15.6. as ozone layer. approximately 97% of all

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15.

6. Stratospheric PollutionOzoneis present at different altitudes of atmosphere. Layer of ozone is present inupper region of stratosphere, known as ozone layer. Approximately 97% of allthe ozone in the atmosphere(10 kmto 50 km) is present in the stratosphere The highestconcentration of ozone is between the altitudes of 12 km and 35 km in thestratosphere.

This zone (12 km to 35 km) of atmosphere is called ozonosphere orthe stratosphere ozone layer and is considered as a protective shield on theearth’s surface. This layer shields the earth from the harmful ultraviolet radiationof the sun. Depletion of the ozone layer is considered as a threat to all formsof life. 15.

6. 1 Depletion of Ozone Layer (Ozone hole)When UV light from the sunstrikes the earth’s atmosphere, it causes photolysis of oxygen molecules intoreactive oxygen atom. O2 + h ¾¾® 2(O) ———- (1) This reaction is followed byanother in which a reactive oxygen atom recombines with an oxygen moleculeproducing ozone. O2 + (O) ¾¾® O3 ———- (2)The ozone formed in reactiondistributes itself in the stratosphere forming a layer. Stratosphere ozone thenabsorbs harmful ultraviolet radiation. O3 + h ¾¾® O2 + (O) ———- (3) Theozone layer filters the incoming UV radiations and provides natural protection. The reaction (3) destroys ozone but it also produces reactive oxygen (Reaction-2)producing more ozone to compensate the loss.

Thus in the stratosphere, ozone iscontinuously created and destroyed by the sun’s radiation.

This results inequilibrium concentration of ozone. The equilibrium is disturbed when reactivechlorine atoms, released from photolysis of CFC’s, enter into the atmosphere. Fig. 15. 3 Ozone holeTheseatoms create an imbalance by destroying ozone molecules.

Generally substancethat cause depletion of ozone or make it thinner are called Ozone Depletion Substances abbreviatedas ODS. The loss of ozone molecules in the upper atmosphere is termed as depletion of stratospheric ozone. Whenthis happens, the ozone layers capacity to filter out harmful U-V rays from thesun decreases.

Nitric oxide and Chloro Fluoro carbon are foundto be most responsible for depletion of ozone layer. i) Oxides of Nitrogen: Nitrogen oxides introduced directlyinto the stratosphere by the supersonic jet aircraft engines in the form ofexhaust gases. These oxides also released by combustion of fossil fuels andnitrogen fertilizers. Inert nitrous oxide in the stratosphere is photochemically converted into more reactive nitric oxide. Oxides of nitrogen catalyse the decomposition of ozone andare themselves regenerated. Ozone gets depleted as shown below The net reactionis Thus ozone decomposition rate increase instratosphere in the presence of nitrogen oxides.

Reaction of NOx with ozonecauses 40% depletion. ii) Chloro Fluoro Carbons (CFC) Freons The chloro fluoroderivatives of methane and ethane

are referred by trade name FreonsThese ChloroFluoro Carbon compounds are stable, non-toxic, noncorrosive and non-inflammable, easily liquefiable gases and are used in refrigerators, air- conditioners andin the production of plastic foams. CFC’s are the exhaust of supersonic aircraft’s and jumbo jets flying in the upper atmosphere.

They slowly pass fromtroposphere to stratosphere. They stay for very longer period of 50 – 100years. In the presence of ultraviolet radiation from sun, CFC’s break up intochlorine free radical Thechlorine free radicals formed react with stratospheric ozone to form chlorinemonoxide radical and oxygen molecule. Reaction of chlorine monoxideradical with atomic oxygen produces more chlorine free radical.

Due to thiscontinuous attack of Cl? thinning of ozone layer takes place which lead toformation of ozone hole. It isestimated that for every reactive chlorine atom generated in thestratosphere1, 00, 000 molecules of ozone are depleted. Now a days air-conditioning and refrigeration industries use hydrochlorofluoro carbons (HCFC)and hydrofluoro carbons (HFC) as short term ozone friendly substitutes forCFC’s. 15. 6. 2 The Ozone hole over Antarctica Depletion of ozone layer take placein all parts of the stratosphere but ozone hole mainly observed in thestratosphere over Antartica. In mostparts of stratosphere reacts with nitrogendioxide and Cl. reacts withhydrocarbons as shown below This prevents the reaction of activechlorine radical with ozone and the stops the chain reaction.

The Ozone hole in Antartica In Antartica, the climatic conditions arequite different. In summer season NO2 and CH4 react withchlorine

monoxide radical and chlorine radical respectively and prevents ozonedepletion. But in winter season special types of clouds called Polarstratospheric clouds (PSC) are formed over antartica. PSC’s composed of eithernitric acid trihydrate at about 196K (Type I) or ice formed at 188K (TypeII). These clouds hydrolysis chlorine nitrate to hypochlorus acid and also hydrogenchloride to chlorine molecule as shown in following reaction Duringspring season (September and October) sun shines over antartica and the sun’swarmth break up the clouds . HOCl and Cl2 undergo photolysis to formreactive chlorine radical. The chlorine free radicals formed initiate the chainreaction of ozone depletion Due to polar stratospheric clouds, polar vortexsurrounds Antarctica.

This rigid and cuts off Antarctica from ozone air of non-polarregions. Hence ozone hole remains unfilled. After the spring the intensity ofsunlight increases and polar vortex breakdown. The ozone rich air fromsurroundings rushes up to fill the ozone hole.

15. 6. 3 EnvironmentalImpact of Ozone DepletionThe formation anddestruction of ozone is a regular natural process, which never disturbs theequilibrium level of ozone in the stratosphere.

Any change in the equilibriumlevel of the ozone in the atmosphere will adversely affect life in thebiosphere in the following ways.

(i) Depletion of ozone layer willallow more UV rays to reach the earth surface. Consequently, the temperature ofthe earth’s surface will increase, which would cause melting of continentalglaciers and ice sheets.

(ii) It increases evaporation of surface water and decrease

themoisture content of the soil.(iii) Depletion of ozone layer wouldcause skin cancer and also decreases the immunity level in human beings.(iv) The heavily fertilised crops would be moreadversely affected due to their exposure to UV radiations and hence plants aredamaged. Plants give poor yield.(v) UV radiation affects thegrowth of phytoplankton, as a result ocean food chain is disturbed and even damages the fish productivity.