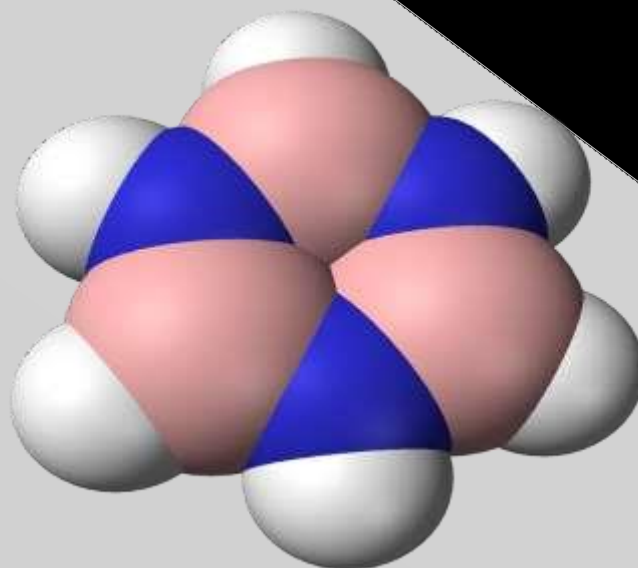


# BORAZINE



Presented by-  
Dr. Neelam Sharma

# Borazine or Borazole, $(\text{BH})_3(\text{NH})_3$ or $\text{B}_3\text{N}_3\text{H}_6$

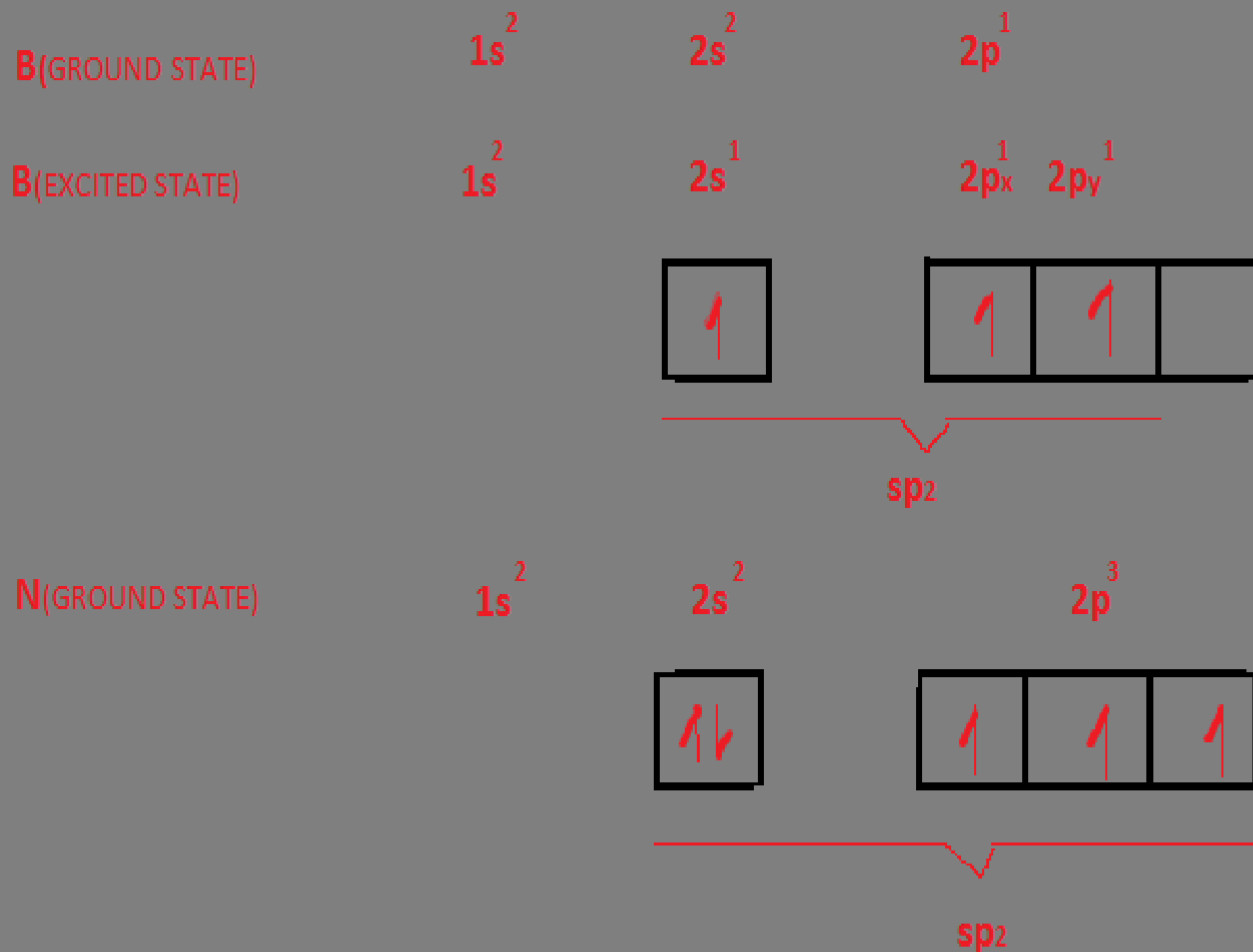


- **Isoelectronic with benzene and hence as been called **INORGANIC BENZENE** by *Weberg***

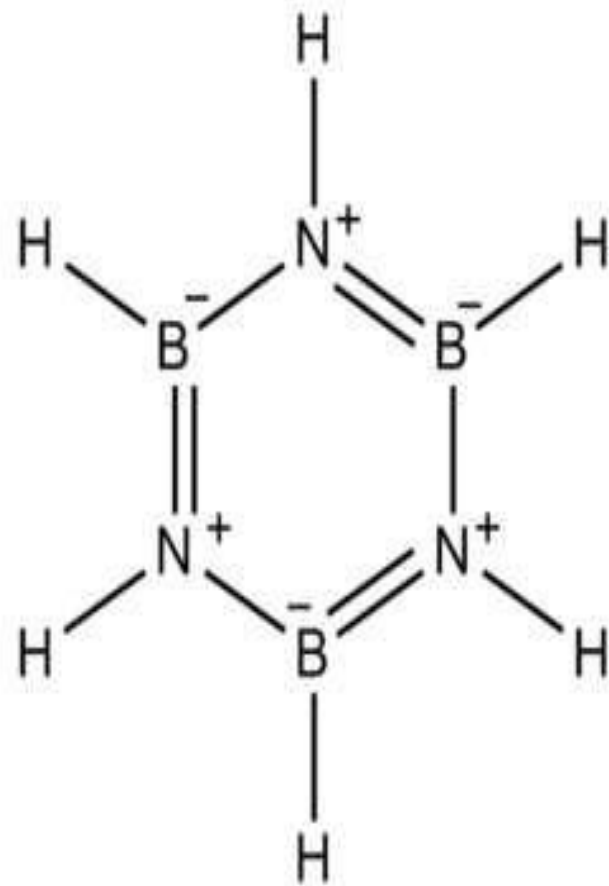
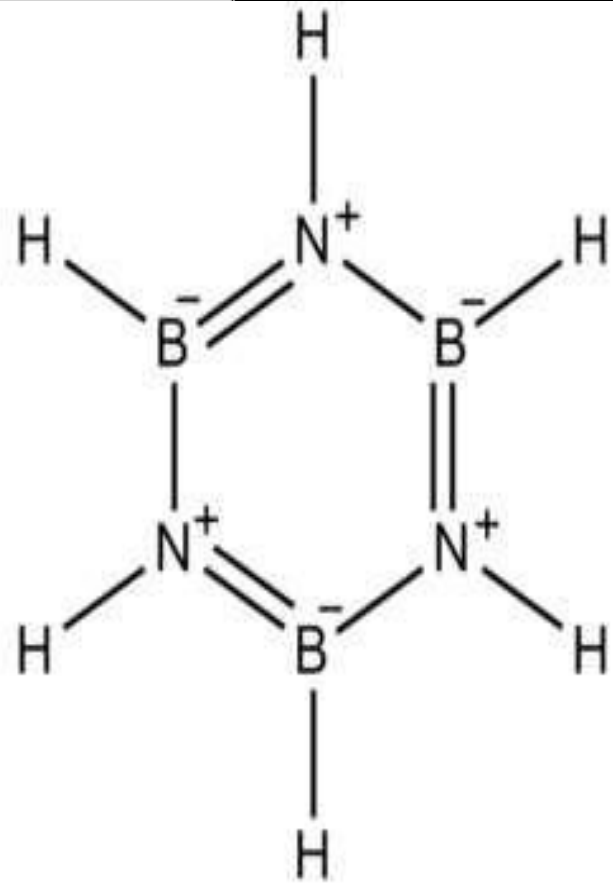
# Structure of Borazine

- In Borazine both Boron and Nitrogen are  $sp^2$  hybridised
- Each N-atom has one lone pair of electrons ,while each B-atom has an empty p-orbital.
- (B-N)  $\pi$ -bond in borazine is a Dative bond ,which arises from the sidewise overlap between the filled p-orbitals of N-atom and empty p-orbitals of B-atom.

# Structure of Borazine



- Since borazine is isoelectronic with benzene, both the compounds have aromatic  $\pi$ -electron cloud.
- Due to greater difference in electronegativity values of B and N-atoms, the  $\pi$ -electron cloud in B<sub>3</sub>N<sub>3</sub> ring of borazine molecule is partially delocalised (since N- $\pi$  orbitals are of lower energy than the B- $\pi$  orbitals)
- while in case of benzene ring, the  $\pi$ -electron cloud is completely delocalised.



- M.O calculations have indicated that  $\pi$ -electron drift from N to B is less than the  $\pi$ -electron drift from B to N ,due to greater electronegativity of N-atom.
- In benzene molecule ,C=C bonds are nonpolar ,while in case of B<sub>3</sub>N<sub>3</sub>H<sub>6</sub> ,due to the difference in electronegativities between B and N atom ,B-N bond is polar.
- It is due to the partial delocalisation of  $\pi$ -electron cloud that  $\pi$ -bonding in B<sub>3</sub>N<sub>3</sub> ring is weakend.

- N-atom retains some of its basicity and B-atoms retains some of its acidity.
- Polar species like HCl, therefore, attack the double bond between N and B. i.e why borazine in contrast to benzene, readily undergoes addition reaction.
- In borazine B-N bond length is equal to  $1.44 \text{ \AA}$ , which is between calculated single B-N bond ( $1.54 \text{ \AA}$ )
- B=N bond length is  $1.36 \text{ \AA}$
- The angles are equal to  $120^\circ$
- In benzene C-C bond length is  $1.42 \text{ \AA}$



# Physical properties

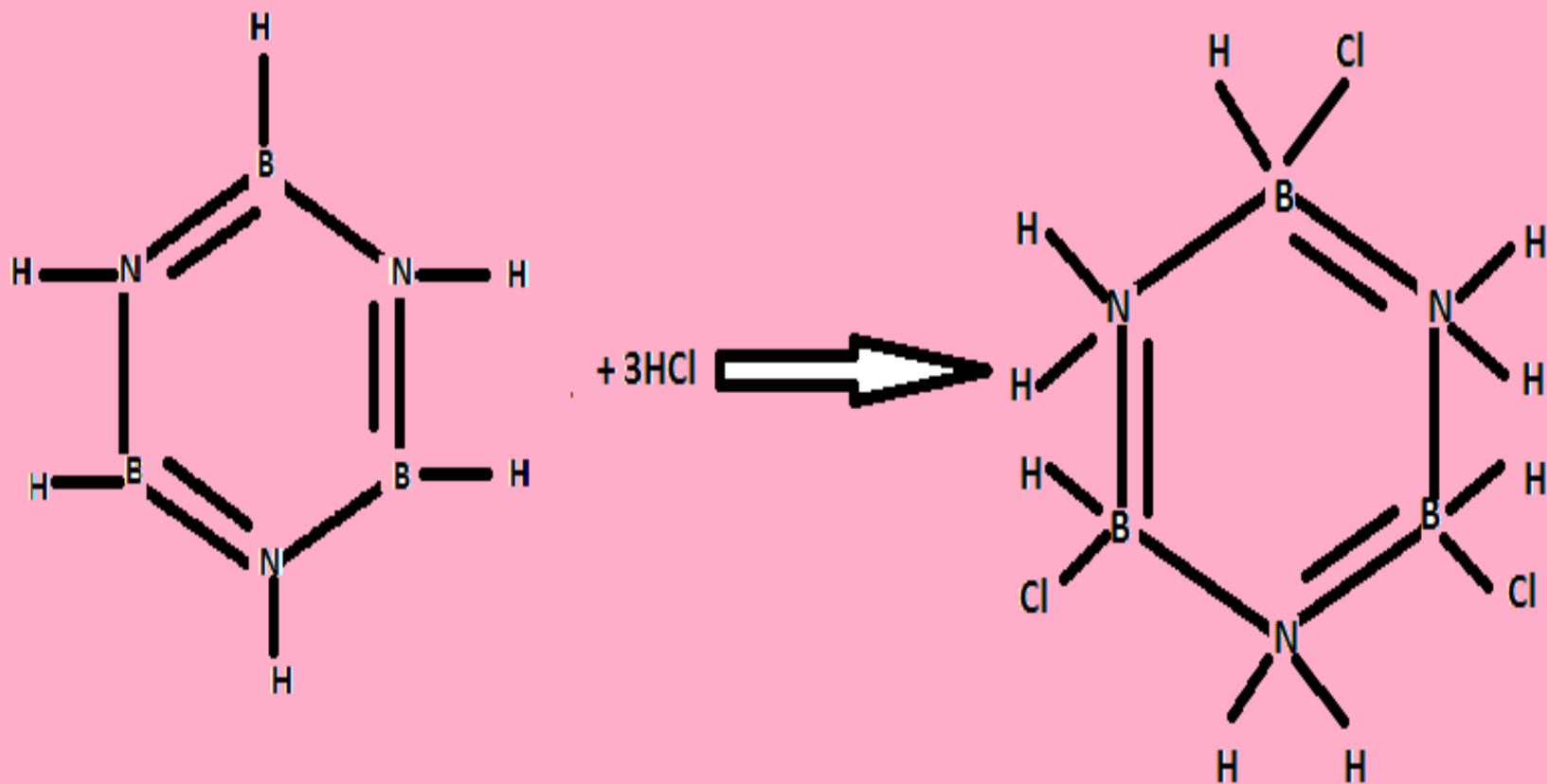
- **Colourless**
- **Volatile liquid**
- **Boiling point : 64.5°C**
- **Melting point : -58°C**
- **Decomposes at -80° C**
- **Molecular weight : 78 g**

# Chemical properties

## 1. Addition reactions

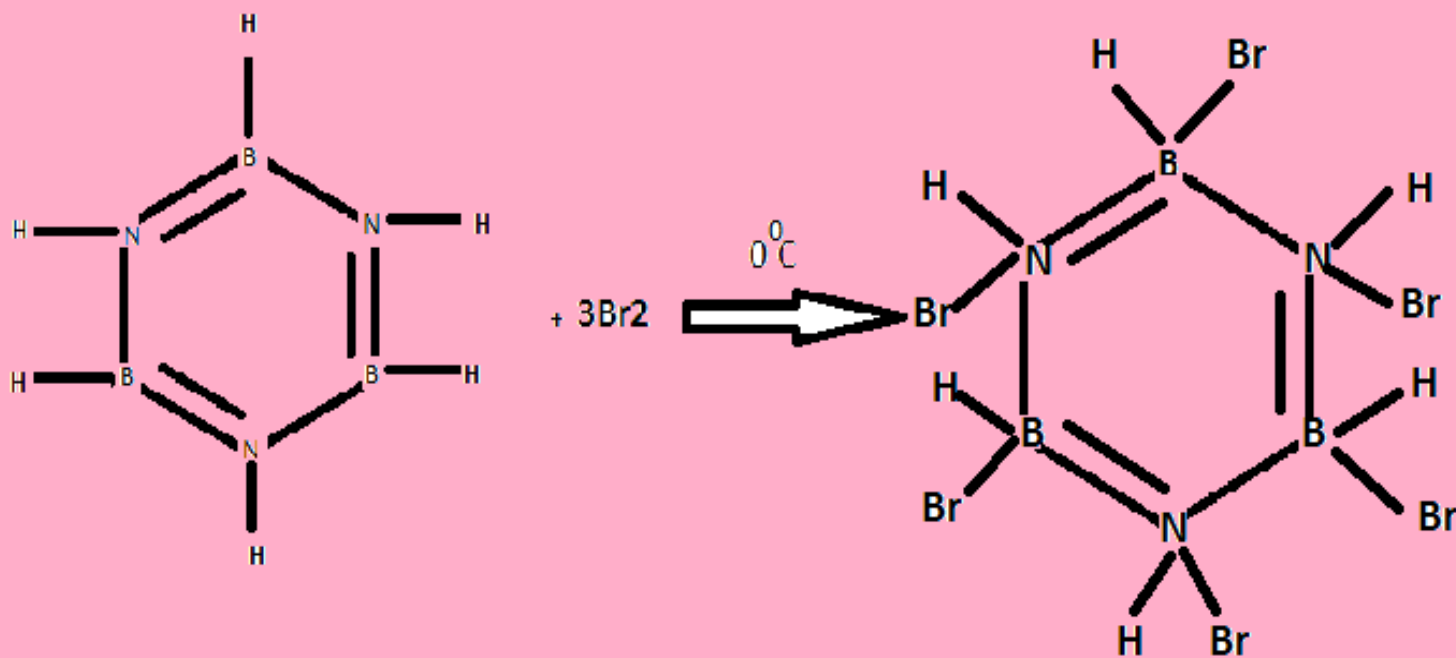
One molecule of BORAZINE adds 3 molecules of HCl or HBr in the cold without a catalyst. These molecules get attached with all the three B atoms of borazine, since B atom is more negative than N atom in B-N or B=N bond and hydrogen chloride derivative is obtained. This addition reaction is not shown by benzene.

# 1. Addition reactions



**Hydrogen chloride derivative**

□ **B. One molecule of borazine adds to 3 molecules of Br<sub>2</sub> at 0 °C and gives B-tribromo-N-tribromoborazine**

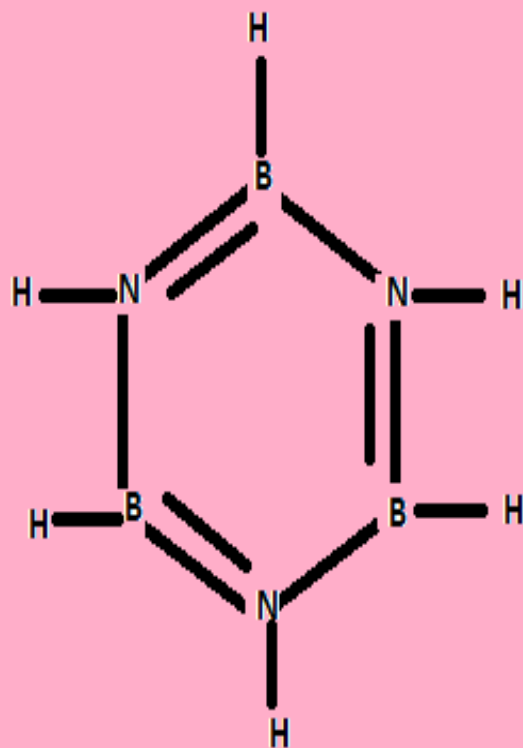


**B-tribromo-N-tribromoborazine**

## 2. Hydrolysis

- **Borazine gets slowly hydrolysed by water to produce boric acid , ammonia and Hydrogen. Hydrolysis is favoured by the increase in temperature**

## 2. Hydrolysis



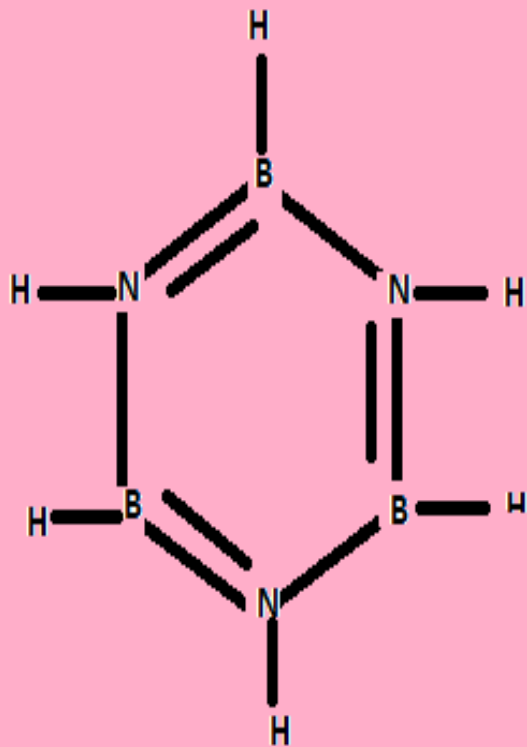
**BORAZINE**



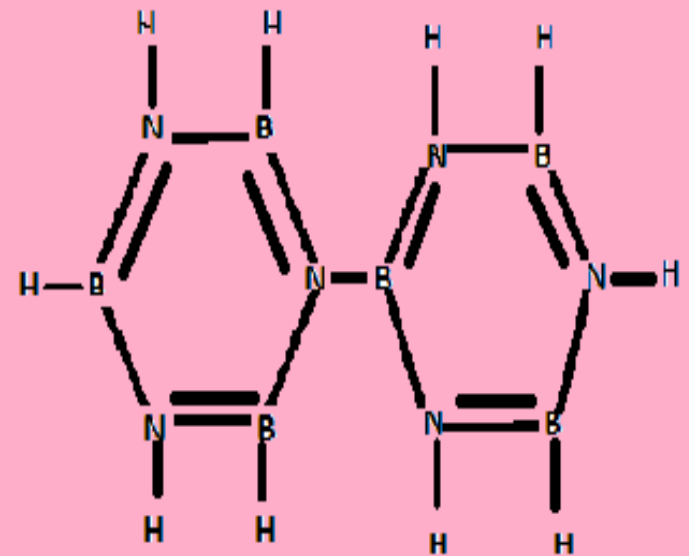
### 3. Pyrolysis

- **When borazine is pyrolysed above 340 °C, B<sub>6</sub>N<sub>6</sub>H<sub>10</sub> and B<sub>5</sub>N<sub>5</sub>H<sub>8</sub> are produced. These products are boron-nitrogen analogues of diphenyl and naphthalene respectively**

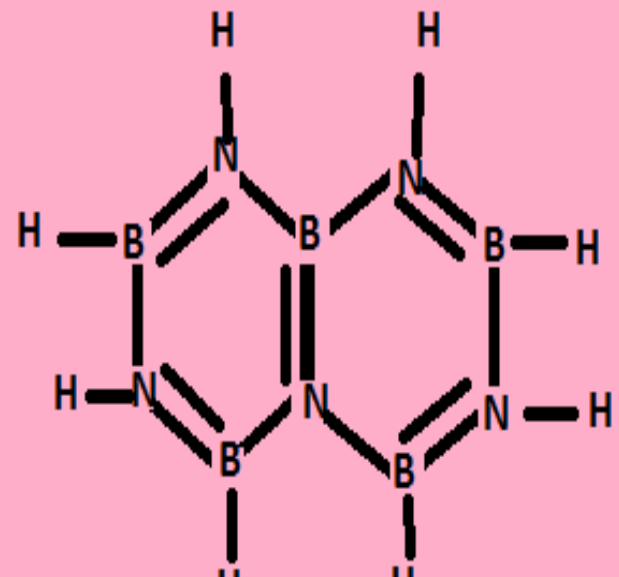
# 3. Pyrolysis



pyrolysis



+

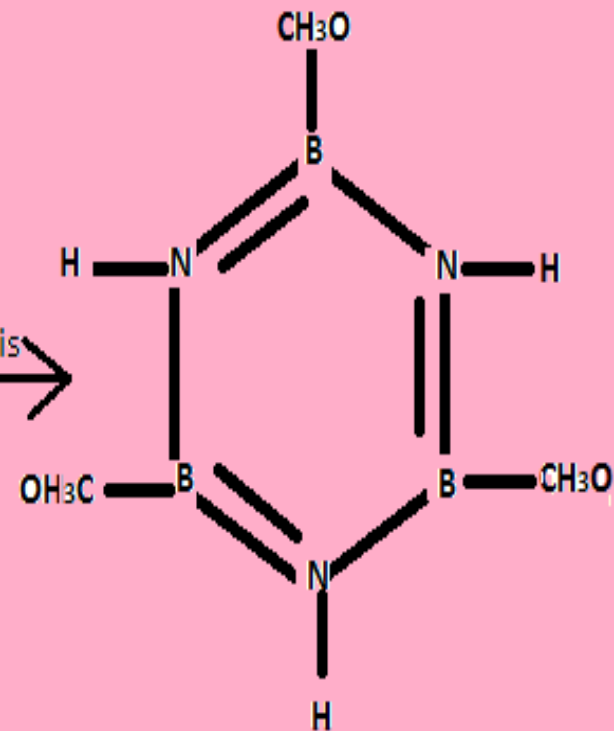
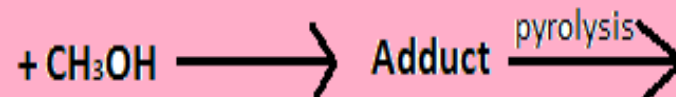
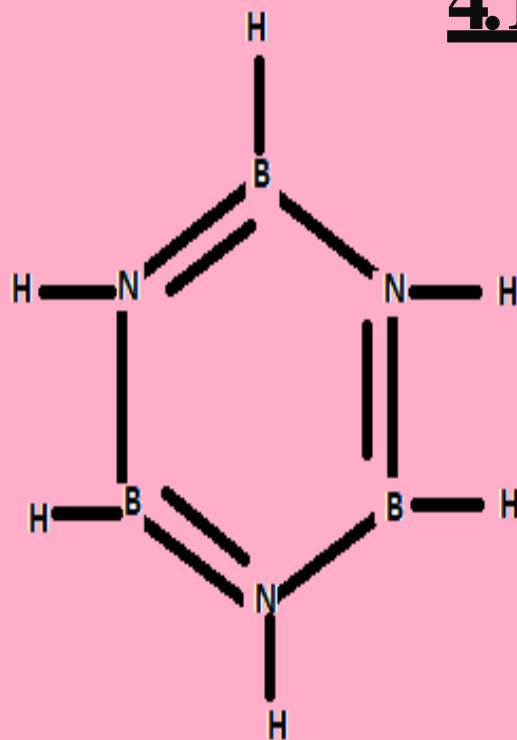




## 4. Formation of adduct

- Borazine forms an adduct with  $\text{CH}_3\text{OH}$ . This adduct undergoes pyrolysis with the elimination of  $\text{H}_2$  and gives B-trimethoxy-borazine.

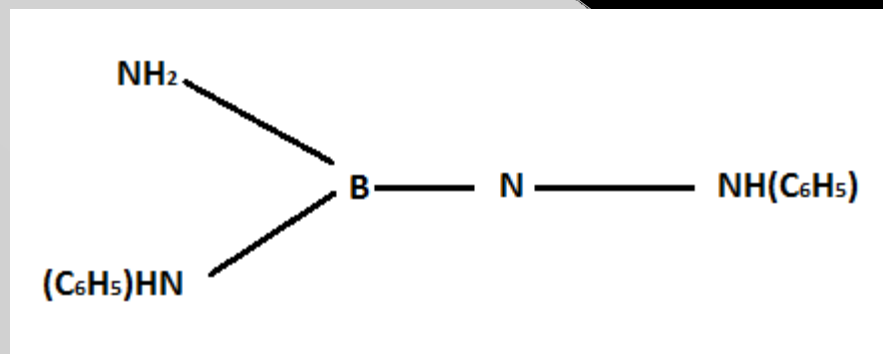
## 4. Formation of adduct



**B- trimethoxy-borazine**

## 5. Reaction with Aniline

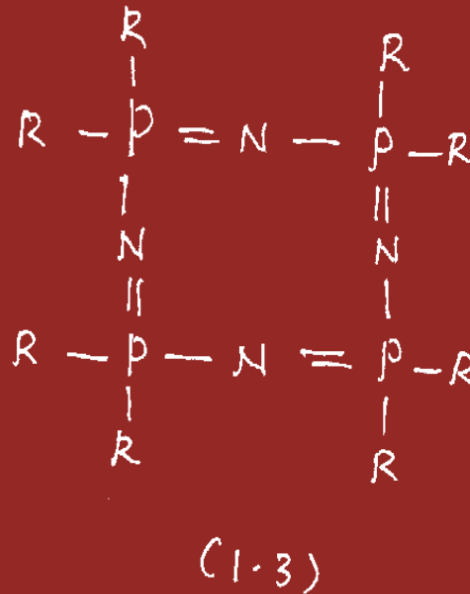
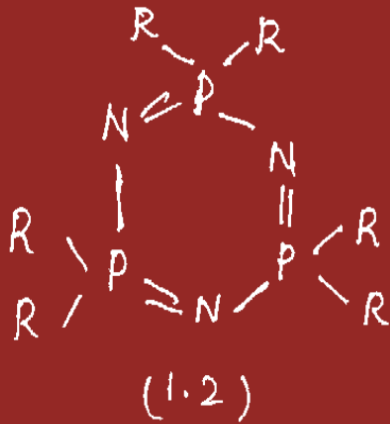
- Borazine undergoes a strongly exothermic reaction with Aniline to produce tri-aminoborine



# PHOSPHAZINE

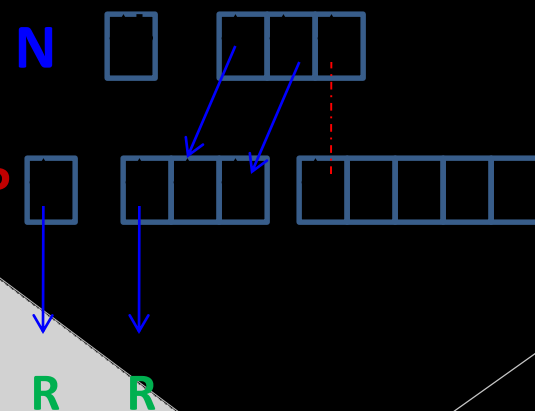
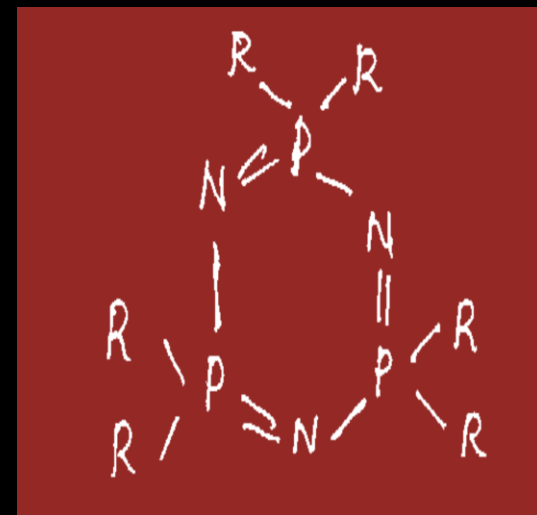
# Phosphazenes - Phosphonitrilic compounds

The Phosphazenes are cyclic or chain compounds that contain alternating phosphorus and nitrogen atoms with two substituents on each phosphorus atom. The three main structural types are cyclic trimer (Fig 1.2), cyclic tetramer (Fig 1.3) and the oligomer or high polymer (Fig 1.4). A few cyclic pentamers and hexamers are also known.



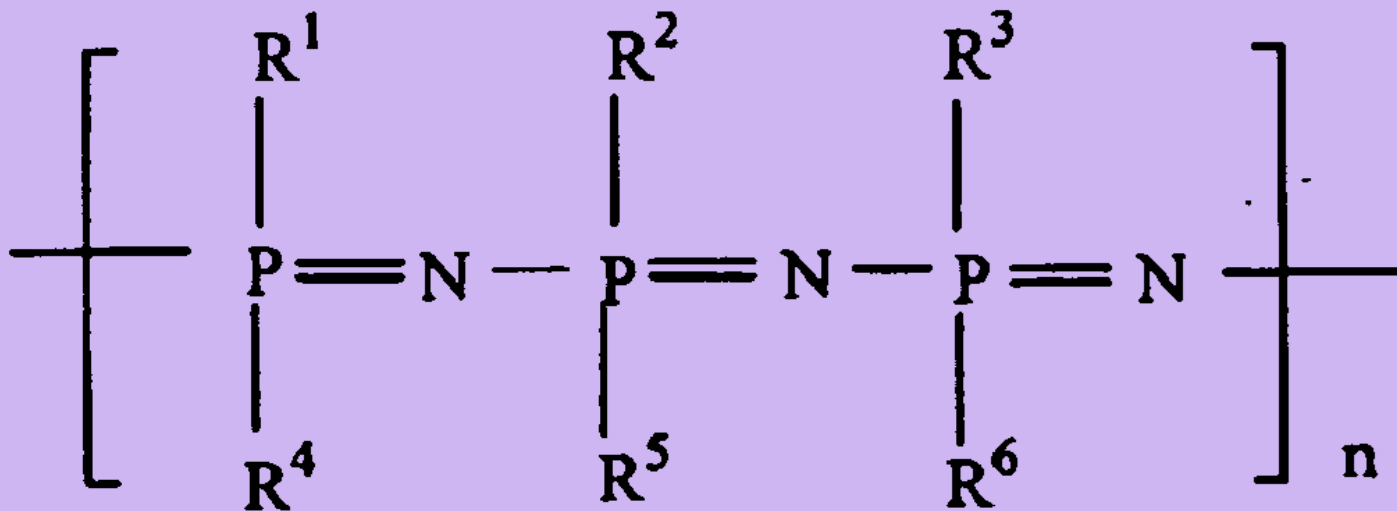
# STRUCTURE

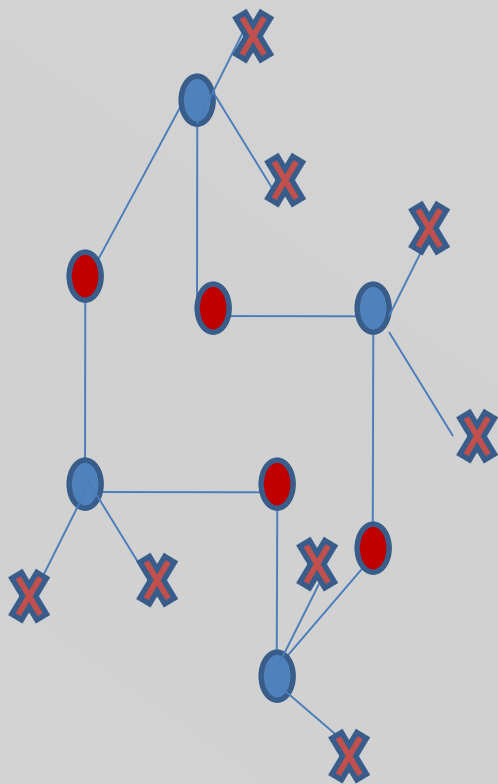
The halide trimers consist of planar six membered rings. The bond angles are consistent with **SP<sup>2</sup> hybridization of the nitrogen and SP<sup>3</sup> hybridization of the phosphorous**. Two of the **SP<sup>2</sup> orbital** of nitrogen, containing one electron each, are used for 's' bonding and the third contains a lone pair of electron. This leaves one electron for the unhybridised PZ orbital. The four **SP<sup>3</sup> hybrid orbital** (containing four electrons) of phosphorous are used for 's' bonding leaving a fifth electron to occupy a 'd' orbital. Resonance structures can be drawn like benzene ring indicating aromaticity . The Planarity of the ring, the equal P-N bond distances and the shortness of the P-N bonds, and the stability of the compounds suggest delocalisation. All phosphazenes are not planar.



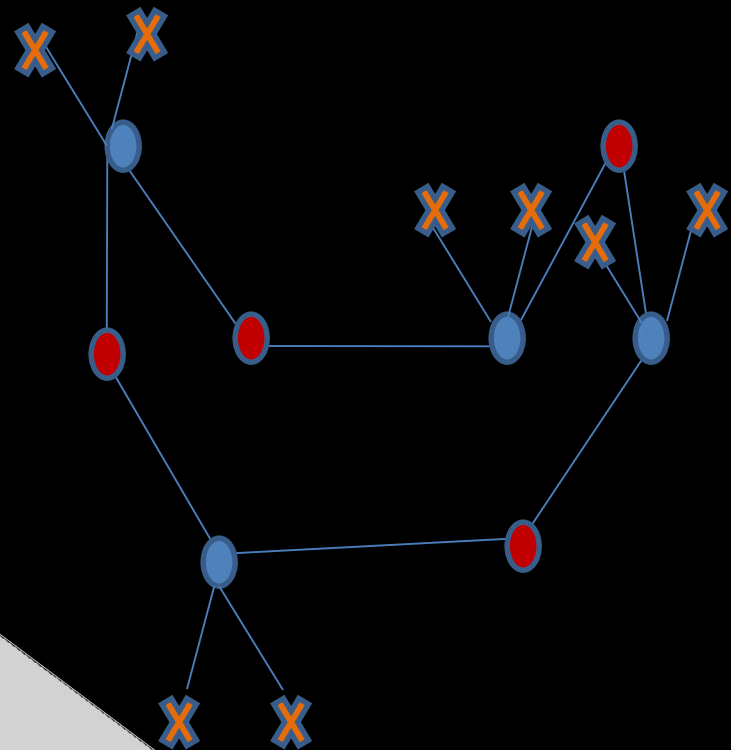
# PHOSPHAZENE POLYMERS

Phosphazenes can be polymerized. Their polymers have advantages over carbon-based polymers, polyolefin's and polyesters. By varying the nature of the side chain 'R' various elastomers, Plastics, films and fibers have been obtained. They are flexible at low temperatures and water and fire resistant. Some R groups like R=CH<sub>2</sub>CF<sub>3</sub> are water repellent and do not interact with living cells and promise to be useful in fabrications of artificial blood vessels and prosthetic devices.





# TETRAMER



 Nitrogen  
...

 Phosphorus



**T H A N K Y O U**

T H A N K Y O U