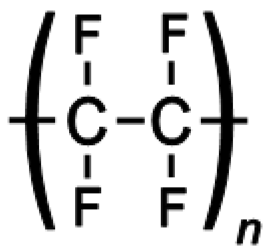
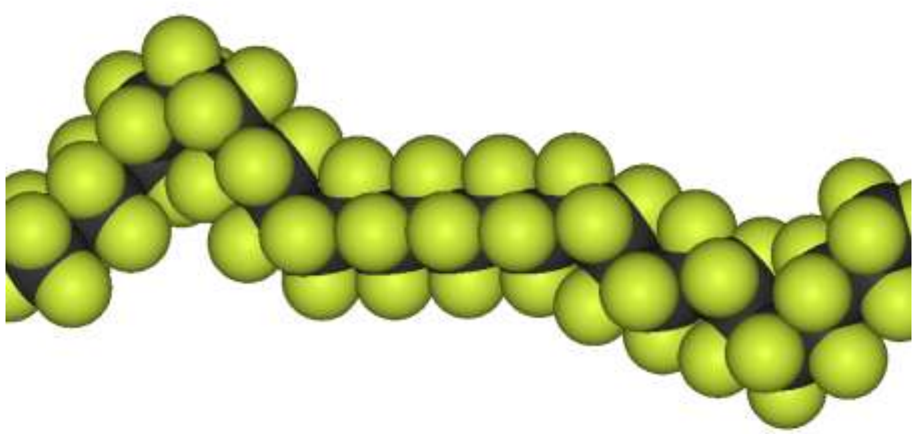
TEFLON (POLYTETRAFLUOROETHENE)



In chemistry, **poly(tetrafluoroethene)** or **poly(tetrafluoroethylene)** (**PTFE**) is a synthetic fluoropolymer which finds numerous applications. PTFE's most well known trademark in the industry is the DuPont brand name **Teflon**.

Tetrafluoroethene (C_2F_4) can be polymerised to a chemically inert, thermosetting plastic PTFE (polytetrafluoroethene); this has an extremely low coefficient of friction and is finding increasing use as a protective coating in non-stick kitchen utensils, razor blades and bearings. PTFE is made by partial fluorination of chloroform using hydrogen fluoride(HF) in the presence of $SbFCl_4$ as catalyst, followed by thermolysis of C_2F_4 and subsequent polymerisation: $\mathbf{CCl_3H \rightarrow CF_2ClH \text{ -(heat)}\rightarrow C_2F_4 \rightarrow (C_2F_4)_n}$



It is very non-reactive, and so is often used in containers and pipe-work for reactive and corrosive chemicals. Where used as a lubricant, PTFE reduces friction, wear and energy consumption of machinery.

FLUORO-CARBONS

These are fluorides or mixed halides of carbon corresponding to different hydrocarbons. Fluorocarbon gained industrial importance owing to certain properties arising from **larger size of halogen atoms** in comparison to hydrogen atoms & the **changed polarities** of the carbon-fluorine bond or carbon-chlorine bond in comparison to carbon-hydrogen bond.

Replacement of C-H bond by a C-F bond releases large amount of energy.

$$\textbf{-C-H + F}_2 \rightarrow \textbf{-C-F + HF ----(1)} \qquad \Delta H = -480 \text{KJ/mole}$$

The C-F bond energy being much higher than C-C bond energy also, uncontrolled fluorination of hydrocarbon would lead to complete decomposition of the carbon skeleton. CF_4, C_2F_2, C_2F_6, C_3F_8 are some important fluorocarbons. Direct action of fluorine on a hydrocarbon is extremely violent and highly exothermic (eqn 1). Controlled fluorination may be achieved by a number of ways.

(i) By dissolving the hydrocarbon in an inert solvent like carbontetrachloride or by diluting the hydrocarbon vapour by nitrogen gas.

(ii) Passing hydrocarbon vapour over cobaltic fluoride at 200°-300°C

$$C_2H_6 + 12CoF_3 = 12CoF_2 + C_2F_6 + 6HF$$

Cobalt(II) fluoride is reconverted into cobalt(III) fluoride in the reactor by treatment with fluorine at 350°C. Trimethylamine (NMe_3) forms trifluorotrimethylamine [$(CF_3)_3N$] on similar treatment.

(iii) Fluorocarbon may be prepared by treating the organic vapour with fluorine-nitrogen mixture in presence of Ag or Au plated copper turnings at 100°C -200°C. The copper acts as a catalyst by formation of intermediate of AgF_2 /AuF_3 on its surface & also acts as a heat transfer agent.

$$C_6H_6 + 9F_2 = C_6F_{12} + 6HF$$

The fluorocarbons have the general formula like hydrocarbons. The fluorocarbons are remarkably chemically inert, does not react with concentrated acids or alkali, dissolves only in non-polar solvent. The inertness is due to:

(i) High C-F bond energy

(ii) Absence of any suitable orbital at "F" or "C" to initiate the hydrolytic attack.

(iii) Due to higher electronegativity of "F" , in C-F bond carbon atom remains in slightly oxidised state. The size of fluorine atom being slightly larger than that of hydrogen atom, Fluorine atoms act as shield to C-skeleton.

Fluorocarbons are used as solvents, lubricants and insulators. Fluorocarbons are likely substitute for Hemoglobine ? as a carrier of dioxygen in blood stream.

CHLORO-FLUOROCARBONS [FREONS](CFC)

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PREPARATIONS:

1. By solvent's Reaction: the mixed CFC is prepared by treating organic chloro compound with antimony trifluoride (SbF_3) in presence of antimony pentafluoride (SbF_5) as catalyst. Anhydrous hydrogen fluoride with antimony pentafluoride (SbF_5) can also be used.

$$CCl_4 + SbF_5 = CF_2Cl_2 + SbCl_2F_3$$

$$2CCl_4 + 3HF = CCl_2F_2 + CCl_3F + 3HCl$$

2. Freons are also produced by the following reaction:

$$CCl_4 + 2HF = (\text{Anh. } SbCl_5) = CCl_2F_2 + 2HCl$$

Under this conditions carbon tetrachloride gives a mixture of CCl_3F, CCl_2F_2 and CF_4 . THE MIXED CHLOROFLUOROCARBONS ARE COLLECTIVELY KNOWN AS FREONS. Difluorodichloromethane (CF_2Cl_2) however often goes by the name of Freon. Freons are colourless, non-toxic, non-inflamable gases. They are non-corrosive & do not attack metals at ordinary temperature. ***They easily liquefy under pressure and the liquid absorbs the large amount of heat on evaporation. Freons are widely used as non-toxic refrigerant fluid and in aerosol propellents.***

The use of freons are discouraged as they can penetrate the upper atmosphere and destroy ozone layer.

EFFECT OF FREONS ON OZONE LAYER

It has been definitely established that freons cause damage to the ozone in the upper atmosphere and hence its use has been banned totally or partially in many countries. Freons escaping in to the upper atmosphere undergo photolysis to produce free radicals, particularly **Cl•** which continue to damage the ozone layer in a cyclic manner.

$$CFCl_3 \xrightarrow{h\nu} Cl\bullet + \bullet CFCl_2$$
$$CF_2Cl_2 \xrightarrow{h\nu} Cl\bullet + \bullet CF_2Cl$$
$$Cl\bullet + O_3 \rightarrow O_2 + OCl\bullet$$
$$OCl\bullet \rightarrow Cl\bullet + O$$
$$OCl\bullet + O \rightarrow O_2 + Cl\bullet$$

The regeneration of Cl• radical continues to damage the ozone layer. Recombination of the type $Cl\bullet + Cl\bullet \rightarrow Cl_2$ would require the presence of a 3^{rd} body., but such 3^{rd} body collisions are extremely rare in the upper atmosphere. Hence small amount of Freon can continue to destroy the ozone layer which acts as an umbrella to save the earth from harmful UV-radiation.