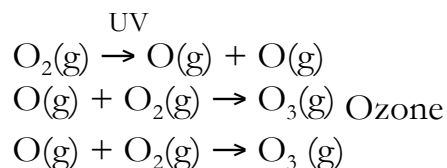


Atmospheric Chemistry and Catalysis

The study of catalysis would not be complete without studying the **catalytic effects of man-made chemical compounds** on the atmosphere, specifically the depletion of the **ozone layer**.

Ozone Layer

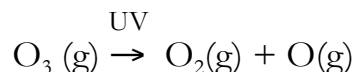
Ozone is produced in the stratosphere (from 16 to 50 km above sea level) by action of sunlight on molecular oxygen:



This thin layer of ozone protects us from **harmful ultra-violet radiation** that contributes to:

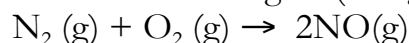
- Skin cancer (1% loss of $\text{O}_3(\text{g})$ = 5% increase in cancer rate)
- Eye cancer
- Genetic mutation
- Species extinction (plankton)

Ozone protects us by decomposing into molecular oxygen and singlet oxygen via ultra-violet radiation absorption:

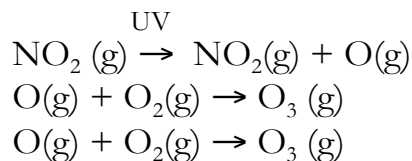
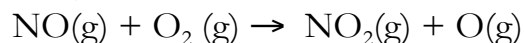


Photochemical Smog

This is a type of pollution occurring in cities due to pollutants emitted from **automobile exhaust**. Here again, UV radiation is used to start a self-catalyzed process. The first step occurs in a car engine (at high T and P):



Then, in the air:



Solutions to this problem include:

- Changing to cleaner burning fuels
- Using a catalytic converter in the exhaust system ($\text{Rh}/\text{Al}_2\text{O}_3$)
- Changing the exhaust to a useful material
- Changing the engine design (introduction of fuel injection)
- Increasing the use of public transportation

Depletion of Ozone by CFC's

Chlorofluorocarbons (CFC's, also known as Freons® or Halons) contributed dramatically to ozone depletion when they were in heavy use.

Some typical CFC's are:

CCl_3F (Freon-11) - used as an aerosol propellant

CCl_2F_2 (Freon-12) - used as a propellant and as a refrigerant

CH_3CCl_3 (Freon-140) - used to clean circuit boards

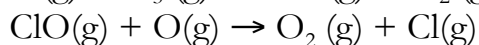
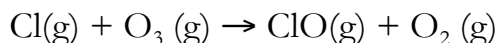
C_2Cl_4 (perchloroethylene) - used as a solvent in dry cleaning

CCl_4 (carbon tetrachloride) - used as a solvent and as a reactant to produce plastics

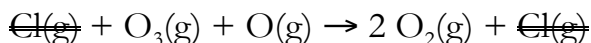
CFC's produce a catalyst that speed up ozone depletion as follows:



Then:



Net:

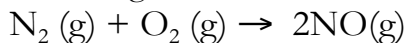


Cl acts as a catalyst, with a single atom catalyzing the disintegration of 10^5 ozone molecules.

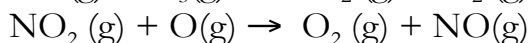
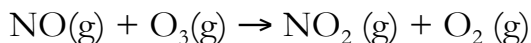
Depletion by Nitrous Oxide (NO)

The **threat to the ozone layer** from vehicles traveling in the stratosphere lead to the cancellation of the U.S.A.'s **SST (supersonic transport) plane** in the 1970's. It is also the major argument against **HST (hypersonic transport) plane** development.

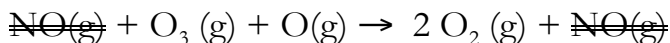
In an engine:



Then, in the stratosphere:



Net:



Therefore, NO(g) acts as a catalyst to destroy ozone!