NARAYANA
IIT ACADEMY
INDIA

40 YEARS OF EXCELLENCE

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Name of the student:: **I.D.No:** **Sec:**

COMPOUNDS OF XENON :

XENON DIFLUORIDE (XeF_2):

PREPARATION:

(i) $Xe + F_2 \xrightarrow[\text{Ni–Tube or monel metal (alloy of Ni)}]{873\text{K}, 1\text{bar}} XeF_2$

❍ Volume ratio should be 2 : 1 otherwise other higher fluorides tend to form.

(ii) $Xe + O_2F_2 \xrightarrow{118°C} XeF_2 + O_2$

(iii) $Xe + F_2 \xrightarrow{Hg(arc)} XeF_2$

(iv) Recently discovered method :

$K^+[AgF_4]^-$ [potassium tetrafluoroargentate (III)] is first prepared and this is reacted with BF_3 .

$K^+[AgF_4]^- \xrightarrow{BF_3} AgF_3$ (red solid) + KBF_4

$2\,AgF_3 + Xe \longrightarrow 2\,AgF_2$ (Brown solid) + XeF_2

PROPERTIES :

(i) Colorless crystalline solid and sublimes at 298 K.

(ii) Dissolves in water to give a solution with a pungent odour. Much soluble in HF liquid.

(iii) This is stored in a vessel made up of monel metal which is a alloy of nickel.

(iv) **Reaction with H_2 :** It reacts with hydrogen gas at 400°C

$XeF_2 + H_2 \longrightarrow Xe + 2HF$

(v) **Hydrolysis :**

(a) $2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2$ (slow)

The above is neither a cationic hydrolysis nor an anionic hydrolysis as seen in ionic equilibrium. It is a covalent compound and hydrolysis is like that of PCl_5 .

(b) Hydrolysis is more rapid with alkali.

$XeF_2 + 2\,NaOH \longrightarrow Xe + \frac{1}{2}O_2 + 2NaF + H_2O$ (fast)

The reaction (a) is slower probably due to dissolution of XeF_2 in HF.

(vi) Oxidising properties :

Higher the value of SRP better is the oxidising property of the species.

The standard reduction potential for XeF_2 is measured to be + 2.64 V. Therfore it acts as a strong oxidising agent.

$2e^- + 2H^+ + XeF_2 \longrightarrow Xe + 2HF$; SRP = + 2.64 V

This oxidises halides (except F^-) to their respective halogens.

$XeF_2 + 2\,HCl \longrightarrow Xe + 2\,HF + Cl_2$

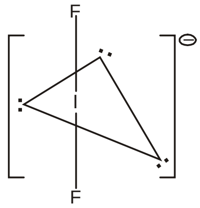
It oxidises $2Br^- \longrightarrow Br_2 + 2e^-$ & $2I^- \longrightarrow I_2 + 2e^-$

❍ Similarly it can oxidise BrO_3^- (bromate) which are themselves good oxidising agents to BrO_4^- (perbromate ions) and Ce^{+3} to Ce^{+4} ion.

(vii) **Oxidising as well as fluorinating properties :** It can act as strong oxidising agent as well as fluorinating agent.

$$C_6H_5I + XeF_2 \longrightarrow C_6H_5IF_2 + Xe \; ; \qquad CH_3I + XeF_2 \longrightarrow CH_3IF_2 + Xe$$

- CH_3IF_2 exists as $CH_3^+ IF_2^-$, IF_2^- is analogous to I_3^-



hybridisation = sp^3d

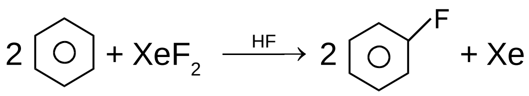
- F_3^- can not be formed as it has no d-orbitals to attain sp^3d hybridisation.

(viii) **Reactions of XeF_2 + HF (anhydrous) :**

$Pt + 3XeF_2 \xrightarrow{HF} PtF_6 + 3Xe$; $\qquad S_8 + 24\,XeF_2 \longrightarrow 8SF_6 + 24\,Xe$

$2CrF_2 + XeF_2 \longrightarrow 2CrF_3 + Xe$; $\quad 2MoO_3 + 6XeF_2 \longrightarrow 2MoF_6 + 6Xe + 3O_2$

$Mo(CO)_6 + 3\,XeF_2 \longrightarrow MoF_6 + 3\,Xe + 6CO$



$$8\,NH_3 + 3\,XeF_2 \longrightarrow N_2 + 6\,NH_4F + 3\,Xe$$

$$2NO_2 + XeF_2 \longrightarrow 2\,NO_2F + Xe$$

(nitronium fluoride)

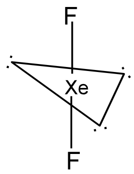
(ix) **Formation of addition compounds :** XeF_2 reacts with fluoride ion acceptors to form cataionic species and fluoride ion donors to form fluoroanions.

$$XeF_2 + PF_5 \longrightarrow [XeF]^+ [PF_6]^-$$

IF_5 (lewis acid) + $XeF_2 \longrightarrow [XeF]^+ [IF_6]^-$; $2SbF_5$ (lewis acid) + $XeF_2 \longrightarrow [XeF]^+ [SbF_6]^-$

- Similar behaviour is shown by PF_5 and AsF_5

Structure : Shape linear and geometry trigonal bipyramidal.



hybridisation = sp^3d

XENON TETRAFLUORIDE (XeF_4) :

PREPARATION :

$$\underset{1}{Xe} \;+\; \underset{5}{2F_2} \;:\; \xrightarrow[\text{7 bar, Ni–tube}]{873K,} XeF_4$$

PROPERTIES :

(i) It is a colorless crystalline solid and sublimes at 298 K.

(ii) It undergoes sublimation, soluble in CF_3COOH. It undergoes hydrolysis violently hence no moisture must be present during it's preparation.

(iii) **Reaction with H_2O :** $6\ XeF_4 + 12\ H_2O \longrightarrow 4\ Xe + 2XeO_3 + 24\ HF + 3O_2$

- XeO_3 is white solid and explosive compound (dry), soluble in water (well behaved in water)
- XeO_3 reacts with NaOH forming sodium xenate

  $XeO_3 + NaOH \longrightarrow Na^+ [HXeO_4]^-$ (sodium xenate)
- It disproportionates into perxenate ion in basic medium.

  $2\ [HXeO_4]^- + 2OH^- \longrightarrow [XeO_6]^{4-} + Xe + O_2 + 2H_2O$

  Xenic acid (H_2XeO_4) is a very weak acid.

  (i) $[XeO]_6^{4-} \xrightarrow[\text{water}]{H^+} XeO_3 + O_2$ (ii) $[XeO_6]^{4-} + Mn^{+2} \longrightarrow MnO_4^- + XeO_3$

  (slow decomposition)

  $[XeO_6]^{4-}$ is obtainable as $Na_4XeO_6 \cdot 8H_2O$ (sodium perxenate)

(iv) **Oxidising properties of XeF_4 :**

$XeF_4 + 2\ H_2 \longrightarrow Xe + 4\ HF$; $XeF_4 + 2\ Hg \longrightarrow Xe + 2HgF_2$

(v) **Addition reactions :** XeF_4 reacts with fluoride ion acceptors to form cataionic species and fluoride ion donors to form fluoroanions.

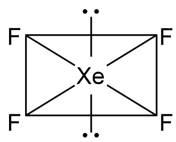
$XeF_4 + SbF_5 \longrightarrow [XeF_3]^+ [SbF_6]^-$

(vi) **Fluorinating agent :**

$XeF_4 + Pt \longrightarrow PtF_4 + Xe$; $XeF_4 + 4NO \longrightarrow Xe + 4NOF$ (nitrosyl Fluoride)

$XeF_4 + 4\ NO_2 \longrightarrow Xe + 4\ NO_2F$ (nitronium fluoride) ; $XeF_4 + 2C_6H_6 \longrightarrow C_6H_5F + 2HF + Xe$

Structure : Shape square planar & geometry octahedral



hybridisation = sp^3d^2

XENON HEXAFLUORIDE (XeF_6) :

PREPARATION:

(i) $\underset{1\ :\ 20}{Xe + 3F_2} \xrightarrow[\text{Ni–tube}]{573K,\ 60–70\ bar} XeF_6$ **(ii)** $XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$

PROPERTIES:

(i) Colourless crystalline solid and sublimes at 298 K.

(ii) It gives yellow liquid on melting where as other form white liquids on melting (a point of difference)

(iii) HF is a good solvent for all three fluorides.

(iv) **Hydrolysis :**

(a) Complete hydrolysis : $XeF_6 + 3H_2O \longrightarrow XeO_3$ (white solid) + 2HF

(b) Partial hydrolysis : $XeF_6 + H_2O \longrightarrow XeOF_4$ (colorless solid) + 2HF

(v) **Reaction with silica (SiO_2) :**

$2XeF_6 + SiO_2 \longrightarrow 2XeOF_4 + SiF_4$

(vi) **Thermal decomposition (effect of heat) :**

$$2XeF_6 \xrightarrow{\Delta} XeF_2 + XeF_4 + 3\,F_2$$

- XeF_2 & XeF_4 do not undergo decomposition

(vii) Formation of addition compounds :

$$XeF_6 + SbF_5 \longrightarrow [XeF_5]^+ [SbF_6]^- ; \qquad XeF_6 + BF_3 \longrightarrow [XeF_5]^+ [BF_4]^-$$

(viii) Reaction With H_2 :

$$XeF_6 + 3H_2 \longrightarrow 6HF + Xe$$

(ix) Reaction of XeF_6 with XeO_3 :

$$XeO_3 + 2\,XeF_6 \longrightarrow 3\,XeOF_4$$

(x) F^- donating/ F^- accepting properties : XeF_6 reacts with fluoride ion acceptors to form cataionic species and fluoride ion donors to form fluoroanions.

$XeF_6 + MF \longrightarrow M^+ [XeF_7]^-$ (M = Na, K, Rb or Cs)

donation { $XeF_6 + PtF_5 \longrightarrow [XeF_5]^+ [PtF_6]^-$

acceptance {
CsF (alkali metal fluoride) $+ XeF_6 \longrightarrow CsXeF_7$ (caesium heptafluoroxenate)
$2CsXeF_7 \longrightarrow XeF_6 + Cs_2XeF_8$ (caesium octafluoroxenate)

- **Order of oxidising power :** $XeF_2 > XeF_4 > XeF_6$

XENON–OXYGEN COMPOUNDS :

Hydrolysis of XeF_4 and XeF_6 with water gives XeO_3.

$6\,XeF_4 + 12\,H_2O \longrightarrow 4\,Xe + 2\,XeO_3 + 24\,HF + 3\,O_2$

$XeF_6 + 3\,H_2O \longrightarrow XeO_3 + 6\,HF$

Partial hydrolysis of XeF_6 gives oxyfluorides, $XeOF_4$ and XeO_2F_2 .

$XeF_6 + H_2O \longrightarrow XeOF_4 + 2\,HF$

$XeF_6 + 2\,H_2O \longrightarrow XeO_2F_2 + 4\,HF$

XeO_3 is a colourless explosive solid and has a pyramidal molecular structure. $XeOF_4$ is a colourless volatile liquid and has a square pyramidal molecular structure.

USES :

Helium is a non–inflammable and light gas. Hence, it is used in filling ballons for meterological observations. It is also used in gas–cooled nuclear reactors. Liquid helium (b.p.4.2 K) finds use as cryogenic agent for carrying out various experiments at low temperatures. It is used to produce and sustain powerful superconducting magnets which form an essential part of modern NMR spectrometers and Magnetic Resonance Imaging (MRI) systems for clinical diagnosis. It is used as a diluent for oxygen in modern diving apparatus because of its very low solubility in blood.

Neon is used in discharge tubes and fluorescent bulbs for advertisement display purposes. Neon bulbs are used in botanical gardens and in green houses.

Argon is used mainly to provide an inert atmosphere in high temperature metallurgical process (arc welding of metals or alloys) and for filling electric bulbs. It is also used in the laboratory for handing substances that are air–sensitive.

Xenon and Krypton are used in light bulbs designed for special purposes.