INTERHALOGEN COMPOUNDS

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INTERHALOGEN COMPOUND

An interhalogen compound is a molecule which contains two or more different halogen atoms (**fluorine**, **chlorine**, **bromine**, iodine, or astatine) and no atoms of **elements** from any other group. Most interhalogen compounds known are binary (composed of only two distinct **elements**)

The common interhalogen compounds include Chlorine monofluoride, bromine trifluoride, iodine pentafluoride, iodine heptafluoride, etc

Interhalogen compounds into four types, depending on the number of atoms in the particle. They are as follows:

XY

XY_3

XY_5

XY_7

X is the bigger (or) less electronegative halogen.

Y represents the smaller (or) more electronegative halogen.

XY	XY_3	XY_5	XY_7
ClF(g)[a]	ClF_3(g)	ClF_5(g)	
BrF(g)	BrF_3(l)	BrF_5(l)	
BrCl(g)			
ICl(s)	ICl_3(s)	IF_5(l)	IF_7(g)
IBr(s)			

All are of the type XX'_n where **n = odd nos. X' is always the lighter halogen** since the smaller halogen X' are bonded around the larger X. As the ratio of the radius of X to that of X' increases, n also increases.

Compound	ClF	BrF	BrCl	ICl	IBr	ClF_3	BrF_3	IF_3	I_2Cl_6	ClF_5	BrF_5	IF_5	IF_7
Appearance at 298K	Colorless gas	Pale brown gas	impure	Red solid	Black solid	Colorless gas	Yellow liquid	Yellow solid	Orange solid	Colorless gas	Colorless liquid	Colorless liquid	Colorless gas
Stereochemistry	linear	linear	linear	linear	linear	T-shaped	T-shaped	T-shaped	planar	square-based pyramid	square-based pyramid	square-based pyramid	pentagonal bipyramid
Melting point /K	117	~240	dissoc.	300(a)	313	197	282	245 (dec)	337 (sub)	170	212.5	282.5	278 (sub)
Boiling point /K	173	~293	~278	~373	389	285	399	-	-	260	314	373	-
$\Delta fH°(298\ K)$ /kJ mol^{-1}	-50.3	-58.5	14.6	-23.8	-10.5	-163.2	-300.8	~-500	-89.3	-255	-458.6	-864.8	-962
Dipole moment for gas-phase molecule /D	0.89	1.42	0.52	1.24	0.73	0.6	1.19	-	0	-	1.51	2.18	0
Bond distances in gas-phase molecules except for IF_3 and I_2Cl_6 / pm	163	176	214	232	248.5	160 (eq), 170 (ax)	172 (eq), 181 (ax)	187 (eq), 198 (ax)	238 (terminal) 268 (bridge)	172 (basal), 162 (apical)	178 (basal), 168 (apical)	187 (basal), 185 (apical)	186 (eq), 179 (ax)

Properties of Interhalogen Compounds

•We can find Interhalogen compounds in vapour, solid or fluid state.

• A lot of these compounds are unstable solids or fluids at 298K. A few other compounds are gases as well. As an example, chlorine monofluoride is a gas. On the other hand, bromine trifluoride and iodine trifluoride are solid and liquid respectively.

•These compounds are covalent in nature.

•These interhalogen compounds are diamagnetic in nature. This is because they have bond pairs and lone pairs.

•Interhalogen compounds are very reactive. One exception to this is fluorine. This is because the A-X bond in interhalogens is much weaker than the X-X bond in halogens, except for the F-F bond.

•We can use the VSEPR theory to explain the unique structure of these interhalogens. In chlorine trifluoride, the central atom is that of chlorine. It has seven electrons in its outermost valence shell. Three of these electrons form three bond pairs with three fluorine molecules leaving four electrons.

PREPARATION

We can manufacture these interhalogen compounds by **two main methods.**

One of them includes **the direct mixing of halogens** and the other includes a **reaction of halogens with the lower Interhalogen compounds**.

The halogen atoms react to form an interhalogen compound. One example includes the reaction when a volume of chlorine reacts with an equal volume of fluorine at 473K. The resultant product is chlorine monofluoride.

In other cases, a halogen atom acts with another lower interhalogen to form an interhalogen compound. For example, fluorine reacts with iodine pentafluoride at 543K. This gives rise to the compound of Iodine Heptafluoride.

$Cl_2 + F_2 \xrightarrow{437\,K} 2ClF$;
(equal volume)

$Cl_2 + 3F_2 \xrightarrow{573\,K} 2ClF_3$;
(excess)

$I_2 + Cl_2 \rightarrow 2ICl$;
(equimolar)

$I_2 + 3Cl_2 \rightarrow 2ICl_3$
(excess)

$Br_2 + 3F_2 \rightarrow 2BrF_3$
(diluted with water)

$Br_2 + 5F_2 \rightarrow 2BrF_5$
(excess)

Iodine mono chloride ICl

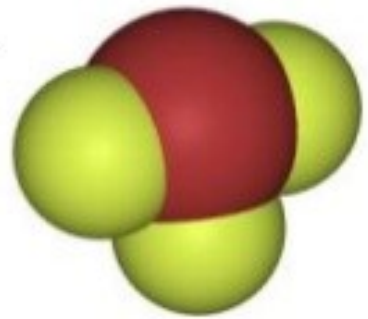
is formed by passing chlorine over solid iodine at temperature below 0 ^{0}C.

$$I_2 + Cl_2 \longrightarrow 2ICl$$

- It is a red-brown chemical compound
- Because of the difference in the electronegativity of iodine and chlorine, **ICl** is highly polar ; $I^{+}Cl^{-}$

Bromine trifluoride… BrF_3

- It is obtained by mixing bromine vapor and fluorine in a stream of nitrogen at 20°C.



$$Br_2 + 3F_2 \longrightarrow 2BrF_3$$

It is a straw-colored liquid with a pungent odor.

It is a powerful fluorinating agent

It is used to produce uranium hexafluoride (UF_6) in the processing and reprocessing of nuclear fuel.

Bromo pentafluoride … BrF_5

It is pale yellow liquid

By the direct reaction of bromine with excess fluorine at temp. over 150°C

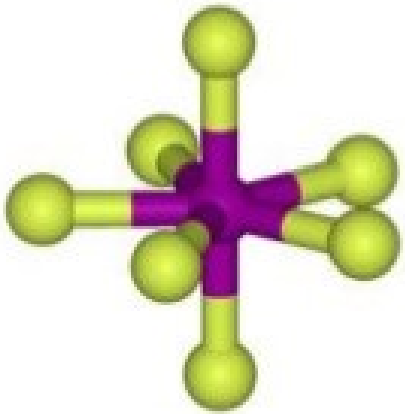
$$Br_2 + 5\ F_2 \rightarrow 2\ BrF_5$$

It is an extremely effective fluorinating agent, converting most uranium compounds to the hexafluoride at room temperature like BrF_3 .

Iodine heptafluoride....IF_7

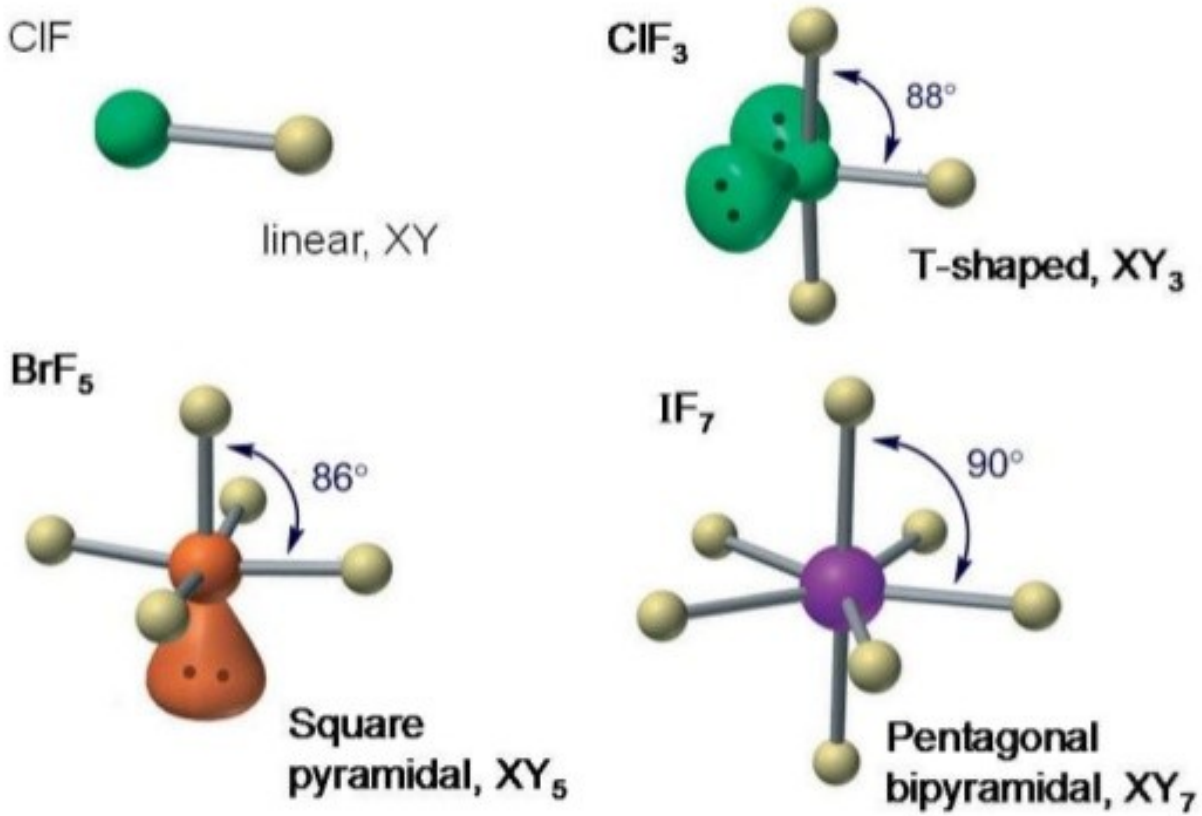
- It is a colorless gas
- It is prepared by passing a mixture of iodine pentafluoride vapors and fluorine through a platinum tube at 300 ^{0}C.

$$IF_5 + F_2 \longrightarrow IF_7$$



- It is a strong oxidizing agent
- Used to prepare periodic acid.

Shapes of interhalogens



Uses of Interhalogen Compounds

- We use interhalogen compounds as non-watery solvents.

- Also, we use these compounds as a catalyst in a number of reactions.

- We use UF_6 in the enrichment of ^{235}U. We can produce this by using ClF_3 and BrF_3.

$$U(s) + 3ClF_3(l) \rightarrow UF_6(g) + 3ClF(g)$$

- We use these compounds as fluorinating compounds.