pollution

- 1.3 billion urban residents world wide are exposed for air pollution level above recommended level.
- **Health Aspect**
 - Immediate
 - Delayed



Health Aspect -Immediate

- Mainly respiratory- Acute Bronchitis
- If intense air pollution- suffocation and even death can occur.



Health Aspect :- Delayed

- Chronic Bronchitis,
- Lung cancer,
- Bronchial Asthma,
- Emphysema ,
- Respiratory Allergies .



Health Aspect- Delayed (Contd.)

- Lead poisons many systems in the body and is dangerous to the children affecting brain and nervous system.
- Elderly, children, smokers and those with chronic respiratory difficulties are more vulnerable



Social & economic aspects

- Destruction of plant and animal life
- Corrosion of metals
- Damage to buildings
- Cost of cleaning, maintenance and repairs
- Reduces visibility in towns
- Soil and damages clothes



Prevention & control

a) Containment-

- enclosure, ventilation & air cleaning

b) Replacement-

- Replacing technological processes causing air pollution, by a new process that does not.
- Increased use of electricity, natural gas and central heating in place of coal
- Use unleaded petrol



Prevention & control

c) Dilution :-

- Some air pollutants are removed by vegetation.
- Establishment of green belts between residential and industrial area.



d) Legislation :-

- Regarding height of Chimneys
- Giving power to local authorities to carryout investigation, research , education concerning air pollution.
- Creating smokeless zone
- Enforcement of standard or ambient air quality.
- GOI :- Air (Prevention and Control of Pollution) Act in 1981.



e) International Action

- WHO established international network of Laboratories –
 - 2 international centers at London & Washington,
 - 3 centres at Moscow , Nagpur and Tokyo and 20 laboratories in various parts of the world.
 - These centres issue warning of air pollution.



Disinfection of air

1) Mechanical ventilation

- This reduces vitiated air and bacterial density

2) Ultra violet radiation –

- Effective in OT, Infectious disease wards
- Since direct exposure to UV rays is a danger to eyes and skin, UV lamps are shaded and located in the upper portion of the rooms near inlet of air.



Disinfection of air

3) Chemical Mists –

- triethylene glucol vapours – air bactericides

4) **Dust Control** – oil to floors of hospital ward reduces bacterial content of the air.



Thank You