

## UNIT 2 : Environmental pollution and control - II

POLLUTION: The undesirable change happens in composition of air, H<sub>2</sub>O, soil in the environment against nature.

POLLUTANT: The unwanted component present in the environment that causes damage to human and environment.

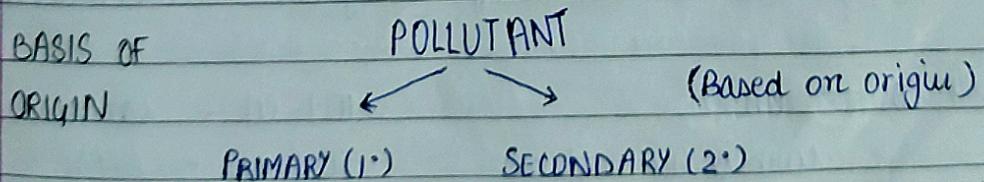
AIR POLLUTION: The ~~presence~~ presence of specific chemical agent (because of its quantity and composition) which causes damage to Human and environment.

### NATURAL

- forest fires
- decay of vegetation
- pollen grains
- volcanic eruption (H<sub>2</sub>S, SO<sub>2</sub>, etc.)

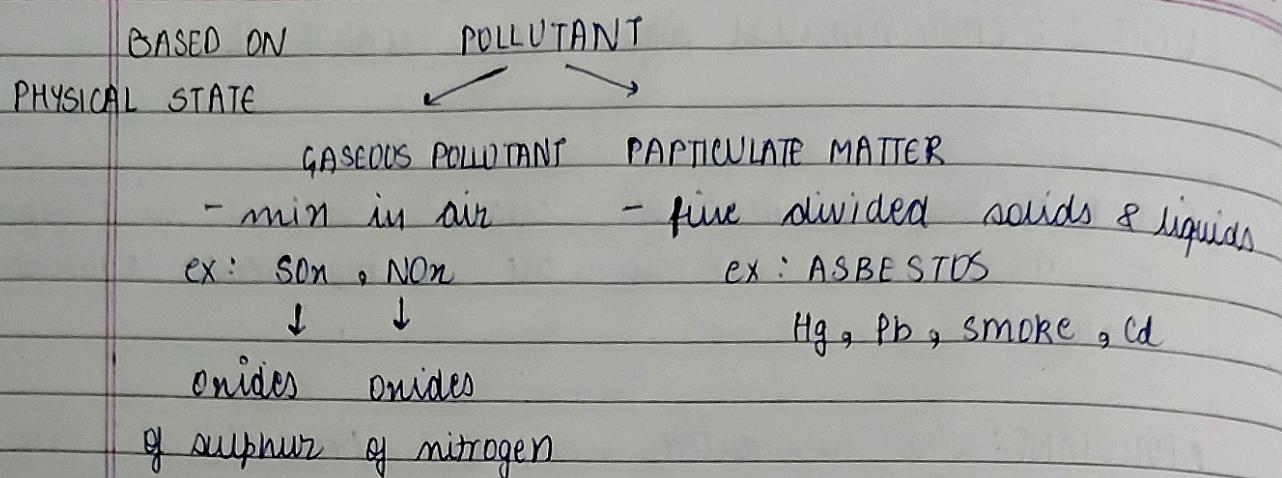
### MAN MADE (ANTHROPOGENIC ACTIVITIES)

- incr<sup>↑</sup> in population
- industrialization
- rillular erosion
- deforestation
- explosive in war
- use of pesticides/insecticides in agriculture.



Man made activities  
and natural ways  
ex - CO, SO<sub>2</sub>, NO<sub>2</sub>, etc.

generated from 1° pollutant  
1° pollutant interact among themselves  
& form 2° pollutants.  
ex - photochemical smog.



### (1) CO (carbon monoxide)

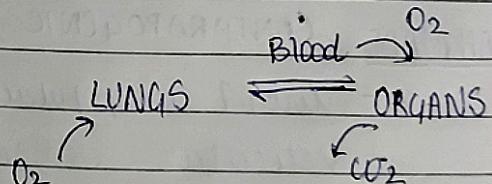
- tasteless, colourless gas

#### 1. SOURCE

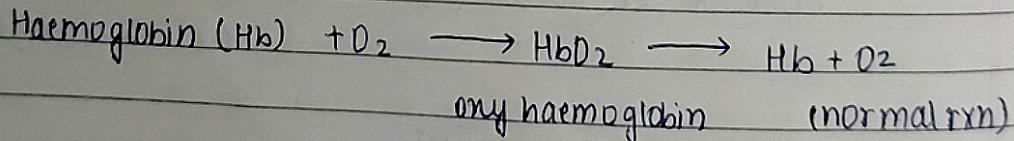
- ~~incomplete~~ incomplete combustion of fossil fuels
- vehicular emission → (coal, diesel, petrol)  
(70% CO emission)

#### 2. SINK

- soil microorganism



#### 3. EFFECTS



in polluted environment



carboxy haemoglobin

10% CO - laziness

50% CO - fatal

#### 4. CONTROL

- ENGINE MODIFICATN: more spacious engine in vehicles
- FUEL MODIFICATN: use of natural gas

## (2) OXIDES OF SULPHUR

- exists in  $\text{SO}_2, \text{SO}_3$  pungent smell, colourless gas

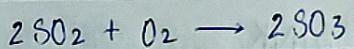
### 1. SOURCE

- natural volcanic eruption  $\text{H}_2\text{S}, \text{SO}_2$  etc..
- MAN MADE SOURCES
  - vehicle emission 67%
  - burning of fossil fuels (coal, petrol, diesel etc)
    - in Thermal power plants } release  $\text{SO}_x$
    - in Electric power plants }

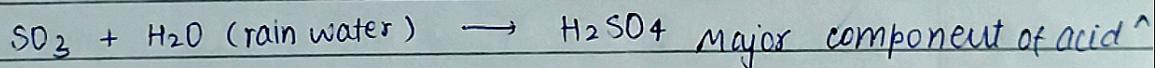
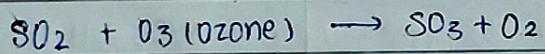
\* SULPHUR is major nutrient

for growth of plant, but

SULPHUR OXIDES are harmful



### 2. SINK



### 3. EFFECTS

- chronic Bronchitis

$\text{SO}_2$  deposits on carbon particles and if inhaled causes upper respiratory tract damage.

- Acid Rain



- chlorosis in plants

↳ color changes from green to yellow       $\text{SO}_2$  in 0.3 ppm

- damage to historical monuments

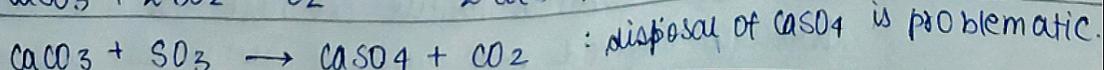
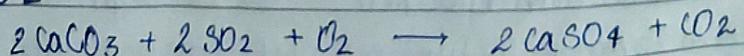


(leakage in Taj Mahal's roof)

(highly soluble in  $\text{H}_2\text{O}$ )

- brittle paper

### 4. CONTROL



: disposal of  $\text{CaSO}_4$  is problematic.

NO (nitric oxide)

NO<sub>2</sub> (nitrogen dioxide)

N<sub>2</sub>O (nitrous oxide)

N<sub>2</sub>O<sub>3</sub> (nitrogen trioxide)

↪ laughing gas

N<sub>2</sub>O<sub>5</sub> (nitrogen pentoxide)

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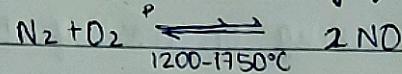
### (3) OXIDES OF NITROGEN

#### 1. SOURCE

- during lightning discharge  $N_2 + O_2 \rightarrow NO$

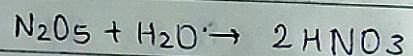
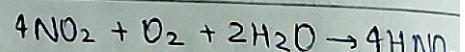
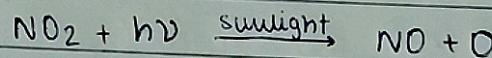
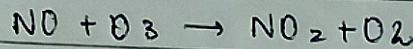
- MAN MADE RESOURCES

- ~~from~~ combustion of fossil fuels



- in chemical industries as by products

#### 2. SINK



#### 3. EFFECTS

- NO has no health effects at atm. conc, but NO oxidizes to NO<sub>2</sub>, which reacts with HC<sub>x</sub> in the presence of hν (sunlight) to form photochemical smog.

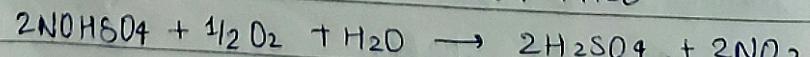
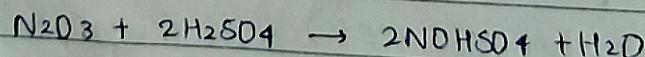
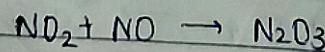
- HNO<sub>3</sub> formed by NO<sub>2</sub>, causes acid rain

- at high conc in atmosphere, it is an acute irritant.

#### 4. CONTROL

- modifying engine design

- FLUE GAS SCRUBBING: ~~NO<sub>2</sub>~~ with H<sub>2</sub>SO<sub>4</sub>



- SELECTIVE CATALYTIC RED: ~~NO<sub>x</sub>~~ through CH<sub>4</sub>, NH<sub>3</sub> & CO.

The NO<sub>x</sub> is added to the exhaust gases & mix is passed through a fixed bed catalyst such as CuO

## Acid Rain ( $\text{pH} = 5.7$ )

1.  $\text{H}_2\text{SO}_4$
2.  $\text{HNO}_3$
3.  $\text{HCl}$
4.  $\text{H}_2\text{CO}_3$  ( $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$ )

## Formation of Acid Rain



- ①  $\text{SO}_2 + \text{O}_2 \xrightarrow[\text{soot}]{\text{NO}} 2\text{SO}_3$
- $\text{SO}_3 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_4$
- ②  $\text{NO} + \text{O}_2 \rightarrow \text{NO}_2 + \text{O}_2$
- $\text{NO}_2 + \text{O}_3 \rightarrow \text{NO}_3 + \text{O}_2$
- ③  $\text{NO}_2 + \text{NO}_3 \rightarrow \text{N}_2\text{O}_5$
- $\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3$
- ④  $\text{HCl}$
- ⑤  $\text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{CO}_3$  (carbonic acid)

## Damages by Acid Rain

- acidification of lakes (fish cannot be able to breath at pH 5)
- leaching of nutrients, aluminium etc from the soil.  
↳ Alzheimer disease (loss of memory)
- damage to vegetation affects seed germination.
- damage to historical monuments. ( $\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2$ )

Q

## Photochemical Smog

$$\text{SMOG} = \text{SMOKE} + \text{FOG}$$

- damages respiratory tract and cause eye irritation
- also called as los angeles smog (1950)
- oxidising in nature
- occurs in summer

  $\text{SO}_x$   
carbon particles  
 $\text{NO}_x$

## Components of PC Smog

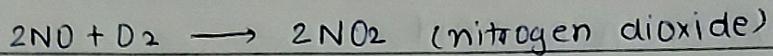
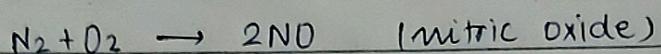
1. hydrocarbons
2. temp above  $78^\circ\text{C}$
3. presence of oxides of N.
4. sunlight

## PRODUCTS OF PC SMOG

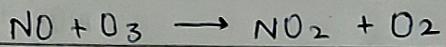
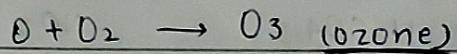
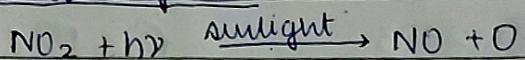
PAN - peroxy acetyl nitrate

O<sub>3</sub> - ozone

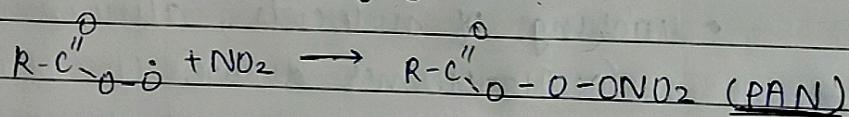
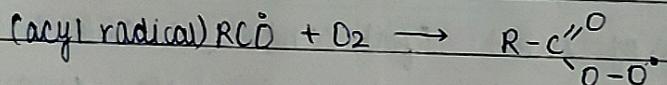
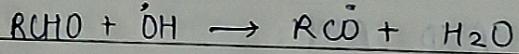
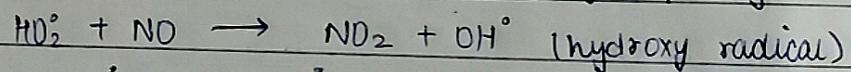
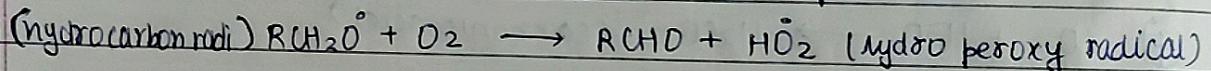
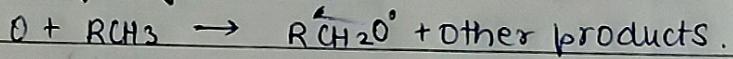
## FORMATION OF PC SMOG



### Photo dissociation of NO<sub>2</sub>

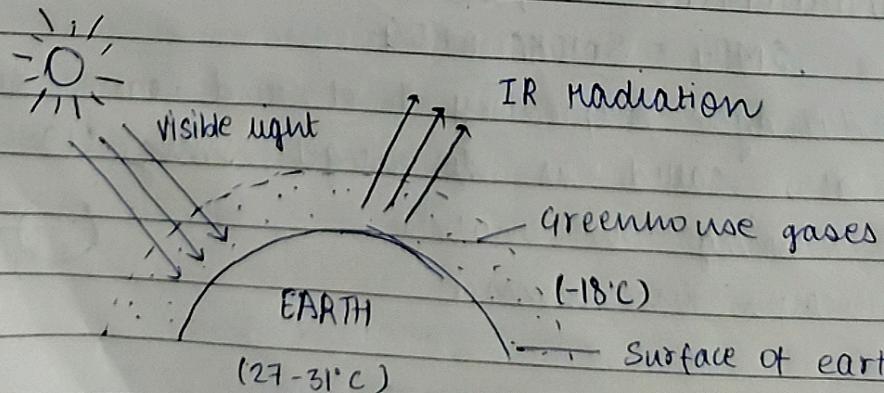


### in presence of hydrocarbons



## Radical mediated mechanism of formation of PC smog

## GREENHOUSE EFFECT



IARI : Indian Agriculture Research Institute

$$E = hc \quad E \propto \frac{1}{\lambda}$$

$$\left. \begin{array}{l} (\uparrow \lambda \downarrow E) : \text{IR} \\ (\downarrow \lambda \uparrow E) : \text{Visible} \end{array} \right\}$$

VIBGYOR  
Visible light | IR  
Radiation

200 nm      800 nm      3000 nm

High  $\lambda$



Low energy

1. Photosynthesis

2. Evaporation of H<sub>2</sub>O

3. Absorbed by soil and rocks

Greenhouse gases : CO<sub>2</sub> (54%) , CH<sub>4</sub> (18%) , O<sub>3</sub> (13%) , N<sub>2</sub>O (6%) ,  
CFCB (9%).

## GLOBAL WARMING

- enhanced greenhouse effect

## CARBON DIOXIDE SEQUESTRATION

→ provision of long term storage of carbon in terrestrial biosphere, underground or oceans, to reduce buildup CO<sub>2</sub> (principal greenhouse gas) conc in the atmosphere

### SOURCES

- burning coal, oil, natural gas & wood.
- expanding use of fossil fuel for energy.

### SINK

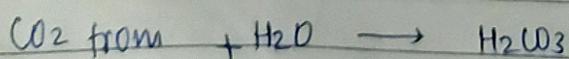
- oceans which take up 1/3 of anthropogenic emiss<sup>n</sup> of CO<sub>2</sub>
- plants & organisms that use photosynthesis, using CO<sub>2</sub>
- soils which contains more organic C than vegetation & atmosphere

### Natural Sequestrat<sup>n</sup>

- reforestat<sup>n</sup> can incr capacity of forests to act as a sink
- in oceans, micrometer part<sup>n</sup> of Fe<sub>2</sub>O<sub>3</sub> & FeSO<sub>4</sub>. 7H<sub>2</sub>O are added to incr carbon sequestrat<sup>n</sup>.
- addition of Fe stimulate growth of ~~RED~~ PHYTOPLANKTON, which inturn removes significant quant. of CO<sub>2</sub> via photos
- soil, no-till farming, over cropping & crop rotat<sup>n</sup> to significantly enhance carbon seq.
- conversion of pastureland with good management of grazing

### Artificial sequestrat<sup>n</sup>

1. capture CO<sub>2</sub> or prevent re-release (combustion, decay etc)
2. by using it in such as constr<sup>n</sup>
3. it can be then passively stored or remain productively utilized over a time in variety of ways.



oceans

dangerous method

format<sup>n</sup>

- geo-sequestration: injecting CO<sub>2</sub> directly into underground geological  
→ oil fields, saline aquifers, & unminable coal seams can be  
→ caverns & old mines for nat. gas (but lack of safety). used to store  
etc.
- Biosequestration: plant<sup>n</sup> of biodiesel crops such as switch grass, algal

CDM (clean development mechanism): an arrangement allowing industrial countries with green house gas commitment to invest in projects (CO<sub>2</sub> emission redn) in developing countries as an alternative to more expensive emissn reduction in their own countries.

## CARBON CREDITS

Global climate change: long term changes in earth's atmosphere and climate pattern.

- Earth's temp will increase by 6.5° F by year 2100
- due to glaciers melting, rise in sea levels etc.
- 6 greenhouse gases (CO<sub>2</sub>, N<sub>2</sub>O, CH<sub>4</sub>, HCFs, PFCs, SF<sub>6</sub>)

16<sup>th</sup> Feb 2005 Kyoto Protocol: aims to solve problem of global warming by aiming to reduce greenhouse gases to 5.2% below.

1. Joint Implementation (JI): developed countries can reduce emission by joint projects with other Annexure I developed countries.  
→ generate ERUs (emission reduction units)
2. Clean Development Mechanism (CDM):
3. International Trading Emission Trading (IET): allows individual companies to emit certain quantity of greenhouse gases allocated by Kyoto companies.