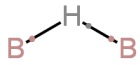
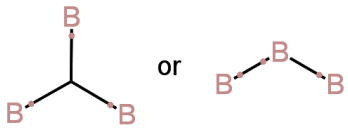
STYX rule

The **styx rule**, also known as **Lipscomb's styx rule**, can be used to calculate the structures of boranes. It was developed by William Lipscomb in 1954. The rule defines boranes to have four types of bonds besides the terminal B-H bonds:

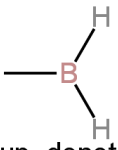


B-H-B bonds, denoted as s



B-B-B bonds, denoted as t

B-B bonds, denoted as y



BH2 group, denoted as x

Where:

- B-H-B bonds are 3c-2e bonds, taking up three orbitals and two valence electrons.
- B-B-B bonds are 3c-2e bonds, taking up three orbitals and two valence electrons.
- B-B bonds are 2c-2e bonds, taking up two orbitals and two valence electrons.
- The -BH_2 group consists of an extra B-H bond formed on the BH units and is thus considered to take up two orbitals and two valence electrons.

The bonding structure deduced by the styx rule doesn't reflect the true symmetry of boranes

❖***STYX NUMBERS:***

The Styx rules were given by Lipscomb to determine what type of bonds are possible for a given formula of boron hydride. It is assumed that one B–H bond is present for each boron atom.

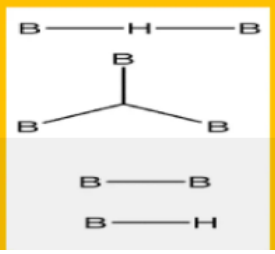
i. The centre 3c-2e, B–H–B bond is labelled as ‘S’

ii. Closed or open 3c-2e B–B–B bond is labelled as ‘T’

iii. The 2c-2e B–B bond is labelled as ‘Y’

iv The B–H terminal bond (2c-2e) labelled as ‘X’ or simply we can say number of BH_2units

The B–B–B bond may be open or closed but it is the closed bonds that are always considered.



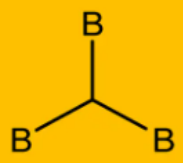
B

H

B_2H_6

Total valence electrons two B and six H = 12
STYX number is 2002

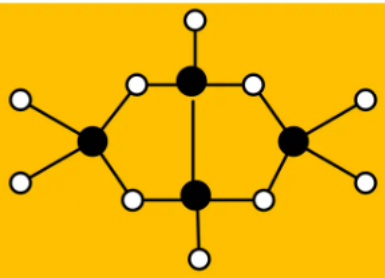
B—H—B (Bridging) Electrons used = 2x2 = 4; S = 2



T = 0

B—B Y = 0

B—H Four terminal BH bonds, electrons used = 4x2=8
Extra BH X = 2



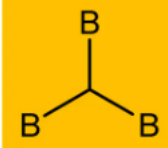
B

H

B_4H_{10}

Total valence electrons; four B and ten H, total = 12 + 10 = 22
STYX number is 4012

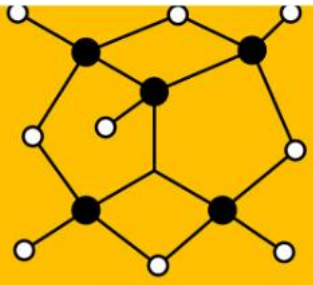
B—H—B (Bridging) Electrons used = 4x2= 8; S = 4



T = 0

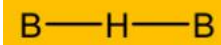
B—B One B-B bond; electrons used = 2; Y = 1

B—H Six terminal BH bonds, electrons used = 6x2 = 12; X = 2



B_5H_9

Total valence electrons; five B and nine H, total = 15 + 9 = 24
STYX number is 4120



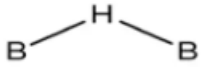
(Bridging) Electrons used = 4x2 = 8; S = 4

One closed B-B-B bond; 3c-2e; electrons used = 2; T = 1

Two B-B bond; 2c-2e; electrons used = 4; Y = 2

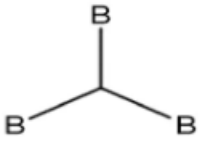
Five B-H bonds, electrons used = 5x2 = 10; X = 0

2c-2e boron-hydrogen bond



3c-2e bridging boron-hydrogen-boron bond

2c-2e boron-boron bond



3c-2e closed boron bond

3c-2e open B-B-B bond

Various types of bonds found in boranes.

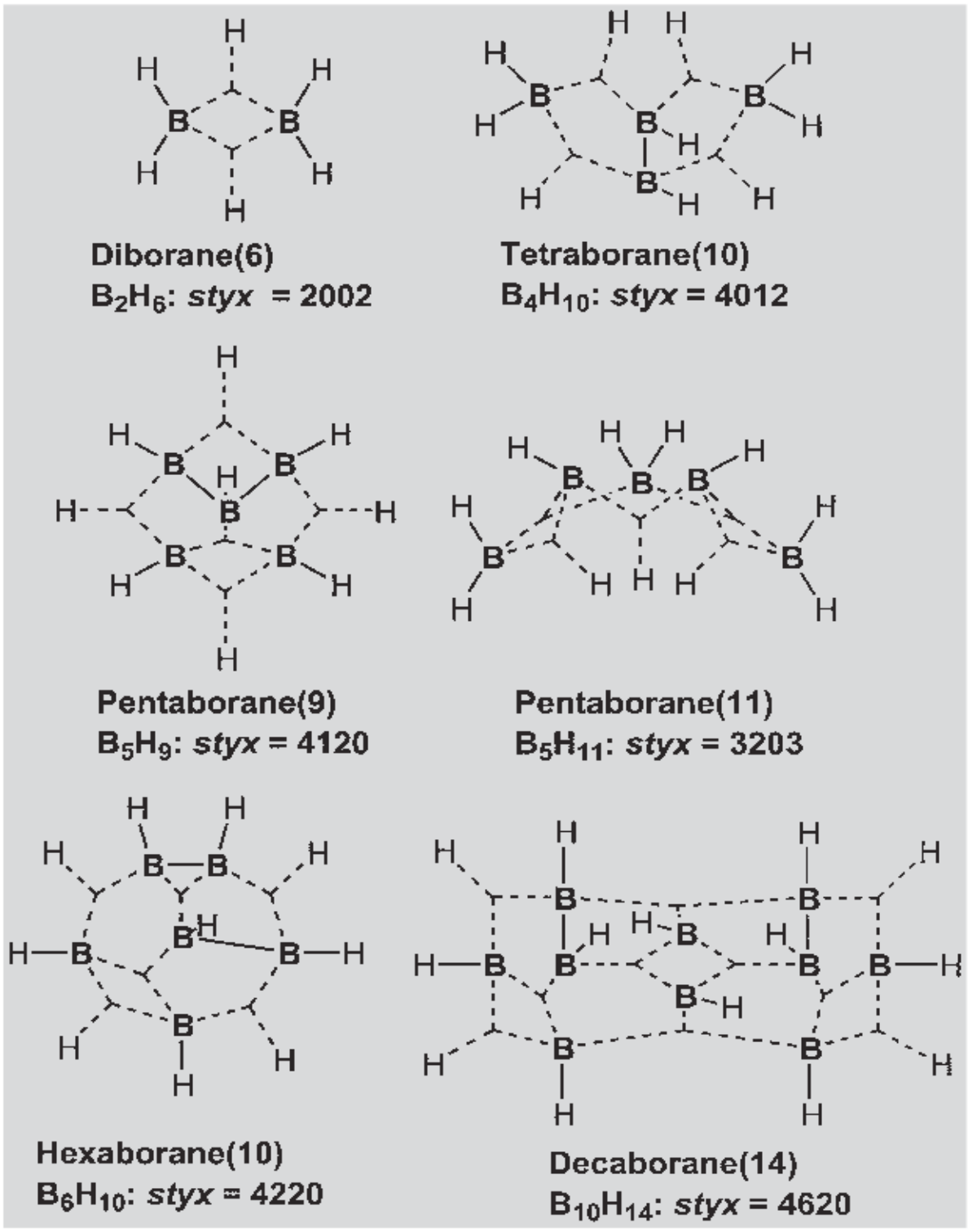


Fig. 1.1 The original neutral boron hydrides (boranes)